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Charting New Pedagogical Paths: Insights and Strategies from Teaching Business Statistics During the Covid-19 Pandemic

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Abstract

The COVID-19 pandemic has had a transformative effect on higher education, altering both traditional teaching methods and the working dynamics of faculty—higher education's knowledge workers. This study empirically examines the impact of different instructional techniques and teaching modalities that were rapidly adopted in response to pandemic-related disruptions. Our focus centers on the experiences of faculty and students within our educational institution, providing insight into the diverse strategies employed by educators as they navigated the pandemic's progression, from initial outbreak to its current status as an endemic concern.

Our research highlights significant differences in student outcomes across four critical semesters affected by the pandemic, shedding light on how variations in teaching modalities influenced academic performance. Specifically, we observed that students participating in face-to-face instruction faced unique challenges when compared to those engaged in online learning. During the fall 2020 semester, traditional face-to-face students encountered particularly severe disruptions, resulting in distinct disparities in educational outcomes that were less prominent in other semesters.

To adapt, faculty implemented a range of interventions aimed at supporting student learning and mitigating the effects of ongoing disruptions. These included innovations in online assessment approaches and a marked increase in the frequency and quality of instructor-student interactions. Our findings suggest that some of these interventions, notably those that fostered meaningful online engagement, may become enduring features of higher education. In contrast, certain pandemic-specific accommodations, such as highly flexible attendance policies and the expanded availability of online courses, may not remain widely implemented as institutions transition into the postpandemic era.

In sum, this study contributes to a deeper understanding of the complex educational and instructional shifts prompted by COVID-19. By focusing on the lived experiences and adaptive strategies of faculty and students, our research provides valuable insights into which practices have effectively supported student learning and well-being, and which may only serve as temporary measures. This knowledge is crucial for informing



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future instructional policies, guiding the development of resilient educational frameworks that can better withstand similar disruptions in the future.

Introduction

The teaching of technical and analytical courses, like statistics, in collegiate settings has been forever altered in the post-COVID-19 world. This includes changes in content delivery methodology, utilization of various instructional techniques, and differences in the way instructors interact and build relationships with students in the classroom. While these changes were appropriate responses to the emergent situations while dealing with the pandemic in real-time, it is incumbent that educators assess how these changes impact our students. We anticipated that there will be both good and bad outcomes of these large-scale shifts in the way that technical courses are taught across the hybrid university learning environment (HULE) today (Wheele, et. AL., 2023).

Recent pedagogically centered research has focused on characteristics of an instructor's speaking style during virtual presentations (e.g. voice, inflection, and pitch) (Mahmood, 2020), digitally enhanced blended learning opportunities (Singh, Steele, and Singh, 2021), and rethinking the goals of education in light of large-scale emergent situations (Cahapay, 2020). Additionally, recent research has focused on the effectiveness of stress intervention techniques on science and engineering undergraduate students (Pollak, Hazzan, and Peled, 2022) as well as assessing the impact of COVID-19 during high-stakes performance-based assessments in skills-based courses among pharmacy students (Hettinger, Baker, Brelage, Smith, and Woodyard, 2022). While these and the other large amount of COVID-19-related research in recent times focus on recommendations to enhance or rethink the learning environment, scant attention has been given to the impacts these methodological, instructional, and relational changes have had on students.

The pandemic itself highlighted the importance of quantitative and analytical skills in understanding and addressing complex challenges in nearly every facet of modern life. This has driven a significant amount of research surrounding COVID-19's effects on knowledge workers (Virtaneva, Feshchenko, Hossain, Kariluoto, and Himmanen, 2021), digital contact tracing (Trang, Trenz, Weiger, Tarafdar, and Cheung, 2020), and remote working from home (Carillo, Cachat-Rosset, Marsan, Saba, and Klarsfeld, 2021) among many other topics (Nenonen and Sankari, 2022). However, little research has yet been accomplished regarding how the pandemic has specifically impacted the teaching and learning of statistical and analytical concepts.

Given the similarities between preparing students with analytical skills and the practical application of these skills by knowledge workers in organizations and businesses, it would be appropriate to assume that there would be parallels between the experiences of students and professionals. It also stands to reason that there will be differences between these groups. This research aims to empirically investigate whether there are differences in outcomes among the various teaching modalities and instructional techniques experienced by students in statistics courses.



