2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
Paper ID #38579

Undergraduate Engineering Students' Time Management and Self Efficacy in Different Learning Formats

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Abstract

Rapid changes in learning environments due to the COVID-19 pandemic led to disruptions in students' routines for studying, exercise, and socialization, causing shifts in time management behavior. This is true for both transitions to remote learning as well as the transition back to in person instruction. The objective of this research is to examine the effect of remote and hybrid learning formats on the time management habits of students and to determine if self-reported time management habits may be related to students' self-efficacy and academic performance. Towards this goal, we collected students' numerical responses to survey questions from the Motivated Strategies for Learning Questionnaire (MSLQ) regarding their time management habits and self-efficacy. The survey was administered at the conclusion of two separate offerings of the same course in Mechanical and Aerospace Engineering at the University of California Irvine (UCI): one in a fully remote format (Winter 2021) and the other in a hybrid format that transitioned from fully remote to in person in the middle of the term (Winter 2022). This required upper division course for mechanical and aerospace engineering majors involves lectures, laboratory experiments, and a final team project. We employ non-parametric methods for hypothesis testing to compare survey responses from students in the two different course offerings, and we compute rank correlation statistics of students' responses and institutional data to determine relationships between time management, self-efficacy, course load, and academic performance. Students in the fully remote course reported better time management and self efficacy than students in the hybrid course, and there were significant relationships between time management, self efficacy, and academic performance in both course formats.

Introduction

While online classes have been widely available for a few decades [1], the COVID-19 pandemic forced college students who had selected in-person engineering instruction into online or hybrid classes. These learning environment changes led to shifts in students' time management behavior. Because undergraduate engineering programs are career-centric, helping future graduates develop skills like time management before entering the workforce is critical to their success. Time management is rarely explicitly taught and is a trait that is often taken for granted in successful students and professionals. Therefore, identifying course and learning formats that can support effective time management skills can assist instructors in effectively preparing their students for employment. While previous research has examined the relationship between time management, online learning outcomes, and self efficacy, fewer investigations have been conducted with students who were forced into an online setting. Moreover, the limited research on this forced transition highlights the need for further research [2]. In this paper, we study students' time management behaviors and self efficacy in a course offered at the University of California Irvine (UCI) in both a remote and a hybrid format during the COVID-19 pandemic.

The relationship between time management and self efficacy is not a new subject of study. Researchers developed the Time Management Behavior Scale to gauge students' feelings in four categories: setting goals and priorities, planning and scheduling, perceived control of time, and preferred degree of disorganization [3]. Responses to the questionnaire demonstrated that students who partook in more time management practices had higher levels of satisfaction with their lives and tended to have higher GPAs and self-reported success. While the study gave compelling evidence for a connection between time management and self efficacy, COVID-19 hindered many students' ability to allocate time for studying and well-being in the same manner they had prior to the pandemic, partially due to the way it "distorted [their] flow of time" [4]. Students recorded the effects of this alteration in time diaries, writing that "the effort put into class feels more intensive yet yields much worse results", and even when they could complete their work, "it takes much longer" [2]. These responses suggest that students are no longer getting the expected returns from their time spent studying. In [5], a modified version of the Time Management Behavior scale [3] was used to evaluate the time management behaviors of undergraduate electrical and computer engineering students prior to the pandemic, and students' perceived control of time was the factor that correlated most significantly with cumulative GPA. However, while time management behaviors seemed to have an impact on academic performance, "they only accounted for a small percentage of the variability of the cumulative GPA, implying that there are other factors, such as study skills, problem solving, socioeconomics, and personality" that warrant exploration [5].

