Resilience in the pandemic: Remote learning on the fly

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Abstract
This study examined students’ learning adjustments in an introductory statistics class in response to the unexpected challenge presented by the COVID-19 pandemic. Results show significant correlations in grades, page views, and on-time assignment submissions (OTAS) suggesting that the in-person and online learning modalities were comparable. The distributions of student learning activities were narrowly clustered around the means with smaller standard deviations recorded during the online sessions. Grades were positively correlated with OTAS for the in-person classes. For online classes using synchronous screen sharing, grades were positively associated with attendance; however, they were negatively influenced by the numbers of page views in the learning management system. The relations between attendance and achievement might be influenced by the complexity of content material. Students benefited more from attending classes in technical topics such as inferential statistics compared to descriptive statistics. It appears that participating in synchronous classes was a more effective means of learning inferential statistics than merely reviewing the instructor’s notes. In contrast, no correlation between grades and attendance was observed for in-person learning sessions covering descriptive statistics. There were no differences in learning adjustments between male and female students and both showed substantial resilience in adapting to the changes. Students unanimously looked forward to returning to campus. This study suggests it is the students’ individual learning approaches and behaviors that have a greater impact on their learning outcomes than the modality in which they are taught. Course designs and assignment formats might be factors that influenced students’ attendance and OTAS.

Keywords
assignment completion, attendance, instructor-provided notes, online learning, open educational resources

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Introduction

The spring 2020 semester began like other years with students and faculty returning from the holiday break. Then came the news of the COVID-19 outbreak in China. In our globally interconnected world, it was inevitable the contagion eventually spread to the United States. Governors responded declaring emergencies and placing entire states under lockdowns, while closing schools and nonessential businesses. Universities across the country began repatriating students studying abroad and following spring break moved from an in-person to an online learning environment. The moves were an emergency response to the pandemic to keep the semester continuing so that students could progress towards earning their credits and degrees. Many institutions have adopted terms such as “emergency remote instruction” to describe their distance learning programs. Everybody was blind-sided by this since nobody anticipated a global pandemic. This study examined the learning adjustments and outcomes of a small introductory statistics class resulting from the unforeseen transition between two learning modalities approximately half-way through a semester.

Literature review

An unanticipated challenge

The sudden shift from an in-person to an online learning modality has been markedly disruptive, necessitating substantial changes in academic behaviors and practices of both instructors and students. A survey of higher education’s immediate priorities related to the COVID-19 pandemic was conducted between April 6th and April 19th by Bay View Analytic (2020). The results revealed that 90% of institutions transitioned some or all of their classes online and 97% of those reported that faculty with no previous online teaching experience were required to move classes online. At the faculty level, 56% reported using teaching methods they had never used before, and approximately 80% of the faculty used synchronous media such as Zoom in online classes. Whereas 48% of the faculty reduced the amount of work they expected students to complete, 32% lowered their expectations for the quality of student work, and 46% dropped some assignments or exams (Johnson et al., 2020).