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As a case study, we will describe our educational setting, our students' academic profiles, and the various approaches and techniques that our faculty employed at the onset of the pandemic, during its continuing phases, and now as we enter the endemic phase. Additionally, we will present some empirical evidence supporting the contention of potential negative impacts resulting from the pandemic-related changes. The reality is that the pandemic has impacted higher education, in both positive and negative ways. However, it is important that we better understand the impact that it had on higher education now and into the future. It is crucial where we ascertain that various changes are improvements, that we follow a research-driven and empirically evidenced approach to know exactly what the results are of our various changes, and that we are not inadvertently harming a subset of our students. The goal is to improve post COVID-19 instruction, identify and disseminate potential best practices for such situations, and ultimately foster our students' success.

Our analysis has found statistically significant differences between each of the four focal semesters surrounding the COVID-19 pandemic. The first semester of our investigation was the fall of 2019, the last full semester preceding the pandemic in the United States. This semester is used to establish a baseline of student success data. The second semester included in our analysis is the spring 2020 semester which included the forced shift to fully online course content delivery methodologies. The third and fourth semesters included in our analysis are the fall 2020 and spring 2021 semesters. These are included to highlight the swings in student outcome measures and a gradual return to near-baseline numbers.

Background

Mid-Sized University

The university in this study is a student-focused public university founded in the early 1900s. Current enrollment is over 11,000 and offers more than 160 academic programs from professional certifications to PhDs. The student and faculty populations are a diverse representation of our larger global society. The university is a Higher Learning Commission (HLC) accredited university with over 65 additional program-specific accreditations. Included in this group is the Association to Advance Collegiate Schools of Business (AACSB) which accredits the College of Business.

College of Business

The College of Business (COB) offers 15 undergraduate degrees, three master's degrees, and two professional graduate-level certifications. Business student enrollment is over 1600 and growing. The COB has 60+ full-time faculty which are supplemented by 13 business partners teaching our students. Every COB undergraduate degree includes 30 credit hours of business foundation courses. In this group of courses is Business Statistics. In addition to COB majors, non-COB majors are allowed to enroll in Business Statistics to fulfill their program's statistics course requirements.



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Business Statistics Course

As stated above, the Business Statistics course discussed in this study is a required course for all business majors as a part of the business foundation. The course is offered in both the traditional face-to-face classroom and fully online delivery methods. Both methods utilize the Blackboard learning management system (LMS). The mode of instruction includes lectures, working problems, and discussions. This course includes an introduction to descriptive statistics, probability theory (theoretical and empirical), discrete and continuous distributions, estimation, and sampling concepts up to and including hypothesis testing. This course is only taught by faculty from the Computer Information Systems and Analytics (CISA) Department in the COB. Because this course is only taught by CISA faculty, they can easily collaborate on course objectives, teaching methods, assessments, and pedagogical techniques across both traditional and online delivery methods.

Literature Review

Challenges Stemming from the COVID-19 Pandemic

The COVID-19 pandemic created several challenges for learning environments across the globe. Students, faculty, administration, and staff were thrust into a state of disrupted equilibrium in the spring semester of 2020, but the challenges did not recede at the end of the semester. The continual challenge was adjusting to the new normal of college teaching during an active pandemic which involved a high percentage of online content associated with traditional face-to-face classes (Hoang & Watson, 2020). One study conducted in the early days after the pandemic reported that 70% of students felt that their learning experience had somewhat or significantly worsened during the time following the initial widespread pandemic quarantines (Kacsmarek & Ohyama, 2020).

Remote Attendance

A study was conducted to explore the obstacles experienced by students and faculty that were suddenly thrust into online learning in the spring of 2020 and subsequent semesters due to pandemic protocols that lasted into and beyond the fall of 2020. The most widely reported challenges found were: (a) the cost and availability of adequate internet service, (b) low confidence in technology, (c) limited availability of educational resources, and (d) lack of communication skills (Noor & Mazhar, 2020). While some college faculty used the pandemic as an opportunity to create innovative educational practices (Ferguson & Drake, 2020), many were left scrambling to provide equitable education in a time of crisis (Dhawan, 2020). One popular method of holding classes or meetings through quarantines, anxiety, social distancing, and an abundance of caution, was to use browser-based streaming meetings tools like Skype, Zoom, Blackboard Collaborate, and others to facilitate remote attendance (Weijers, et. al., 2020).

Colleges and universities significantly altered their model of education in response to the pandemic. Procedures were added like social distancing and extended quarantines by shifting course deliveries to fully online, or partially online by using live



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streaming videoconferencing software, like Zoom, to take the place of traditional lectures (Marsicano et al., 2020). In the semesters following the initial pandemic campus closures, face-to-face attendance became scarce and remote attendance increased. However, with the spike in remote attendance opportunities, some argue that student engagement took a steep decline (Oloyede, Faruk, & Raji, 2021). Possible explanations for that steep decline in student engagement during remote course attendance were student attitudes towards live stream learning.