The ways in which the COVID-19 pandemic has impacted students have been broad and dramatic. In general, COVID-19 had a negative impact on undergraduate students' academic motivation and sense of belonging [6]. A qualitative data analysis shows that a majority of engineering students struggled to build relationships with their professors and peers [7]. An analysis of how the transition to remote learning impacted engineering students' access to resources, exam formats, and test anxiety is presented in [8]. An interview study of engineering students and instructors from a calculus course highlights the diverse needs of students and students' decreased access to resources [9]. Research found that undergraduate engineering students were concerned with learning course material, getting instructional support, and time management when transitioning from in person to online/remote learning [10]. A significant portion of students who felt greater anxiety about their ability to learn also struggled with time management during remote instruction. The survey in [10] included two open-ended questions about online class, and one two-item scale which assessed students' confidence in online engineering learning. Nearly a third of responses addressed difficulty in tracking and completing tasks. Students also reported feeling less motivated about learning, found material harder to absorb, struggled to focus at home, and worried about academic performance compared with traditional university education. These combined responses illustrate that online education impacted pre-pandemic perceptions of learning. Even after a return to in person learning, some institutions later mandated a return to remote learning when there were significant increases in infections, such as in Winter 2022. This further disrupted students' study habits and time management, as described by the results of a qualitative study that investigated how students adapted during these disruptive transitions [11]. These studies motivate the need for more longitudinal research on the impacts of the COVID-19 pandemic on engineering education and how to both take advantage of, and avoid the pitfalls of, different learning formats.

A particular challenge for online engineering courses is facilitating virtual laboratory experiments and hands-on projects where students work collaboratively on teams. Typically, students set aside a portion of time during any given week to work with peers on team projects, which is both a social and educational experience that can positively impact learning [12]. Participants and instructors note that projects help reinforce classroom knowledge and help students understand the creation of and adherence to a timeline. However, the pandemic forced these projects to go remote. Some research has been done on hands-on team projects during the pandemic, such as studying the impact of COVID-19 on senior capstone design courses (see, e.g., [13]), but there is less research on team projects in regular lecture and laboratory courses. As universities begin to return to pre-pandemic instruction methods and experiment with hybrid classes, it is important to study these courses in which students are again having to adjust study habits and team-working behaviors.

We present a quantitative analysis of engineering students' responses to survey questions related to their learning strategies and motivation. This survey was given just before final exams in Winter 2021, a term in which all courses were remote, and Winter 2022, which was a unique term at UCI because courses started online and returned to in person later in the term. Therefore, Winter 2022 was a particularly disruptive term for the students who had previously experienced the transition to remote learning in Spring 2020 and had transitioned back to in person courses by Fall 2021, only to return to online courses in Winter 2022 due to the spread of highly contagious COVID-19 variants. We analyze the survey responses and institutional data to explore possible relationships between time management, self-efficacy, course load, and academic performance, comparing survey responses from students who were enrolled in the different class formats. Specifically, we employ non-parametric methods for hypothesis testing and assessing rank correlation of students' self-reported survey responses. The results showcase how different learning formats and disruptive transitions on students' learning impact students' learning behaviors, such as time management.

Research Questions

Our work is motivated by the following research questions.

- R1: Do undergraduate engineering students manage their time differently when learning in person versus online or in a hybrid format?
- R2: Do undergraduate engineering students report different levels of self efficacy when learning in person versus online or in a hybrid format?
- R3: Is there a relationship between students' self reported time management and their feelings of self efficacy when learning in different formats?

R4: Is there a relationship between students' academic performance (e.g., GPA) and self reported time management or self efficacy when learning in different formats?

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Research Methods

In this section, we describe the data collection and assessment methods used in this study, as well as the survey questions and the demographics of the student participants.

Data Collection

The data for this study consist of self-reported survey data and institutional data from the same course, ENGRMAE 106 Mechanical Systems Laboratory, in two different terms, Winter 2021 and Winter 2022, with the same instructor. The course is a required upper division undergraduate engineering course in Mechanical and Aerospace Engineering at UCI that involves lectures and significant hands-on learning experiences through laboratory experiments and a team project. All study participants were undergraduate engineering students enrolled in the course, and all participation in the study was voluntary and uncompensated, and the survey was administered online just before final exams in both terms.