Outcomes of online learning

According to the Digest of Education Statistics: 2018 (2019), a total of 35.3% of the college students took distance education course(s) comprised of 18.7% taking at least one online course and 16.6% exclusively attending distance education course(s) (Digest of Education Statistics: 2018 (Table 311.15); U.S. Department of Education(2019)). Several meta-analytic studies examining online learning in higher education have concluded positive learning outcomes compared to those for in-person learning. Brinson (2015) illustrated that student learning achievement was equal or higher in non-traditional lab (i.e. virtual) to traditional lab (i.e. hands-on) settings across all learning outcome categories, including knowledge and understanding, practical skills, perception, analytical skills, and scientific communication. However, the majority of studies focused on outcomes related to content knowledge while scientific inquiry skills were the least assessed learning objectives. Shachar and Neumann (2010) revealed that an upward trend of overall effect size was observed for the 2000-2009 decade after a decline in the second half of the 1990s. This was despite the fact that achievement for online students was higher than for their in-person counterparts in various subject areas. The United States Department of U.S. Department of Education (2010) confirmed that on
average, students in online learning conditions performed better than those receiving in-person instruction. Means et al. (2013) found modestly large mean effect sizes for learning outcomes (e.g. grades, scores on midterm/final exams) for students in online learning compared to traditional in-person classes in studies published between 1996 and 2008. However, effect sizes were larger for blended than fully online courses. In addition, studies in various fields detected no differences in student performances between in-person and online courses in physical sciences (Nennig et al., 2020), an undergraduate C programming course (Rorrer and Bahamón, 2019), a public relations course (McKeever, 2019), and an engineering drawing course (Wang et al., 2019). Moreover, approximately three quarters of academic leaders rated learning outcome achievement in online education as equal to or better than in-person instruction (Allen and Seaman, 2015). Likewise, 85% of students who had previously enrolled in both in-person and online courses reported their online experience was the same or better than the classroom course (Magda and Aslanian, 2018).

In contrast, Faulconer et al. (2018) observed the highest withdrawal rates in asynchronous introductory physics classes and no withdrawals for the in-person courses. Students with low grade point averages (GPAs) performed better in the in-person classes, whereas those with high GPAs performed better in the blended settings and no significant difference was detected for those with mid-range GPAs. The findings suggest that prior academic achievement played an important role in online learning (Asarta and Schmidt, 2017). Some online students might be more motivated to become self-disciplined learners, while those who remain unengaged could be a challenge as their activities cannot be monitored in class (Kim et al., 2021; Waschull, 2005).

Using data from DeVry University, Bettinger et al. (2015) found that on average students in online courses performed not on a par with those taking in-person courses and also showed more variable grade dispersion. This was despite the fact that individual instructors explained less of the variation in student performance in online settings than in-person classes. The results suggest there are differences in students’ ability to productively utilize online offerings to reduce within-course variation in outcomes which are not due to variations in instructor performance. Furthermore, taking a course online is associated with reduced student learning in future courses and persistence in college (Bettinger et al., 2015, 2017). However, one positive note is that females and older students were more likely to engage in student interactions (Bettinger et al., 2016).

Page views in LMS

The numbers of page views in the learning management system (LMS) recorded frequency of access overall (e.g. homework assignments, online quizzes, and examinations) as well as frequency of access to course materials (e.g. the instructor-provided PowerPoint notes, lecture videos, and class worksheets). Most of the extant research focused on the benefits and drawbacks of the instructor-provided PowerPoint notes. In online courses, significantly positive relations have been observed between the students’ course grades and their frequency of accessing course materials (Cerezo et al., 2016; Li and Tsai, 2017; Nelson, 2015; You, 2016). Student benefits linked to instruction with PowerPoint notes include: better organization and focus on important information to sustain attention, increased comprehension of the material, and enhanced exam preparation (Hill et al., 2012). In addition, use of PowerPoint slides by instructors was considered more effective by students (Zdaniuk et al., 2019). Grabe (2005) found some students use notes as an alternative to class attendance and note users outperformed those who did not use notes on examinations. Most notes were viewed during the class time concurrent with the delivery of the lectures rather than the time immediately before examinations (Grabe, 2005; Grabe et al., 2005). Moreover, the instructor’s use of different technologies (e.g. PowerPoint slides) had a small positive influence in large lecture
classes (Dean et al., 2017). Babb and Ross (2009) noted that the availability of lecture slides to students before classes may lead to better overall attendance and participation, however, examination performance is determined by more than the mere availability of lecture slides.