Zoom Fatigue

After experiencing the replacement of traditional lectures with Zoom videoconferencing, student interviews conducted at a major university in the United States indicated that only 48% of students disagreed when asked if using Zoom for class was enjoyable, and 55% indicated that they would not like to use it in other classes (Serhan, 2020). In addition, 61% of students reported that their interaction decreased using Zoom and suggested that Zoom had a mostly negative impact on classroom engagement. In addition, a study conducted pre-pandemic found that student participation while using Zoom for lectures was low, students shut off their webcams and did not answer questions when called upon (Wang et. al.,).

One potential explanation for the student and instructor perceptions that Zoom learning is not as effective as the traditional classroom is the phenomenon known as Zoom fatigue (Fosslien & Duffy, 2020). In addition to the ever-present concerns surrounding the pandemic like social isolation, other contributing factors towards Zoom fatigue stemmed from challenges staying focused on learning during class sessions, uncontrollable disruptions, and technical issues like inadequate bandwidth, or poor internet connection speeds and spotty service (Peper et. al., 2021). These technical disruptions were amplified when it was the instructor who experienced them. Other factors contributing to Zoom fatigue include the propensity for participants to become distracted, use poor sitting posture, and become non-responsive without being in the physical presence of the lecturer or their peers (Peper & Yang, 2021). Nearly 80 percent of students, in one study focusing on Zoom fatigue, reportedly found Zoom classes, in lieu of face-to-face learning, to be significantly more challenging (Peper et. al., 2021).

Compassion Fatigue

During the pandemic, faculty were being asked to practice radical empathy when faced with issues that students may experience due to physical or emotional trauma related to the Covid-19 pandemic. Consistently being confronted with individuals experiencing trauma can be complicated by a phenomenon known as compassion fatigue, which has been documented to describe mental health complications among medical professionals. Compassion fatigue describes the stress resulting from exposure to traumatized individuals and is characterized by exhaustion, anger, irritability, and a decreased ability to empathize (Cocker, Joss, 2016). With the preponderance of special circumstances experienced by students during the pandemic, faculty were asked to make exceptions concerning attendance, due dates, and grading. Compassion fatigue was described as being experienced by educators in a 2021 study (Yang et. al., 2021).



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Challenges Stemming from the Sudden Transition to Online Learning

While the challenges of the traditional classroom were multiplied by implementing remote attendance, many universities replaced multiple sections of face-to-face courses with fully online versions (Marsicano et al., 2020). Many students did not have the option to enroll in their required courses as face-to-face lectures and therefore had to take a fully online version of the course to keep progressing toward degree completion. Although online learning was already happening at universities before the pandemic, many faculty and students were given no choice and found themselves thrust into unfamiliar situations with little or no prior experience.

Characteristics of Online Learning

Online courses provide opportunities that the face-to-face environment does not, like multimedia representations of the content, more interactivity, and flexibility, however, it also requires the student to be more self-disciplined and self-directed (Zhang, et. al., 2004). Fully online courses implement the replacement model of online learning which replaces all class meetings with online, interactive learning activities for students (Twigg, 2003). The replacement model was used to protect students and faculty during the pandemic as it decreased human presence on campus, thereby increasing social distancing and reducing anxiety induced by the COVID-19 virus. Online course offerings typically attempt to replace classroom lectures with activities like discussion boards, email, instructor-created videos, and external video content, delivered through a learning management system (Moore et. al., 2010).

When comparing online learning to the traditional classroom, a pre-pandemic study found that students enrolled in online learning courses considered technical issues with their equipment, or the learning management system to be among the most limiting factors of the online model of course delivery (Smart & Cappel, 2006). Although the online model of course delivery has many benefits, such as enriched course materials, on-demand interaction and support, and more flexibility (Kassop, 2003), these are mostly experienced by students who choose to enroll in online courses by choice or convenience, not strictly because of necessity due to the paucity of face-to-face course offerings, like the one created by the pandemic.

