Influence of Hybrid Class Format on Student Performance in Civil Engineering Courses

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Abstract

The objective of this Work-In-Progress study is to assess the effect of a hybrid class format on student performance in Civil Engineering classes. In Fall 2020, many colleges and universities reopened with modified operations due to the ongoing COVID-19 pandemic. One common response was to create hybrid classes (alternating online and in-person teaching days) to ensure adequate social distancing within classrooms. This study presents exam score data from Fluid Mechanics and Mechanics of Materials, two junior-level Civil Engineering courses, taught in Fall 2020. Each course had two sections. Both course sections were taught using identical instructional materials, but one was hybrid while the other was fully in-person. Statistical analysis was used to determine the trends in student performance based on class modality. Further, the study also assessed students' perception of out-of-class workloads in each of these modalities. This work has implications for understanding the effect of instructing current cohorts using hybrid models and the future of such instructional modalities in the post-pandemic world.

Keywords

COVID-19, Civil Engineering, hybrid class

Introduction

In response to the COVID-19 pandemic, colleges and universities had to adopt alternative teaching modalities to limit the spread of the virus. While some opted for fully online courses due to their location and demographics, The Citadel was able to maintain a fully on campus student body utilizing a hybrid class model when necessary to meet social distancing requirements. Under this modality, students alternated in-person or livestream video classes. This paper evaluates the impact of the pandemic on student academic performance and perceptions.

Methods

Courses: Data was collected on the student performance and perceptions in two junior-level Civil Engineering courses with two class sections each. The first course was Fluid Mechanics ("Fluids") and the second course was Mechanics of Materials ("Materials"). These lecture classes each cover a wide range of learning objectives and are generally perceived by students to be difficult and time-intensive. The two courses were taught by different faculty members but the faculty taught both sections of their respective courses. Students are predominately traditional undergraduate students (enrolled directly after high school) though a few are non-traditional.

Class Modality: The modality of the class sections in Fall 2020 was dictated by The Citadel's COVID-19 response strategy. All rooms were assessed to identify a socially-distanced maximum

capacity. For sections with higher enrollment, the section was assigned a "hybrid" format. This split the enrolled students in groups with alternating in-person and online days. During online days, students participated in class via livestreamed video. They were able to ask and/or answer questions using speakers installed in the room. Due to The Citadel's attendance policy, students participated equally whether online or in-person. For both Fluids and Materials, the section enrollments resulted in one hybrid class section and one fully in person section. As the room capacities were approximately 14-15 students, this means the data is limited.

***Lesson Format**:* In each course, similar teaching methods were employed. Classes consisted of topical lectures and example problems to introduce or reinforce concepts. Weekly homework assignments mandated additional student practice outside of lecture times. Module tests were held throughout the semester to assess retention and understanding of course material.

Data Collection and Analysis: Student performance data was collected from their scores on module tests (Fluids = 4 and Materials = 3). These scores were normalized to the student's previous academic performance using Equation 1 to approximate the influence of class modality without influence of individual student capacity given the small sample size.

$$Normalized\ Score = \ Student\ Test\ Score - \left(\frac{Student\ GPA}{Max\ GPA} \times 100\right) \qquad Eqn\ 1$$

Students in all four class sections were asked to complete an author-developed survey. This survey met the standards of The Citadel's Institutional Review Board. It consisted of eight questions (including 3 Likert Scale questions) and one confirmation of participant consent. The survey aimed to collect data on the durations of student work outside of class, as well as their perception of the effect of class modality on performance and workload. Survey completion for each class section ranged from 75% to 85%.

Data was reported as section means and standard deviations. Additionally, statistical t-tests helped establish significant differences.

Results and Discussion

Academic Performance: Student performance on unit tests did not significantly vary between the two class modalities (Figure 1A and 1C). Even when normalizing the prior academic performance, there was no significant effect from the class modality (Figure 1B and 1D). Positive normalized scores imply that a student scored more points than their GPA would indicate and negative scores suggest they underperformed on the current test as compared to their prior classes. The lack of change in academic performance is in line with results found elsewhere comparing online and in person class modalities.[1-5] While not statistically significant, it is interesting that the Fluids test scores improved throughout the semester regardless of modality.

Student Perception: The survey also quantified the students' perception of the effect of their class's modality. Their level of agreement with three statements was assessed using a Likert Scale. In the statements in Table 1, "X" was replaced with the students' own class format while "Y" was the alternative modality. As Table 1 illustrates, the Level of Agreement with three statements addressing students' perceptions. The Level of agreement ranges from -2 (strongly disagree) to 0 (neutral) to 2 (strongly agree).

Students in hybrid sections perceived that their ability to learn and their grade were negatively impacted by the class format, while in person students felt their modality had a positive impact (Figure 2). This aligns with previous research that indicates students believe more time is required for classes with online modalities.[6] While students perceived there should be a difference, from Figure 2, there was no difference in measured performance.