In contrast, researchers have also demonstrated PowerPoint slides impede learning and that traditional (chalk and talk) instruction is better. In several studies, students who received traditional instruction had higher course grades than students who received PowerPoint instruction. Kim (2018) reported that accessibility to slides was a significantly negative predictor for students’ learning, while students often opt not to take notes in online courses (e.g. Morehead et al., 2019). Nevertheless, Worthington and Levasseur (2015) maintained that the instructor-provided slides had no impact on class attendance and an adverse impact on course performance. Zdaniuk et al. (2019) found no evidence to suggest that the provision of PowerPoint slides has unconditional pedagogical value. Male students with high self-efficacy performed significantly better when they were provided with PowerPoint notes. In contrast, female students with low self-efficacy performed significantly worse when notes were provided. However, a meta-analysis by Baker et al. (2018) concluded that PowerPoint slides had no effect on students’ cognitive learning.

Chang (2020) reasoned that students’ usage of the instructor-provided notes might be influenced by the availability of access to the required textbooks. When the instructor adopted open education resources (OER), the numbers of page views recorded in LMS were significantly lower than those in the traditional textbook class. In addition, the standard deviation of the number of page views was much larger in the traditional textbook class which might suggest there are differences for learning approaches and behaviors between those who have access to the textbook and those who did not. Those who did not utilize the required textbooks or make use of the course reserves at the library apparently depended exclusively on the instructor’s PowerPoint notes in the LMS. Whether the instructor-provided PowerPoint notes resulted in diminished student focus and motivation to study and increased the use of unproductive “short cuts” remains undetermined.

**Attendance and achievement**

Research has consistently confirmed the positive relation between attendance and grades in the in-person courses (e.g. Chennevile and Jordan, 2008; Marburger, 2006; Moores et al., 2019; Naganawa et al., 2020). A meta-analysis study reveals that attendance has strong relationships with both class grades and GPAs and is a better predictor of college grades than any other known predictors of academic performance, such as standardized admissions tests (e.g. SAT), high school GPA, study habits, and study skills (Credé et al., 2010). Nieuwoudt (2020) asserts that it is important for students to attend class, but it does not necessarily make a difference whether students attend synchronously or watch the recordings of the asynchronous virtual classes. A significant relationship was found between academic success and the number of hours students participated in and interacted with the online learning system. Murphy and Stewart (2015) suggest weaker performing students may benefit from self-selected watching of advanced level recorded lectures which can help narrow the gap between themselves and those who were initially higher performing and more engaged. Furthermore, Latif and Miles (2013) found that both class attendance and completion of online assignments have a significant positive impact on grades, and further suggest class attendance and online assignments have independent effects on grades.

Many students considered the remote access and real time discussions as positive aspects to their learning experience in online courses blended with synchronous and asynchronous learning modalities. Despite challenges such as work schedules, internet connections, and other technological issues, a synchronous remote learning modality may benefit and provide an alternative to
students who would not otherwise be able to attend a course. Vale et al. (2020) maintained that attendance is a critical factor of student grades in a remote or in-person course.

The instructor’s course design may be one of the crucial factors that need to be taken into consideration when examining the influence of students’ engagement (e.g. attendance and on-time assignment submissions). For instance, Evans et al. (2021) demonstrated that when instructors in a prerequisite mathematics course incorporated frequent low stakes low difficulty pre-lecture online quizzes, observed benefits included: increased attendance, student engagement, and improved grades. The availability of the textbook could have a role in the intricate relations between attendance, On-time assignment submissions (OTAS), and final grades. In an in-person class, using attendance as the mediator to examine the relations between OTAS rates and grades, Chang (2020) found much stronger total effect in the OER class than that of the traditional textbook class. Specifically, attendance contributed strong indirect effects to the final grades in the OER class. However, whether students’ learning approaches and behaviors in an online learning modality would follow the same patterns as those in in-person classes remain unknown. Furthermore, the students’ characteristics might be determinant factors that motivate them to complete and submit the assignments on time and attend class regularly. These students might have higher levels of conscientiousness, engagement, and self-regulation skills. Note that attendance encompasses more than mere physical presence in class but also attention to the lectures. The relations between attendance and achievement might also be influenced by the level of complexity of the content material. For instance, students might benefit more from attending class in technical topics such as inferential statistics compared to descriptive statistics.