Student Self-Selection

Concerning learning outcomes, a study into the student preferences on course delivery revealed that while the online learning environment was preferred for flexibility and self-direction, the students favored the traditional classroom for acquiring conceptual knowledge and skills in the application of knowledge (Gherheş, et.al., 2021). Another study indicated that face-to-face learning was preferable to students when considering social interaction and overall satisfaction (Bali & Liu, 2018). These studies lead one to the conclusion that, although online learning is an appropriate alternative for some students in various situations, there are still many students and situations that will select face-to-face traditional lecture courses when given the opportunity.



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Students that self-select into face-to-face traditional lecture course offerings are those who value social interactions, application of specific skills, and have technological insecurity based on their technical knowledge and availability of resources, while students who value media representations, autonomy, and accessibility prefer online course offerings (Rodriguez, 2014). Student self-selection into face-to-face or online course offerings also depends on the student's perception and preference of comparative course flexibility, comparative interaction, comparative knowledge gained, and comparative ease (Platt, et. al., 2014). Individually, students will naturally prefer to enroll in course offerings that align with their priorities according to the above characteristics. Unfortunately, for many students, the pandemic response of most universities nullified their opportunity to choose the traditional face-to-face classroom.

Case Study

In this case study we will address several pedagogical lessons learned from the COVID-19 pandemic semesters, specifically:

- How did business faculty adjust their teaching in response to the pandemic?
- What perceived effects did the pandemic have on student learning and performance?
- What pedagogical lessons were learned through the implementation of interventions, and experiences throughout the pandemic?

Interventions

For the fall of 2020 our university implemented the following policies to mitigate the spread of the Covid-19 virus, as well as maintain some sense of normalcy concerning student education. Many of the pandemic interventions remained in place through the spring semester of 2021 although each semester saw changes reflective of the fluid situation.

Course Delivery: Summer

With the pivot to 100% online course delivery for the final weeks of the spring 2020 semester, the summer of 2020 continued with only online delivery options. However, our institution feels we are at our best in face-to-face course delivery and thus began shifting back to in-person course delivery in the fall of 2020. This shift was considered and purposeful with several options being utilized to respect what was by this point in time a normalized concept of social distancing. Classroom occupancy limits were halved and classroom attendees were expected to maintain appropriate separation. Although classroom seating was cut in half, demand for courses was not. Thus, course instructors were afforded several options.

A/B scheduling was used in some cases whereby the course roster was split into A and B groups that would each attend in-person activities on alternating days. The non-in-person days would consist of distance education-based activities appropriate for the curricular content. An additional option was to simply offer more online sections of courses that had historically been taught face-to-face. This included converting courses



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to an online delivery modality that had only ever been delivered in person. Both of these options were used but were in the minority in our College of Business.

The majority of instructors elected to provide simultaneous in-person and remote instruction on a synchronous basis. Several technologies were used with the most popular being Blackboard Collaborate and Zoom. These technologies allowed instructors to provide the same amount and level of instructional content to all students regardless of whether they attended the classes online or in the classroom. An additional benefit was that the class time could be recorded and distributed for viewing later for those students who missed class sessions for a variety of reasons.

Attendance Policies

As the fall of 2020 approached, a number of policies were implemented by college and university-level administration. One such policy advised faculty that they would not be able to compel students to physically attend classes due to the potential for higher infection rates, and mental distress that may be experienced by students during the pandemic. While this intervention was valuable for students' physical and mental well-being, regular academic attendance has been shown to have a significant positive influence on student learning and success (Park & Kim, 2020; Ginsburg, Jordan, & Chang 2014; Westerman, et.al., 2011).

Instructors were unable to compel students to attend course sessions synchronously online. Instead, recorded streams were expected to be available for all students who missed the synchronous session for any reason. Instructors could maintain an expectation that the synchronous or recorded sessions were viewed by all students. Online attendance was tracked and chronic absences were addressed individually. Instructors of the subject course sent additional "nudge emails" to all students to reinforce the importance of class attendance on student success. Instructors also adopted the habit of sending reminder emails to students during the pandemic about their commitment to the course and to continually encourage attendance. Additionally, the university enacted a policy wherein no classes could have a face-toface component after the Thanksgiving break in the fall of 2020, which dictated that the final three weeks of the semester were fully remote for all students and instructors.

Assessments

In conjunction with the revised attendance policies, all forms of assessment had to be available completely online. This meant that all exams, homework, and quizzes would be administered using the university's online learning management system, Blackboard. While most Business Statistics courses were already using an online learning platform as a means for formative assessment like student reading assignments and homework, summative assessments were performed using traditional problem-based questions and pencil and paper. The new policy required those traditional paper-based exams to be converted to multiple choice, matching, and short answer exams administered online.