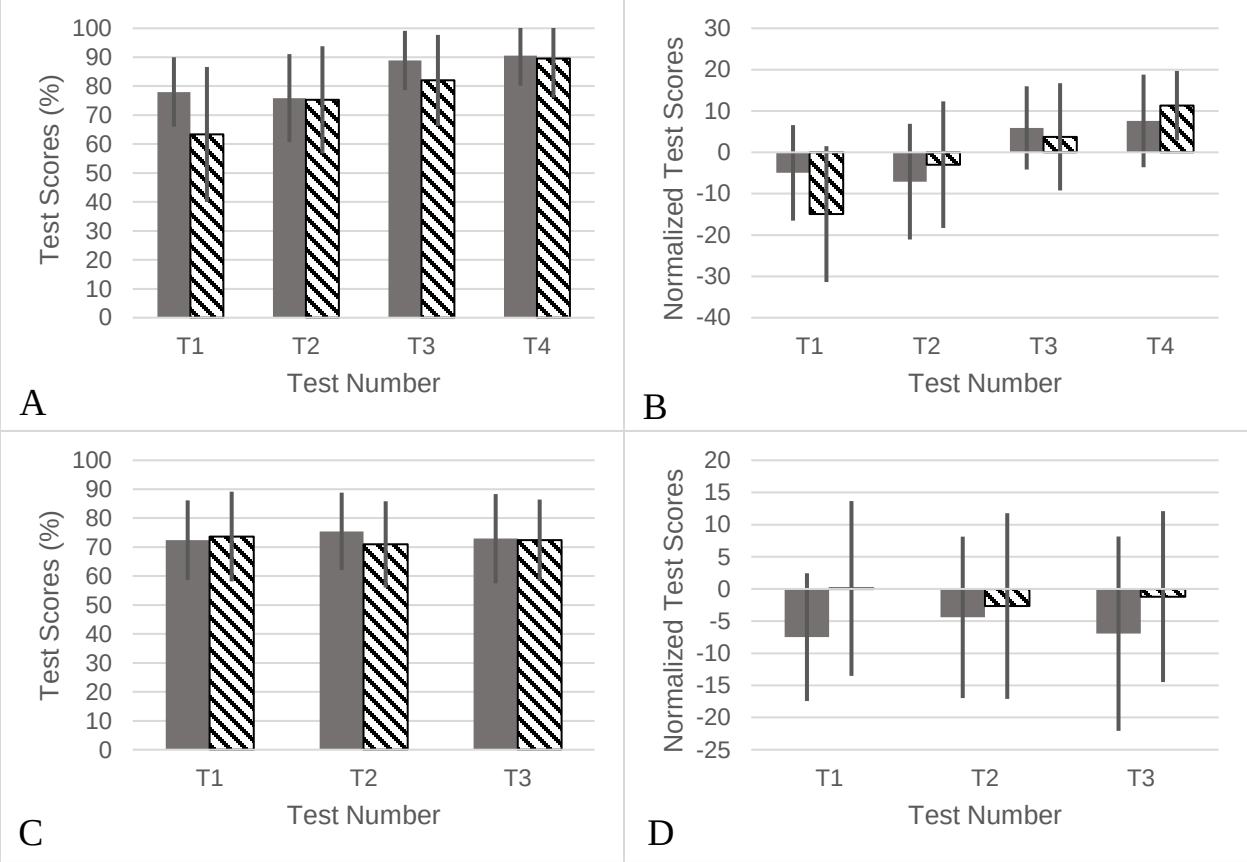

Figure 1: Absolute (A, C) and normalized (B, D) test performance in Fluids and Materials classes, respectively. Hybrid is shown in solid grey while fully in person section scores are shown in stripes. The vertical bar shows the standard deviation.

Table 1: Data reported as average and standard deviation. Asterisk indicates significant difference at the 0.01 level.

Statement	Fluids		Materials	
	Hybrid	In Person	Hybrid	In Person
My ability to learn the material in the course has been positively affected by the "X" format of the class compared to if I had been enrolled in a "Y" section	-1.0 ± 0.7*	1.6 ± 0.7*	-0.8 ± 1.2*	1.0 ± 0.9*
My current overall grade has been positively affected by the "X" format of the class compared to if I had been enrolled in a "Y" section	-0.9 ± 0.6*	1.1 ± 1.0*	-0.8 ± 1.2	0.3 ± 0.7
I believe that participating in a "X" class has increased the duration of my workload outside of lectures compared to "Y" students	0.0 ± 1.2	0.1 ± 1.6	0.75 ± 1.2	0.3 ± 0.7

While there was no significant difference in student responses to Statement 3 (increasing workload duration), the lack of significance was largely due to the wide variety of responses in each section. When asked to quantify the time spent outside of "lecture hours" each week, student responses varied within each section (Figure 2), but the average remained the same regardless of modality (3-4 hours for Fluids and 4-5 hours for Materials). However, when asked to estimate how much additional time they spend outside of class compared to the alternative formatted class, estimates varied for Fluids. While there was no significant difference in GPA between the two sections, perhaps students perceived that the "other" group was more intelligent and/or needed to study less than their section. The mean "increased workload" did differ slightly between the modalities with in- person students reporting and increase of 0-1 hour while the hybrid students average was 1-2 hours. This trend did not also occur in Materials where both sections estimated spending 1-2 hours more than the alternate format.

