Comparison of Student Performance and Perception of Course in Online and Face-to-Face Settings

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Abstract

The objective of this study is to compare students' performance and perceptions of the course when taught via an online version versus a face-to- face version. The face-to-face and online modalities of the Mechanics of Materials course at The Citadel were offered in summers 2019 and 2020, respectively. The course was offered online due to the college's COVID-19 pandemic response. The same instructor taught both sections with the same course objectives and exams. The study found that the students' performance in online version of the course was not significantly different from the face-to-face version. In addition, students self-reported perceptions of the course did not differ based on delivery modality.

Keywords

Mechanics of Materials, COVID-19

Introduction

The COVID-19 pandemic brought about an almost total transition to emergency online teaching in the United States in spring 2020. While many schools were able to regain some level of in-person interactions by fall term 2020, summer terms remained online for safety reasons. Though there was slightly more time and ability to strategically plan online classes for the summer rather than simply react to an emergency transition as in the spring.

Anecdotally, many instructors in spring and summer 2020 at The Citadel were concerned with students' ability to achieve educational objectives and thus the school adopted a Quality Matters[1] criteria system for the faculty to adhere to. This provided minimum course requirements for faculty who had never taught online, or had reservations about the process, to hopefully better ensure their students' learning. While this structure did support faculty development, it only addressed some components of issues regarding online teaching. A 2020 review of available literature regarding online teaching readiness found that online teaching resulted in affective changes and identity disruptions for faculty.[2] While organizational and pedagogical structures greatly affect the success (both personally and professionally) of a faculty member transitioning online, the faculty member's own mental and emotional reactions are possibly a greater concern. This was echoed in an earlier 2017 review which outlined three categories of challenges to online teaching: content, instructor, and learner issues.[3] Content and instructor issues centered on faculty's identity, time management, and ability to develop effective online lessons/tools. The learner issues revolved around student's expectations, identity, and participation.

While work by Kinney et al. indicates that students and faculty alike are generally convinced of the effectiveness of a wide range of online learning tools (e.g., videos, course websites, etc.) there is less agreement that online modalities allow timely, effective communication and learning.[4] These concerns have been confronted in several studies that directly measure student academic success. While the student's perception of the course may be altered due to the online environment, the learning outcome is largely unaffected. For example, in an industrial engineering course, Singh et al. found that there was no significant difference in performance between classroom, synchronous, and asynchronous learners.[5] Notably though, other factors regarding the instruction (e.g., asynchronous students viewing lessons more than once before testing) may have influenced the student performance. Student perception of the course was evaluated in four categories- content, usefulness, organization, and learning. In general classroom students gave the highest scores while asynchronous students gave the lowest and synchronous students varied between based on category. However, these differences were often not statistically significant. Work by Douglas in an engineering statics course found that online and face-to-face students performed similarly on tests.[6] In the first cohort studied, the online students even slightly outperformed the in-person students. In terms of student perceptions, they were similar and generally positive for in-person and asynchronous online students, but slightly lower for the online synchronous students. Other studies, including introductory sociology, psychology, management, and engineering design, found little to no difference in student performance between online and in-person students.[7-10] A study investigating student reactions to emergency online teaching in a range of chemistry classes found that not all students respond equally well to an online transition. [11] Some students may have benefitted from the increased agency that an online class allows, while others struggled with a lack of structure and personal interaction.

While student learning may not be significantly affected by a transition to planned online classes, the negative perceptions of online environments still exist. Thus, faculty, even when employing best practices, to foster discussions and hold students accountable, may battle the negative pre-conceptions of their students regarding online classes.[12] Such biases were anticipated to continue into Summer 2020 courses, since many students' first and only experience with online classes was under less-than-ideal emergency transitions.[11,13]

In this study, two summer term sections of a Mechanics of Materials class are evaluated to compare students' (1) academic performance and (2) class perceptions. The terms took place in summer 2019 and summer 2020, representing times before and after the COVID-19 mandated transition to online learning. Each section was taught by the same instructor and had the same learning objectives, however the online section adopted new exercises and activities per Citadel's Quality Matters recommendations to faculty. This work adds to the body of literature comparing academic performance via in-person and online teaching modalities but also can lend insight into students' perceptions of future online classes in light of the Spring 2020 emergency transition to online classes.