**OTAS and grades**

You (2015) reported that approximately 70% of college students identified themselves as procrastinators who often submitted their assignments late and missed classes which might result in lower grades. Inconsistency assignment submission patterns could also be a sign of at-risk students and increased rate of course withdrawals (Falkner and Falkner, 2012). In addition, studies detected a negative correlation between student postponement and academic performance (Akram, et al., 2019; Kim and Seo, 2015; Latif and Miles, 2013; Nordby et al., 2017). Yilmaz (2017) noted that students delayed assignment submissions more in an online learning environment compared to their traditional in-person counterparts. Research has shown that the online learning environment demands a high level of personal discipline from students due to its self-governing nature (Brierton et al., 2016; Garrison, 2003; Klingsieck et al., 2012). Likewise, self-regulation is a critical trait in effective learners, and less diligent students are lacking engagement possibly due to insufficient self-regulation (You, 2015). Positive time management awareness promotes timely assignment submissions (Yamada et al., 2016) and online students struggled with deadlines and time management more than those in in-person learning environments (Keramidas, 2012). Furthermore, procrastinators perform worse than those who are more punctual in an online learning modality, and the negative relation between postponement and achievement in online learning was stronger than that in the traditional in-person learning environment (You, 2015).

In an on-campus learning environment, using OTAS as a mediator to examine the relations between attendance and final grades, Chang (2020) detected strong direct effect from attendance to the final grades and limited effect to the OTAS in the OER class. In contrast, attendance contributed a strong effect to OTAS but a weak effect to the final grades in the traditional textbook class. The results suggest that in the traditional textbook class, students’ final grades were primarily determined by the OTAS and the OTAS were enhanced by attendance. In comparison, students’ final
grades were strongly determined by their attendance but with a limited effect from OTAS in the OER class. More studies are warranted to examine whether students learning strategies and behaviors in an online learning modality would follow the same patterns of those in the on-campus learning environment.

The characteristics of an assignment might be possible factors explaining why college students often procrastinate. For example, task aversion (e.g. students’ perceptions of boredom associated with the task) is a strong predictor for postponement of assignments. In addition, the levels of difficulty (too challenging) and easiness (not challenging enough) are both associated with assignment deferral (Nordby et al., 2017). This might be the primary reason why students tend to defer statistics assignments with their tedious formulas and computations. Instructors of statistics can create assignments that lay out step-by-step computation templates incorporating visually facilitated graphs to help students grasp the underlying logic of concepts and encourage them to complete and submit assignments on time.

**The present study**

This study examined the abrupt transition in respect to:

1. compatibility of in-person and online learning modalities in (a) grades, (b) the numbers of page views on LMS, (c) OTAS, and (d) attendance;
2. learning adjustments associated with: (a) equipment availability, (b) prior online learning experience, (c) adjustments to the online learning environment, and (d) textbook utilization;
3. living arrangements including: (a) accommodations, (b) suitability (e.g. quietness/distractions) when attending lectures, (c) housing stability; and (d) physical wellness;
4. readiness of returning to the campus.

**Method**

**Participants**

A small introductory statistics class with 25 students at a large, urban, publicly funded research I institution in the mid-Atlantic United States were included in this study. Most students were sophomore year psychology majors. The classes were comprised of 50-min lectures by the instructor twice a week and one recitation at the computer lab using Statistical Package for the Social Sciences (SPSS) to gain hands-on experience testing hypotheses and generating graphs and tables. The course counted for three credits and is required for psychology majors. Students were encouraged to bring their laptops to class for in-class assignments while those who did not have or did not wish to bring laptops were advised to borrow from the library. All assignments included online examinations and quizzes (multiple-choice items), homework assignments (short-answer questions), in-class group activities and discussions, step-by-step computation worksheets containing visually facilitated graphs, and in-class “bite-sized” interactive learning checks on LMS. Throughout the semester there were a total of 65 assignments given for 710 possible points. All assignments were interactive and created by the instructor and students responded to all items posted on the LMS. All assignments were graded, and real-time results and feedback were provided. The instructor did not dilute or reduce expectations regarding the quantity or quality of student work after moving to the online learning modality. There was no reduction in the amount of assignments given nor were any exams or quizzes dropped. In fact, the topics for the online portion of classes
were inferential and more complex than the descriptive statistics covered during the in-person classes earlier in the semester.