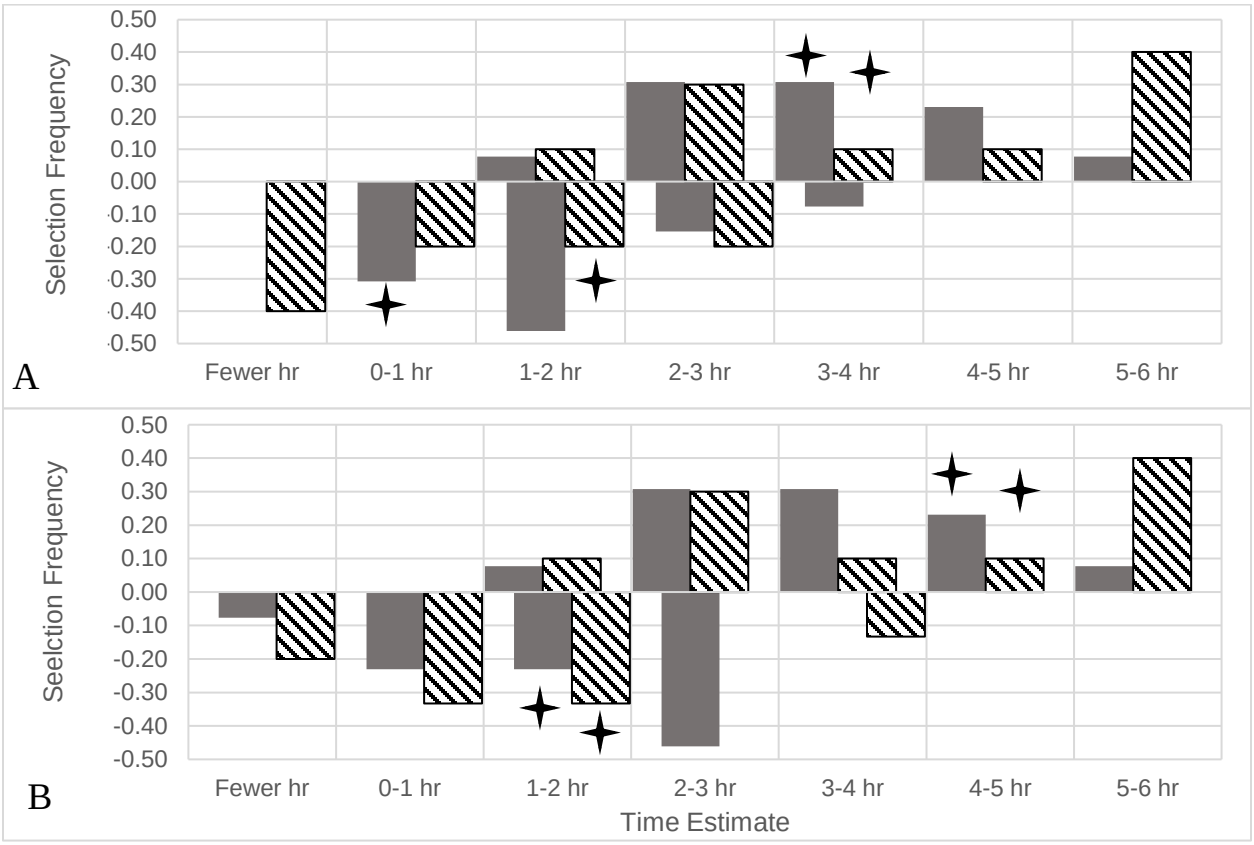

Figure 2: Students' self-reported estimate of the duration of time they spend on Fluids (A) and Materials (B) content outside of lecture (top bars) and estimate of additional time compared to the other modality (lower bars). Hybrid student responses are shown in solid grey bars while in person is striped bars. The average response for each group is indicated with a star.

Conclusions

The implementation of a hybrid class modality (alternating in-person and online live-streamed lectures) had little to no impact on student academic performance. However, students assumed that there should be a discrepancy due to format. Additionally, there is no clear evidence that

student workload duration outside of lecture was affected by the class modality. It must be recognized that this study is limited in scope due to the cohort size.

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