When in person, as was the case for the second half of Winter 2022, the course project requires students to work in teams of three or four to design and build a pneumatically actuated ground robot that autonomously completes a course. While all students on a team work together to complete the project, to divide the work, each student is responsible for one of four main roles: mechanical design and manufacturing, electrical circuit design and debugging, control system design and microcontroller programming, and experimental testing and analysis. A high degree of collaboration and testing is needed to produce a working robot. Additionally, students worked in these same teams to complete six hands-on laboratory experiments related to mechatronics, control systems, and vibrations throughout the ten-week term. The majority of enrolled students are in their third year and are studying mechanical or aerospace engineering, with a few other students from majors such as computer, biomedical, or materials science engineering, or applied physics. Therefore, the class includes a variety of engineering students who had time to develop study habits in some capacity prior to the COVID-19 pandemic.

When the course was fully remote in Winter 2021, each student received a hardware kit in the mail that they used to design and build a mechatronic device to control the cursor of their computer, similar to a mouse. Students used hardware and software to enable both analog and digital means of controlling the motion of the cursor on the screen. The project culminated in a competition between all of the students using their devices to control a virtual player in an online game. Each individual student also used software and their hardware kit to perform remote laboratory experiments throughout the quarter. A description and initial assessment of the transition to remote learning for this course in Spring 2020 is given in [14].

The Winter 2021 course was fully remote for all students. The Winter 2022 course was fully remote for the first four weeks for all students, and then was in a hybrid format for the remaining six weeks of the quarter for all students. This delayed all manufacturing work until hybrid instruction began. Laboratory experiments, team projects, and two lectures per week were in person, and the third lecture per week was given synchronously online (which was the preference of the majority of enrolled students). When both Winter 2021 and 2022 courses were remote, online lectures were delivered synchronously with a recording made available immediately after their conclusion. The course is also offered in the Spring term each year with a different instructor. While both Winter and Spring 2021 terms were fully remote, Spring 2022 was fully in person. This may have affected students' decisions to take the course in Winter or Spring in 2022.

To study the relationship between variability in responses to the survey questions and student demographics, we received institutional data for the students who participated in the survey during Winter 2021 and Winter 2022 from the university's Teaching Center. All data were collected with approval from the university's Institutional Review Board.

The numbers and demographics of students who completed the survey are reported in Table 1. The total enrollment in Winter 2021 was 137 students, and 57 students provided responses to the survey questions. The total enrollment in Winter 2022 was 192 students; demographic information is only available for 164 of those students, and 141 students provided responses to the survey questions.

Table 1: Total numbers of students who were enrolled and who responded to the survey in Winter 2021 and Winter 2022.

	Number of Students (and % of total in each category)			
	Winter 2021		**Winter 2022**	
Group	Enrolled	Respondents	Enrolled	Respondents
Total	137 (100%)	57 (100%)	164 (100%)	141 (100%)
Low income	39 (28.5%)	17 (29.8%)	36 (22.0%)	31 (22.0%)
First Gen.	66 (48.2%)	29 (50.9%)	57 (34.8%)	49 (34.8%)
Transfer	36 (26.3%)	15 (26.3%)	6 (3.66%)	6 (4.3%)
Female	19 (13.9%)	10 (17.5%)	39 (23.8%)	34 (24.1%)
URM[1]	48 (35.0%)	17 (29.8%)	58 (35.4%)	47 (33.3%)
Freshmen	1 (0.73%)	0 (0%)	0 (0%)	0 (0%)
Sophomore	0 (0%)	0 (0%)	2 (1.22%)	1 (0.71%)
Junior	50 (36.5%)	21 (36.8%)	28 (17.1%)	27 (19.2%)
Senior	86 (62.8%)	36 (63.2%)	134 (81.7%)	113 (80.1%)

Assessment Methods

We perform hypothesis-testing of the collected data to investigate differences in the responses to the survey questions listed above from the students enrolled in Winter 2021 as compared to Winter 2022. For the hypothesis-testing, we employ Kruskal-Wallis nonparametric statistical tests, which are tests that compare the medians of groups of data to determine if their samples come from the same population (or distribution). In these analyses, the null hypothesis is that

[1]UCI defines Underrepresented Minority (URM) students as those who identify as Black, Latino, American Indian, Pacific Islander, Chicano, or Filipino.

responses from different groups of students come from the same distribution. Therefore, if the p-value is small (e.g., $p < 0.05$), we would reject the null hypothesis and say that there are statistically significant differences between the responses of students from different groups.