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An unintended consequence of moving the exams online was an increased emphasis on test security and preventing academic integrity violations. Lockdown browsers, video proctoring software, and strict time limits were implemented as strategies to deter potential cheating in all courses. Business Statistics instructors built question pools that consisted of similar questions with a variety of numerical inputs to prevent the sharing of question content between students taking exams at different times across the exam window.

Drawing Monitors

A major drawback of moving Business Statistics courses from the classroom to online synchronous teaching sessions was the loss of the whiteboard. In courses like Business Statistics, a whiteboard is used daily for graphs, work problems, and explaining concepts with pictures. One solution to this dilemma was the purchase of a drawing monitor (e.g., Wacom, XP-Pen). These drawing monitors are traditionally used by artists and graphic designers to create detailed works of art or graphics for visual communication. Drawing monitors are tailor-made for this purpose with special drawing pens, a variety of digital ink sizes and colors, and pressure-sensitive screens with almost no parallax (i.e., the distance between the surface of the glass and the actual image produced by the monitor).

Drawing monitors work seamlessly with existing computers and require no proprietary software (other than a driver). They are intuitive to use for basic drawing and writing; if you can use a pen, you can use a drawing monitor. Instructors found the transition from the physical whiteboard to the digital whiteboard not only seamless but also an improvement in content delivery. The drawing monitor allowed instructors to create professional-grade videos enabling students to learn at their own pace.

Instructor-Student Interaction

Apart from implementing better technology, and a variety of course delivery methods, instructors were also intentionally more personable with their students. Instructors reported being more intentional with small talk before and after the official content portion of the synchronous session, both in person and via video conferencing software. Examples of this include asking about students' well-being, pets that are noticeable in the video, and their family and friends. Then they reciprocated with stories of their own. Instructors also shared news about the pandemic, new vaccinations, or changes in policy and procedures caused by the pandemic.

The goal of the increase in bi-directional personable interaction was to strengthen the connection with students that were strained by the online distance. In addition to more frequent and personable communication, instructors also reduced their response time to emails. In place of the standard business day replies, instructors would respond to emails on the weekends and after hours, often immediately. An increased emphasis was placed on the digital availability of instructors to students. Google voice messaging, SMS text messaging, and direct cell phone access were other strategies implemented to that end.



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Students were encouraged to actively participate in synchronous online sessions by turning their cameras on or talking into their mics in addition to texting for questions and answers. The goal of shifting the student's attention from passive to active participation was to enhance not only their learning but that of other students in the session.

Student Learning and Performance

For the empirical portion of this study, student learning and performance were analyzed by collecting student final letter grades for the fall semester of 2019, the spring and fall semesters of 2020, and the spring semester of 2021. The final letter grades were each assigned a numerical value based on a 4-point scale. F = 0, D = 1, C = 2, B = 3, A = 4. Once the final letter grades were assigned numerical values, the overal1 performance could be analyzed and compared across semesters. For example, in the fall of 2019, the average final letter grade for all students enrolled in Business Statistics was 2.71, which is comparable to a letter grade between C and B (being closer to a B).

In addition, the study also discusses the incoming institutional grade point average (GPA), which is similarly measured on a 4-point scale. Incoming institutional GPA for a semester is found by calculating the mean GPA of all students enrolled in Business Statistics classes prior to the start of the semester being discussed.

The graphs displayed in the student learning and performance section of this study will primarily show the performance of students enrolled in traditional face-to-face course sections. In addition to showing the proportion of students earning an A, B, or C, there is also a category for students that earned a letter grade of a D, an F, an incomplete, or a withdrawal from the course. This category is denoted by the acronym DFIW.

Fall 2019: Baseline Semester

The CISA 2330, Business Statistics course, has been a part of the College of Business's core courses and taught by the same department prior to and throughout the pandemic with a minor rotation of instructors prior to fall 2019. Therefore, it is reasonable to assume student learning and grades would be similar in the fall of 2019 and beyond. The enrollment in CISA 2330 for the fall 2019 semester was 208 students across five sections, 134 in three face-to-face sections and 74 in two online sections. The average incoming institutional GPA was 3.07 on a 4.00 scale. At the end of the fall 2019 semester, the average final letter grade for the Business Statistics course across all 208 students was 2.71 (on a 4.00 scale), with 42% of students earning an A, and 19% DFIW. Figure A shows the average final letter grade of students (y-axis) grouped by their average incoming GPA (x-axis).