An OER from the LibreTexts, considered by the instructor to contain up-to-date, clear, and well-organized content, was adopted and a pdf file of the text was posted in the LMS assuring textbook availability for every student. Students could download and review it at any time of their choosing. Attendance was recorded for every meeting throughout the semester. The instructor developed many computation worksheets, with facilitated graphs and formula templates, to help students visually grasp the logic behind the concepts and tackle intimidating computations with the goal of assisting students to complete and submit assignments on time.

Classes between January 14th and March 13th were in a traditional class learning setting and moved to online between March 16th and April 27th due to lockdown ordered by the state government in response to the COVID-19 pandemic. The instructor had never taught an online course prior to this sudden change and forthrightly informed students about this fact, despite over the years having attended many workshops addressing online teaching offered by the institution’s Center for the Advancement of Teaching. Likewise, many students had no prior online learning experience, and the instructor demonstrated a practice session on Zoom with students on the last day of in-person class (i.e. March 13th) to familiarize them with the application.

The instructor surveyed the class about the availability of a functional computer and internet accessibility to attend lectures at the onset of online learning. In addition, the instructor contacted the university computer center and local charities for possible free computers for students. After 2 weeks of online lessons, the instructor administered a nontraceable Google Forms survey on student learning adjustments and living arrangements. Note that there were several international students enrolled in this class and one of the University dorms was open to all international students who decided to stay in the country. The instructor attempted to make the transition as smooth as possible for students by exhibiting empathy and compassion.

All lectures and discussions were synchronous, and students were encouraged to review the recordings when needed. From the start of the semester, the instructor had been using online in-class “bite-size” learning checks and activities, homework assignments, quizzes, and examinations which might have minimized disruptions stemming from the shift in learning modality. Since none of the students had SPSS loaded onto their computers, the instructor switched to the open statistical software Jamovi for the lab sessions. The instructor had developed lab assignment worksheets and shared screens with the students so that students could easily follow the commands.

All data were aggregated with no individual identification of students to ensure confidentiality. Data downloaded from LMS included grades, the numbers of page views, OTAS, and attendance, and data related to learning adjustments and living arrangements were downloaded from Google Forms. Data included in this study were from January 13 through 1 May 2020 (final exam date). The statistical software SPSS (IBM, 2020) was employed to analyze the data.

Results

Descriptive statistics and a correlation matrix of grades and page views, OTAS, and attendance of the in-person and online learning environments are displayed in Figure 1 and Table 1. There were significant associations between in-person and online learning environments in three categories, namely grades ($r = .93$, $p < .001$), page views ($r = .83$, $p < .001$), and OTAS ($r = .58$, $p = .005$),
indicating the two learning modalities were comparable. Three of four categories in research question 1 were supported, except attendance ($p = .346$).

Attending synchronous screen sharing classes had a significantly positive influence on grades ($r = .53$, $p = .011$) in the online learning environment covering topics in inferential statistics which are generally considered more challenging than those of descriptive statistics taught during the in-person portion of the semester. The frequency of viewing pages in the LMS negatively impacted students’ grades ($r = -0.53$, $p = .012$) during the lockdown. For the in-person portion of classes primarily covering descriptive statistics, a significantly positive link between grades and OTAS ($r = .42$, $p = .049$) was observed.