We also investigate correlations between responses to different survey questions and institutional data, which include course grade, term GPA, number of units students are taking in the term, and cumulative GPA. We do this by performing pairwise comparisons using Spearman's rank-order tests on responses from survey questions and the institutional data, which give correlation coefficients and corresponding p-values. The null hypothesis is that there is no monotonic association between the data.

Survey Questions

The survey questions we analyze in this study are given below and are taken from the Motivated Strategies for Learning Questionnaire (MSLQ) [15]. The MSLQ is a comprehensive and widely used survey instrument that has been used and validated in engineering education [16].

The first eight survey questions (Q1-Q8) ask about learning strategies such as time management and study environment. The next eight survey questions (Q9-Q16) ask about students' motivation related to self efficacy for learning and performance. Responses to these questions are reported on an anchored numeric scale from 1 to 7 where 1 = 'Strongly Disagree' and 7 = 'Strongly Agree'.

Learning Strategies, including time management:

Q1: I usually study in a place where I can concentrate on my course work.

Q2: I make good use of my study time for this course.

Q3: I find it hard to stick to a study schedule.

Q4: I have a regular place set aside for studying.

Q5: I make sure I keep up with the weekly readings and assignments for this course.

Q6: I attend class regularly.

Q7: I often find that I don't spend very much time on this course because of other activities.

Q8: I rarely find time to review my notes or readings before an exam.

Motivation related to self efficacy for learning and performance:

Q9: I believe I will receive an excellent grade in this class.

Q10: I'm certain I can understand the most difficult material presented in the readings for this course.

Q11: I'm confident I can understand the basic concepts taught in this course.

Q12: I'm confident I can understand the most complex material presented by the instructor in this course.

Q13: I'm confident I can do an excellent job on the assignments and tests in this course.

Q14: I expect to do well in this class.

Q15: I'm certain I can master the skills being taught in this class.

Q16: Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.

Results

First, we present the statistics of the numerical responses to survey questions Q1–Q16 as box plots in Figure 1. The p-values from pairwise Kruskal Wallis tests comparing the responses of students from the two different terms are shown in each sub-figure's title. For Q1-Q8, the questions related to learning strategies such as time management and study environment, the most significant differences in students' responses ($p < 0.05$) between the two terms appear in Q6 and Q7. This signifies that students in the fully remote course (W21) reported greater agreement with the statement "Q6: I attend class regularly" and greater disagreement with the statement "Q7: I often find that I don't spend very much time on this course because of other activities" as compared to the students in the hybrid course (W22). For Q9-Q16, the questions regarding motivation related to self efficacy for learning and performance, the differences in responses are significant ($p < 0.05$) for all questions except Q15. These results highlight that students in the hybrid learning format (W22) reported weaker agreement or more disagreement with the motivation and self efficacy questions, which signifies lower self efficacy.

Next, we explore correlations between students' responses and students' numerical grade (from 0-4) in the course, term GPA (from 0-4), number of enrolled units in the term, and cumulative GPA (from 0-4). We present Spearman rank correlation coefficients when comparing each of these institutional data as well as the responses to survey questions Q1-Q16. The results are shown in Tables 2 and 3, and the results with p-values of $p < 0.05$ are highlighted in red. The results generally show similar trends between the two courses in terms of positive or negative correlations, but there are a greater number of significant correlations for the hybrid learning format course (W22, Table 3). For example, there is a larger positive rank correlation coefficient for term units and cumulative GPA for W22 (0.314) as compared to W21 (0.065).

We discuss the implications of these correlations, as well as how these results in Figure 1 and Tables 2 and 3 answer our research questions, in the next section.