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Figure A: Grade distribution by GPA

COVID-19 Starts

COVID-19 was initially discovered in December 2019 when a cluster of 44 patients in Wuhan, China had become ill with pneumonia of an unknown origin, labeled SARS-CoV-2 (Pneumonia, 2020). On 11 Jan 2020, China reported its first COVID death. On 21 January 2020, the United States reported its first confirmed case of COVID-19 and initial reports stated the first US fatality from the pandemic was on 28 Feb 2020. However, postmortem autopsies confirmed much earlier US deaths as of 9 Jan 2020. The rapid spread and lethality of COVID-19 caused a worldwide pandemic response, including higher educational institutions.

Spring 2020: Initial Pandemic Response

The bulk of students enrolled in their spring 2020 courses in October and November of the fall 2019 semester before COVID was on the radar. They had no reason to believe that the spring 2020 semester would be any different. By March 2020 the pandemic had spread to such an extent businesses and universities had to implement drastic social distancing measures including moving all classes online. On Thursday, March 12th, the university canceled all face-to-face classes and gave faculty until Monday (4 days) to develop a plan to convert face-to-face classes to online. The newly converted courses began Friday, March 17th.

The radical shift in course delivery resulted in a massive disruption to instructors and students. Instructors had to quickly and radically implement the interventions previously mentioned. They were also instructed to be more empathetic to the impact these changes were having on students. Of the 222 students enrolled in Business Statistics at the start of spring 2020, 222 students were enrolled across six sections, 157 four in face-to-face sections and 65 in two online sections with an average incoming institutional GPA of 2.89 and 2.58 respectively. By the end of the spring term, the average final letter grades were 2.73 for face-to-face students, 2.35 for online students, and 2.73 overall, with 42% earning an A, and 20% DFIW. Figure B compares the final grade distribution, by letter grade for students enrolled in traditional face-to-face



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classes, as they saw the greatest disruption of equilibrium when the pandemic measures were implemented.



Figure B: Grade distribution by semester (up to spring 2020)

Fall 2020: the Zoom Semester

During the 2020 summer, between spring and fall, instructors and the university had time to more fully prepare for teaching with modified delivery methods. The University's Center for Excellence in Teaching and Academic Leadership (CETAL) published guidance on multiple course delivery options (see Figure C). The new guidance included suggestions to accommodate student attendance, social distancing in the classroom, and faculty-to-student interactions. The table was intended for instructions of traditional classes as they prepare for modified delivery, attendance, and assessments in the fall 2020 semester.

One week prior to the start of the fall 2020 semester, a crucial policy change was directed:

"Dear Faculty:

Due to the unique demands of the fall semester, we are asking all faculty to record and make available in Blackboard all of their in-person or online, live-streamed (synchronous) class sessions.

Why Do We Need to Record?

Because of the potential for students to be unavailable at scheduled class sessions due to illness or being isolated or quarantined, faculty should record live class sessions delivered in-person or online via Zoom, Blackboard Collaborate, or Google Meet. Recordings also ensure that students who experience technical issues during the live class session do not miss content or activities.

These recordings will benefit all of our students too because it allows them to review class sessions; research shows that traumatic situations like the one we've been experiencing the past six months negatively affect





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memory and learning in general. Thus, recordings will assist all students in mastering course content...."

This policy had unexpected consequences on attendance and student outcomes. Despite the measures put in place to reduce the spread of COVID-19, including modified delivery methods, social distancing, and masking requirements during face-to-face classes, the fall 2020 enrollment for face-to-face sections was one student shy of capacity while seats were available in the online sections. This would seem to indicate that students were eager to get back into the traditional classroom. However, the number of students attending face-to-face Business Statistics classes during the fall of 2020 was never above 77% of enrollment and had dropped below 25% midway through the semester.

Of the 218 students enrolled in Business Statistics at the start of fall 2020, 103 were enrolled in three face-to-face sections and 115 in three online sections with an average incoming institutional GPA of 3.01 and 2.89 respectively. By the end of the Fall term, the average final letter grade (on a 4.00 scale) was 2.17 for face-to-face students, 2.50 for online students, and 2.34 overall. Notably, after the fall of 2020 there were more students with a DFIW than students earning an A, 28% and 36% respectively. Figure C compares the final outcome by letter grade for students enrolled in traditional face-to-face classes during the fall of 2019, the spring of 2020, and the fall of 2021.