The repeated-measures t-test results show that the frequencies of page views in the LMS were significantly lower in the online classes ($M = 596$, $SD = 295$) than those during the in-person sessions ($M = 1214$, $SD = 547$), $[t(24) = 8.39, p < .001, d = 1.79]$. The rates of OTAS during the lockdown ($M = 94.73$, $SD = 4.34$) were significantly higher than those for the in-person sessions ($M = 89.62$, $SD = 7.32$), $[t(24) = 4.02, p = .001, d = 0.86]$. Note that students had higher OTAS rates

### Table 1. Descriptive statistics and correlation matrix of grades and page views, on-time assignment submissions, and attendance in In-person and online learning environments.

|            | IGrades | IViews | IOtas | IAttend | OGrades | OViews | OOtas | OAttend |
|------------|---------|--------|-------|---------|---------|--------|-------|---------|
| IGrades    | —       |        |       |         |         |        |       |         |
| IViews     | -.36    | —      |       |         |         |        |       |         |
| IOtas      | .42*    | -.07   | —     |         |         |        |       |         |
| IAttend    | .22     | .10    | .38   | —       |         |        |       |         |
| OGrades    | .93***  | -.41   | .39   | .22     | —       |        |       |         |
| OVIEWS     | -.53*   | .83*** | -.25  | -.01    | -.53*   | —       |       |         |
| OOtas      | .07     | .08    | .58** | .17     | .10     | -.14   | —     |         |
| OAttend    | .40     | -.31   | .32   | .21     | .53*    | -.19   | .11   | —       |
| M          | 84.80   | 1214   | 89.62 | 97.04   | 85.20   | 596    | 94.73 | 98.18   |
| SD         | 9.23    | 547    | 7.32  | 3.65    | 8.31    | 295    | 4.34  | 4.77    |

Note: IGrades = In-Person Grades; IViews = In-Person Page Views; IOtas = In-Person On-Time Assignment Submissions; IAttend = In-Person Attendance; OGrades = Online Grades; OViews = Online Page Views; OOtas = Online On-Time Assignment Submissions; OAttend = Online Attendance; M = mean; SD = standard deviation; * $p < .05$, *** $p < .001$. 

![Figure 1. Descriptive statistics of page views, on-time assignment submissions, attendance, and final grades for two learning modes.](image_url)
and a narrower standard deviation in online learning than those in the in-person class. Overall, there were no differences observed in final grades, page views, OTAS, and attendance between male and female students throughout the semester regardless of the learning modality.

A multiple regression analysis was conducted to evaluate how well page views, OTAS, and attendance predicted grades in the in-person sessions. The linear combination of these three predictors was strongly related to grades ($R^2 = .30$, $F((3,21) = 2.58, \ p = .086)$. The multiple correlation coefficient was .55, indicating that approximately 30% of the variance of the grades can be accounted for by the linear combination of these three variables. In addition, a multiple regression analysis was employed to test if page views, OTAS, and attendance significantly predicted students’ final grades in the online sessions. The results of the regression indicated these three predictors explained approximately 46.7% of the variance in grades which can be accounted for by the linear combination of these three variables ($R^2 = .47$, $F(3, 21) = 5.26, \ p = .009$). It was found that attendance significantly predicted grades ($\beta = .45, \ p = .021$), as did page views ($\beta = -.44, \ p = .022$). Results of multiple regression are exhibited in Table 2.

### Learning adjustments

Results of survey items related to learning adjustments are exhibited in Figure 2(a). Approximately 38% of the students had prior online learning experience including during K through 12, and the majority of students (96%) had suitable equipment (both computer availability and internet accessibility) for distance learning. Approximately 87% of students reported that they adjusted to the learning modality “fairly well” to “very well” by the end of the second week of the transition, and the number increased to 96% by the end of the semester.