Course Description

At The Citadel, Civil and Mechanical Engineering majors are required to take Mechanics of Materials in the first semester of junior year and second semester of sophomore year, respectively. Mechanics of Materials is a three-credit course that meets for 2.5 hours of lecture (twice a week for

75 minutes each). The main topics of the course include stress, strain, deformation, and stress/strain transformation.

Study Methods

This study consisted of a summer 2019 face-to-face class and summer 2020 online class. The face-to-face section contained 20 and the online section contained 23 students. Students primarily were enrolled via the evening program, a transfer and non-traditional student curriculum, though others were "day" students (i.e. full time, traditional college students).

The modality changes between 2019 and 2020 was due to the Citadel's COVID-19 pandemic response. This unique opportunity provided the opportunity to collect data that would allow determination of if the mode of instruction influenced student performance and satisfaction. Both sections were structured as similarly as possible with slight changes to student participation per the Quality Matters standards.[1] Both covered the same content. Students in each took three exams and completed the same set of assignments. Despite these similarities, there were some differences between the two courses. In the online course, students had access to a complete set of instructor provided notes. Furthermore, students in the online course were required to participate in an online discussion board. They responded to questions and comments made by other students. This attempted to promote the student conversations that would spontaneously occur in an in-person classroom setting.

Face-to-Face Section

Prior to each lesson, web-based pre-class reading responses[14] were employed to motivate students to prepare for class regularly. Students were required to respond to one open-ended question on the course website addressing the learning objectives of a specific lesson. Immediately before class, student responses were examined and the in-class activities were tailored to meet their actual needs. To further stimulate learning and to get the students motivated about Mechanics of Materials, a song with the word related to topic (i.e., "Heat is on", "Let's Do the Twist", etc.) was played prior to each lesson. Learning objectives were written on the board and were referred to frequently during class to assist students as to where the content fit into the knowledge they were assembling. In addition, as students entered the classroom, thought provoking questions were written on the board, and they were instructed to write their responses to the questions on a sheet of paper. Students were then asked to pick one question to discuss and correct any misconceptions as a group and report the summary to the entire class. At the beginning of each lesson, pre-class reading responses were summarized on the board and common errors were discussed. Following the discussion, Think-Pair-Share[15] was employed to help students organize prior knowledge and engage with the mechanics concepts. Students were provided with daily handouts, which contained a partially completed outline of the lesson and a number of questions, with blank spaces for answers. A mini-lecture was employed to correct the misconceptions and allow the students to fill-in-the-blanks in their handouts. The presented material was always linked to students' previous knowledge and previous concepts in Statics and to future material in analysis and design of systems. Physical models were used to demonstrate the key mechanics concepts. At the end of each lesson, One-Minute paper[15] and Muddiest point paper[15] activities were used to monitor student learning. One-Minute paper technique required students to answer a big picture question from the material that was presented in the current or previous lesson in 60 seconds. Muddiest point paper required students to write the single, most confusing point related to the concept on a piece of paper. After class, the muddiest points were addressed and posted to the course website.

Online Section

The online section retained the same course objectives as the in-person semester, but activities were updated for the online environment using the Quality Matters Standards[1]. The course was designed based on the alignment of the course learning objectives, module level objectives, instructional materials, learning materials, learning activities, and assessment. Numerous active learning activities were used in online section such as: providing opportunity for students to engage in peer instruction by presenting a 5-10 minutes lesson, reflection writing at the end of each lesson, group problem solving and developing a concept map of provided list of terms in Zoom breakout rooms, brainstorming a question and submitting answers via Zoom chat box, polling at the beginning, during, and at the end of lesson to assess and engage students, using Zoom whiteboard to play games such as Pictionary as a tool for an exam review, using asynchronous tools such as discussion boards requiring active participation and multimedia resources, and providing immediate feedback through email and texting and posting comments in the chat box.

The online environment promoted more student-centered learning than the face-to-face setting. This was due to a variety of online tools that appealed to many different learning styles. In authors' opinions, online learning requires a greater commitment for students to be successful because online learning requires students to be active learners.

Assessing Performance and Satisfaction

Student performance was measured directly through the use of midterm and final exam questions. The student satisfaction was measured via data collected by an end-of-semester institutional survey of student evaluation of instruction.