Figure C: Grade distribution by semester (up to fall 2020)

Spring 2021: Returning to Normalcy

By the spring of 2021, vaccines were readily available and other measures to reduce the spread of COVID-19 seemingly having an impact, and everyone prepared for a new semester. Instructors and universities had become more accustomed to the COVID-19 modifications and to teaching in new modalities. Instructors realized that students, given the choice of coming to class or watching the recorded lectures asynchronously, would almost certainly choose not to come to the in-person class sessions. This resulted in not only a drop in attendance but also in student engagement and overall performance. Because of this negative trend, many faculty dropped the



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recording of face-to-face lectures and required students to either attend in person or watch lectures synchronously. The instructors also kept the pedagogical lessons learned and took the opportunity to increase the usage of online tools and blended learning.

Many students reeling from poor performance in the fall, began to prepare for the spring with renewed self-awareness. Realizing that to do well requires hard work, active engagement, and the ability to adapt to a new learning environment, both attendance and performance increased in the spring of 2021.

Of the 232 students enrolled in Business Statistics at the start of spring 2021, 105 were enrolled in three face-to-face sections and 127 in three online sections with an average incoming institutional GPA of 2.90 and 2.82 respectively. By the end of the spring term, the average final letter grades (on a 4.00 scale) were 2.44 for face-to-face students and 2.58 for online students, and 2.52 overall, with 34% earning an A, and 28% DFIW. Figure 4 compares the final grade distribution, by letter grade, for students enrolled in traditional face-to-face classes during the fall of 2019, the spring of 2020, the fall of 2020, and the spring of 2021.



Figure D: Grade distribution by semester (up to spring 2021)

Pedagogical Lessons Learned

Course Delivery

Streamed content delivery for classroom activities was not the panacea it was intended to be and had several drawbacks associated with it. As students learned that instructors were following various "radical empathy" policies, requests to miss class times for a variety of reasons multiplied. Additionally, the number of absences without prior notice increased substantially. In either case, students justified absences to themselves and the instructor because the recorded content-related activities would be available after class time and thus they could make up anything they missed. However, viewing is not participating. Thus, although some students who missed class time at an increasing rate over the course of the semester did go through the motions of watching



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the recorded classes, their understanding of the materials was significantly reduced. And, as LMS metrics would indicate, many students ultimately did not watch the recordings as they would get busy catching up with other course activities, other courses, or other events in their lives.

Attendance

The attendance policies implemented for the fall semester of 2020 created a situation where students were not incentivized to attend face-to-face class sessions. Although some individual instructors had course policies requiring attendance either inperson or via video conferencing, many did not. Students also had the option to watch the recorded class in lieu of synchronous attendance.

For the first half of the fall 2020 semester, instructors teaching Business Statistics courses kept track of the physical attendance of their students (see Figure E below). Face-to-face attendance dropped off precipitously during the semester which may have contributed to the steep drop in student performance the same semester. This could be explained by the fact that students who self-selected into a face-to-face Business Statistics class during registration essentially transitioned to a fully online course halfway through the semester. Although students committed to attending the streaming class or watching it later, their level of engagement may have deteriorated using those lecture methods. Figure E illustrates the face-to-face attendance of students throughout the first half of the fall 2020 semester.



Figure E: Face-to-face attendance trends

In the spring of 2021, instructors were once again able to implement face-to-face attendance requirements and physical attendance was encouraged throughout the college. Although Business Statistics faculty were still lenient with the enforcement of mandatory attendance policies it became the norm for students to attend face-to-face lectures. The rise in physical attendance coincided with an overall rise in student performance approaching the previously established baseline.



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Assessments

Administering summative assessments using the online learning management system was considered a successful endeavor among Business Statistics instructors and students, which continued into the spring semester of 2021 and has persevered into the fall of 2022. Offering the Business Statistics exams online eased the grading load of instructors, while also giving the students more flexibility to take the exam in a comfortable environment, potentially easing testing anxieties experienced by some students. In addition, the online exams allow more flexibility within the course schedule, the students receive their grades immediately, and instructors can continue to build deeper question pools, which further mitigates the potential for academic dishonesty.

Drawing monitors

The use of drawing monitors mentioned previously gave live-streamed online lectures a classroom-like feel because the strokes of the pen can be seen by students attending remotely via live video conferencing software. The use of the drawing monitor allowed the instructor to adapt to online students' questions in real-time, illustrate concepts with digital inking, take notes that can be digitally shared, and answer questions more interactively. The drawing monitors allowed the instructor to create information-rich content that was more interactive and immersive than both traditional and online lecture methods. The use of drawing monitors and digital ink was so successful at improving both face-to-face and online classes that all classroom monitors in the COB are being replaced with drawing monitors.