### Living arrangements

Results of survey items related to living arrangements are displayed in Figure 2(b). All students from the United States moved back home to be with their families and all international students (approximately 12% of the class) stayed at the same place as before the lockdown. All responded that their family members or roommate(s) understood that they needed periods of quiet time and space to attend online lectures, and 88% of students considered their living environments as suitable

| Table 2. Results of the Multiple Regression Analyses. |
|------------------------------------------------------|
| **In-person**                                        |
| Overall model                                        | 2.58 | .086 | .30 |
| Page views                                           | −1.74 | .099 | −.35 |
| OTAS                                                 | 1.65 | .116 | .35 |
| Attendance                                           | .55  | .590 | .12 |
| **Online**                                           |
| Overall model                                        | 5.26 | .009 | .47 |
| Attendance                                           | 2.53 | .021 | .45 |
| Page views                                           | −2.51 | .022 | −.44 |
| OTAS                                                 | −.06 | .953 | −.01 |
for learning. Approximately 96% of the students reported that they had adjusted to the living environment “fairly well” to “very well,” and all responded their living arrangements were stable. None of the students responded that their study environment was negatively affected due to family member(s) having been infected by coronavirus. Students almost unanimously (96%) looked forward to returning to campus in the fall. Overall, no differences in learning adjustments or living arrangements between male and female students were detected.

**Textbook utilization**

Approximately 70% of students had utilized their OER textbook for more than half of the assigned reading chapters while on campus. This decreased slightly to 67% during the online sessions even though the OER textbook was available to every student. Students did not utilize the textbook more during the lockdown, despite the lack of potentially distracting non-class related social events, and the fact that many had lost their part-time jobs. However, there was no correlation found between the self-reported number of chapters reviewed and grades.

**Discussion**

The comparable outcomes of the two instruction modes suggest that students showed resilience during the pandemic and continued to progress their learning through the rest of the semester. During the lockdown, students had higher grades, attendance, and OTAS and lower numbers of page views but all with smaller standard deviations, indicating their learning activities narrowly clustered around the means. These results might have been owing to less social distractions during the lockdown. It appeared to the instructor, that for this particular class, a stronger sense of collaboration and enhanced interaction was more prevalent during the online sessions perhaps prompted by the “in the same boat” mentality. These satisfactory outcomes are supported by students’ responses on the survey indicating they adjusted well to the new learning and living arrangements and maintained physical and mental wellness. Nevertheless, it is apparent from the survey that students looked forward to returning to campus in the fall and that they missed the traditional college experience including close social interactions with their friends.

These results could also suggest that the instructor adapted equally well to the novel teaching mode. In addition, the instructor had frequently endeavored to make the transition as smooth as possible for students by expressing empathy and compassion and making sure that students had the equipment needed for the remote learning. The instructor also asked students to enable their videos so that they might see each other and feel a greater sense of community and connection to their
peers. Similarly, during the sessions, positive student feedback strengthened the instructor’s resolve to continue to provide them the most effective and valuable online teaching experience despite being a novice in online teaching.

The screen sharing, by enhancing hands-on experience during the synchronous instructions and lab assignments, might have contributed to desirable outcomes, such as higher grades, attendance, and OTAS. In addition, the number of page views recorded in the LMS was lower and had a negative association with grades which was not observed during the in-person sessions. The instructor created worksheets incorporating graphs and step-by-step computation templates to teach more complex topics such as independent-samples $t$-test which might have helped students better grasp the logic behind the concepts. In addition, these activities and assignments might have enhanced attendance, on-time assignment submissions, and grades. It also appears that students benefit more by attending class when learning technical material with complex formulas. That said, it suggests that attendance is a factor that influences the comprehension of more complex concepts. One valuable lesson the instructor has taken away from the online teaching experience is the advantages of screen sharing. It is effective and beneficial for student learning and this feature will be adopted for future classes when returning to an in-person learning environment. Sharing screens with students might have also strengthened the benefit of attendance when learning technical content with multi-step computation formulas.