Figure 1 illustrates the average and standard error associated with midterm exams and the final exam. The average exam scores for students in the face-to-face course were 88.2%, 90.6%, and 74% and for those in the online course were 93.5%, 92.1%, and 88%. Figure 1 illustrates that students performed slightly better in an online format than they did in face-to-face section in the summer of 2019.

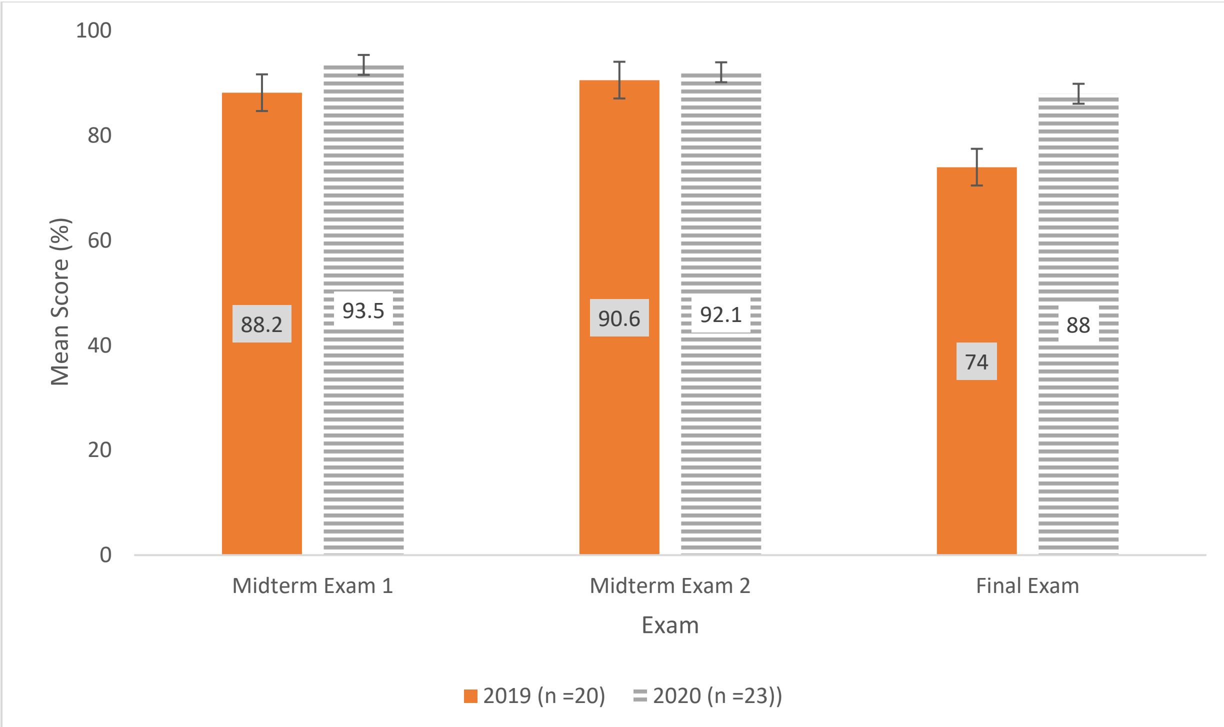

Figure 1. Means and standard errors of the midterm and final exam.

Satisfaction with the course was measured by a 6-item evaluation instrument. The student perception of learning and satisfaction with course was measured through an end-of-semester survey. The survey was conducted in electronic format only for both classes and students had access to the survey during the last week of summer session. Students were asked to respond to the statements shown in Table 1. The questions in the survey were specifically aimed at comprehending the students' perception of their own learning, their professor effectively challenging students to think, and the instructor's availability to assist students. Students responded to the questions on a five-point Likert scale (1-5), with '1' representing a strong disagreement with the survey statement and '5' representing a strong agreement with the survey statement.

The student perception survey responses were converted to a percentage scale in the standard way, with a score of "5" being considered equivalent to 100. In this way, an equivalent mean percentage was obtained for the survey questions. Figure 2 illustrates the mean and standard error of responses for each survey question, respectively. Figure shows that the mean scores for the online section is slightly higher than the mean scores for the face-to-face sections for all six questions. Figure 2 also shows much lower variability in student perception in online section compared to the face-to-face sections. This indicates that the student perception of learning and satisfaction is slightly higher in the online section of Mechanics of Materials.

Table 1. Institution's online student perception survey.