Discussion

After reviewing the student performance outcomes across each semester it becomes clear that students enrolled in traditional face-to-face classes were affected most significantly by the pandemic. This is likely because students select the course that best fits their specific learning style and comfort level. In other words, students that typically enroll in online classes are students that have previously been successful in online classes. However, policies implemented for the fall of 2020 converted more sections to completely online and adjusted the face-to-face sections into hybrid courses with remote attendance, and fully online assessments. These changes in essence created a opportunity gap for students preferring traditional courses during the fall of 2020. Figure F, shows the final average grade comparison between online and face-to-face Business Statistics courses across the semesters being studied.



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Figure F: Final grades online vs traditional

Interestingly, in the spring semester of 2020, when the pandemic forced all classes to go completely remote, overall student performance was not significantly different from the baseline semester of fall 2019 for either face-to-face or online courses. A possible explanation for this could be the radical empathy shown by instructors at the end of the 2020 semester. The disruption caused by the pandemic and the immediate response shaped the policies and interventions developed for the fall semester of 2020, which unintentionally moved traditional Business Statistics courses closer to online or hybrid courses.

In the fall of 2020 students enrolled in face-to-face Business Statistics courses, implementing the pandemic policies, had a statistically significant drop in average final letter grade from the baseline semester of fall 2019. Table 1 shows the difference in final average letter grades for face-to-face students in the fall of 2019 (2.72) and fall of 2020 (2.17), which is significantly different in two-tails t(235) = 2.89; p = 0.0042).

t-Test: Two-Sample Assuming Equal Variances		
	F19	F20
Mean	2.723881	2.165049
Variance	1.900628	2.531315
Observations	134	103
Pooled Variance	2.174373	
Hypothesized Mean Difference	0	
df	235	
t Stat	2.892085	
P(T<=t) one-tail	0.002093	**
t Critical one-tail	1.651364	
P(T<=t) two-tail	0.004186	**
t Critical two-tail	1.97011	

Table 1: t-Test results for fall 2019 and fall 2020



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Due to the overall unease during the pandemic, students enrolled in traditional face-to-face classes were not required to attend classes, many opted instead to view the recorded lectures or attend the live stream via virtual meeting software like Zoom. The attendance trend discussed above illustrates that students increasingly chose lecture recordings, or Zoom attendance, over physical attendance throughout the semester. Decreased face-to-face attendance, Zoom fatigue, inexperienced online students, and instructor compassion fatigue could explain the steep drop in performance (from 2.72 to 2.17) for the fall of 2020 from the pre-pandemic semester, fall 2019. In addition, there was a higher percentage of DFIW outcomes than A letter grades for students enrolled in Business Statistics classes in the fall of 2020.

Through lessons learned during the fall of 2020 and the tentative optimism surrounding the evolution of the pandemic response, and medical technology, in the spring 2021 semester, traditional face-to-face courses more closely resembled normal operation than the previous two semesters, and students reacted in kind. Final student letter grades at the end of the spring 2021 semester began to rise closer to the pre-pandemic levels seen in the fall of 2019. Although the final letter grade average for spring 2021 (2.44) remained lower than the fall of 2019 (2.72), they were not significantly different, and the percentage of DFIW outcomes was lower than the percentage of A letter grades again.

Limitations

This study provides valuable insights into the effects of pandemic-driven instructional changes on student performance in business statistics courses. However, it is important to acknowledge certain limitations. As this research was not conducted as a controlled experiment, there may be additional unknown factors influencing the observed changes in student outcomes. External variables, such as individual stress levels, access to resources, or varying technological proficiencies among students and faculty, could have contributed to the results. Future research could benefit from employing controlled methodologies to isolate specific factors and better understand their impact on student performance.

Conclusions

Based on the student learning and performance outcomes discussed in this case study we can conclude that students, in this sample, enrolled in face-to-face sections were disproportionately affected by the pandemic and the interventions in place when compared with online students. In addition, we can conclude that traditional face-to-face students enrolled during the fall of 2020 were disproportionately affected when compared to face-to-face students in the other semesters that were discussed. Overall, some interventions, such as online assessment, drawing monitors in classrooms, and an increased emphasis on instructor-to-student interaction will continue to be implemented in various iterations, but the extremely flexible attendance policies and increased online course offerings will not be used moving forward. This study underscores the evolving nature of pedagogy and knowledge work in response to



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enduring challenges posed by the pandemic, emphasizing the need for tailored approaches to support effective teaching and learning in the new HULE normal.

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