No correlation between the self-reported numbers of assigned chapters studied and grades was detected suggesting that some students might have provided socially desirable responses to the survey question. Given that, some students might have been overly dependent on the instructor’s PowerPoint notes posted in the LMS (i.e. taking shortcuts) to get by during the lockdown despite the fact they did not have other social events to attend. Whether this was due to students prematurely falling into a summer vacation mindset after they moved back home remains unknown. Comprehensive studies of how student’s learning approaches and behaviors (e.g. dependency on the instructor’s notes instead of utilizing OER textbooks) affect their learning are imperative if education institutions really want to improve teaching and students’ learning outcomes. Most critically, initiatives to improve teaching should be based on understanding students’ various learning approaches and behaviors and how they impact their academic success.

**Limitations**

Findings from this study provide valuable information for undergraduate programs by identifying differential learning outcomes that students experienced between in-person and online course instructions. No significant differences were observed between the two course modalities. While this is encouraging, further data collection and analyses are needed. With a larger sample size, more advanced analyses can be performed with sufficient power to test hypotheses regarding the multifaceted influences of students’ learning patterns and their impacts. The results can be utilized to inform instructors as to how students learn and to better accommodate their educational needs. Furthermore, future online course designs should follow the guidelines of the Interregional Guidelines for the Evaluation of Distance Education developed by the Council of Regional Accrediting Commissions (C-RAC) (2011).

**Conclusion**

It is most unfortunate that the education community and society at large had to deal with the upheaval associated with the COVID-19 pandemic and lockdowns not to mention the illnesses and
deaths suffered by its most severely impacted victims. Nobody anticipated these drastic challenges and changes. Despite its small sample size, results from this class were consistent with many existing studies on online learning such as the comparable performance between the in-person and online learning modalities. The outcomes of online learning were on a par with those for the in-person learning environment. When learning more complicated topics with multi-step computations, such as in inferential statistics, students will likely require more than mere views of the notes in the LMS to comprehend the lessons. In-class worksheets and homework assignments with visually facilitated graphs and formula templates might encourage attendance and on-time assignment submissions for students in both in-person and online learning modalities. It appears that college students’ learning outcomes have been impacted by their learning approaches and behaviors as well as the instructor’s course designs and pedagogy more than the learning modality.

Synchronous screen sharing seems to be an effective way to teach statistics, particularly when requiring multiple steps of calculations to test a hypothesis such as independent-samples t-test. Synchronous meetings might have kept students running normal schedules as if they were still attending in-person classes. Online learning also requires a higher commitment to self-direction. In addition, students had reported having reviewed the previously recorded lectures in order to clarify some concepts or to view any classes they had missed. It should be emphasized that the students in this study had already been exposed to real-time online assignments and examinations prior to the switch to the online learning environment which likely helped ease the transition. One further potential complicating factor that must be considered is that, due to the pandemic, a number of students were laid-off from their part-time jobs or had their hours reduced. This may have afforded them additional time to devote to their studies. Despite the challenges presented, the instructor did not reduce the quantity or difficulty of assignments given and most importantly, did not lower the high performance expectations from students. It appears that the students had shown substantial resilience during the pandemic to complete the course under unprecedented circumstances. In summary, students and instructors across the country moved to the online learning environment with extremely short notice; nevertheless, in at least this one class, results would appear to show that students and the instructor adapted well, supported each other, and exhibited strong resilience. Continuing study of the situation is warranted as the coronavirus pandemic appears to be an evolving and persistent challenge which may be with us for a long time to come even with the introduction of safe and effective vaccines. The education community must continue to adapt and advance innovative strategies including course designs and pedagogies that best serve our students under these unprecedented circumstances. While the comparisons between in-person and online learning will likely continue, it appears that the students’ individual learning approaches and behaviors rather than the learning modality are what really affect their educational outcomes.

Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

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