Q1. My professor effectively challenged me to think Strongly Disagree= [1] Disagree = [2] Neutral = [3] Agree = [4] Strongly Agree = [5]
Q2. My professor is accessible to answer questions Strongly Disagree= [1] Disagree = [2] Neutral = [3] Agree = [4] Strongly Agree = [5]
Q3. My professor communicates enthusiasm when teaching Strongly Disagree= [1] Disagree = [2] Neutral = [3] Agree = [4] Strongly Agree = [5]
Q4. My professor makes a good use of examples and illustrations Strongly Disagree= [1] Disagree = [2] Neutral = [3] Agree = [4] Strongly Agree = [5]
Q5. I learned a lot in this course Strongly Disagree= [1] Disagree = [2] Neutral = [3] Agree = [4] Strongly Agree = [5]
Q6. I would enjoy taking another course from this professor Strongly Disagree= [1] Disagree = [2] Neutral = [3] Agree = [4] Strongly Agree = [5]

Two independent samples t-tests were employed to compare mean exam grades between online and face-to-face sections. The results showed that the difference between mean scores was not statistically significant at α =0.05. Means of self-reported perceptions were also compared. For all six questions, the means were above Likert-scale 3, so no significant differences were observed for any questions.

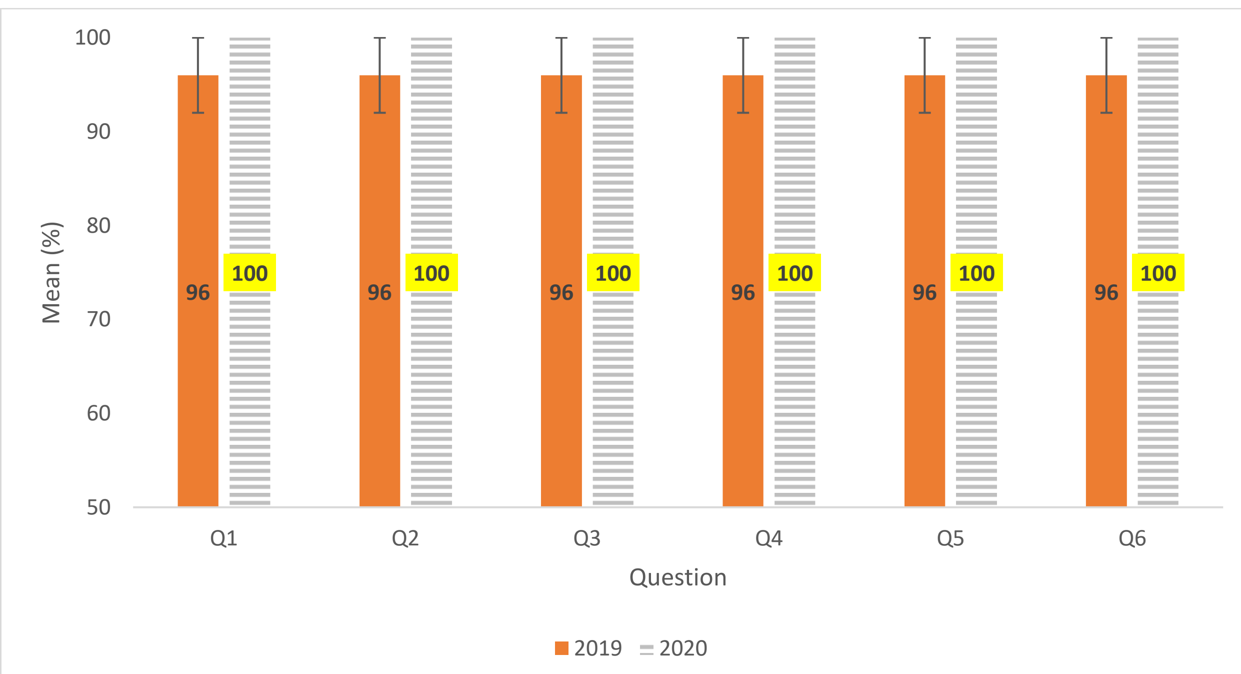

Figure 2. Means and standard errors for questions 1-6 of survey.

Conclusions

The study found that the students' performance in online version of the course was not significantly different from the face-to-face version. In addition, students self-reported perceptions of the course did not differ based on delivery modality. The perceptions of the course were generally positive regardless of delivery method.

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