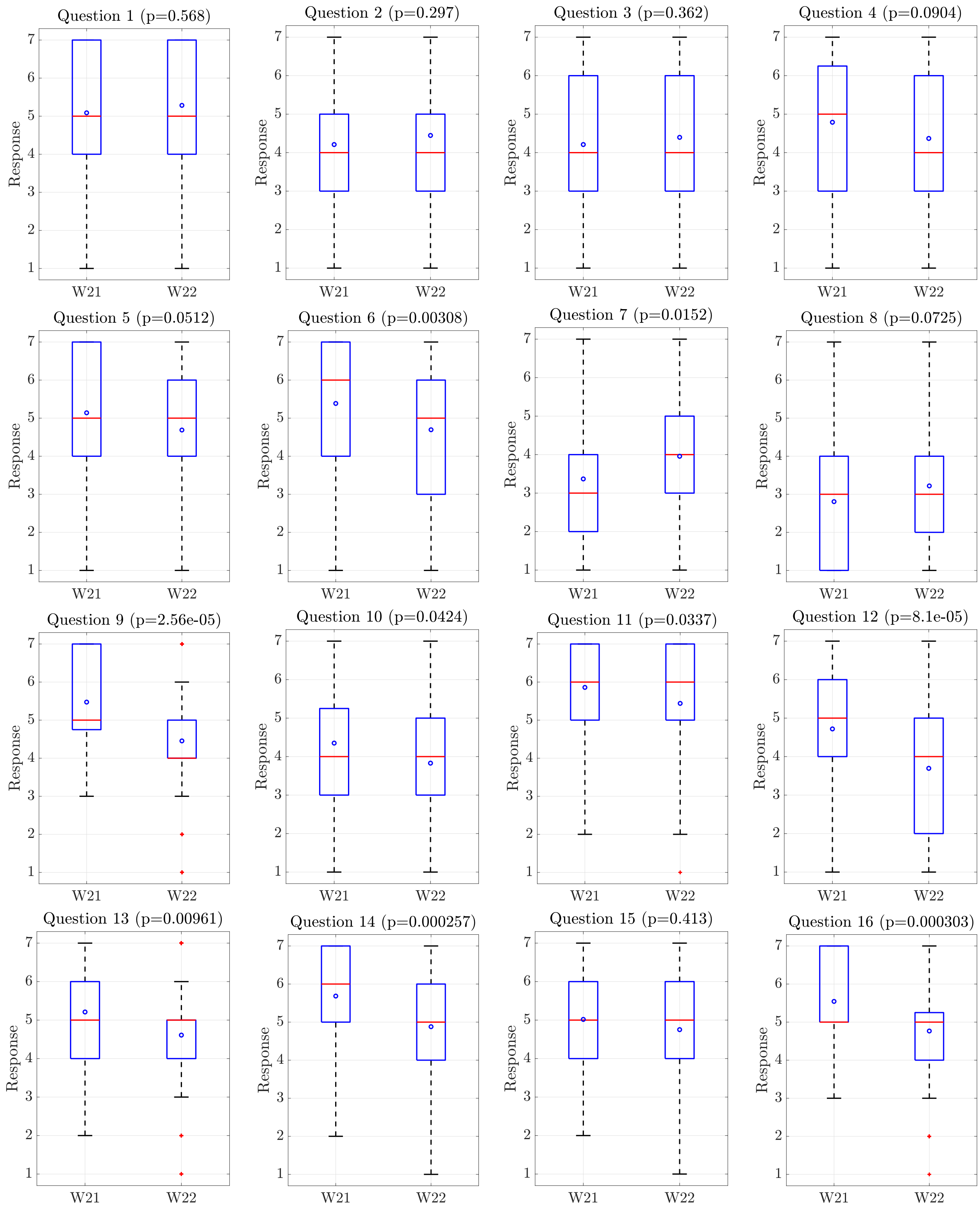

Figure 1: Responses to Q1-Q16. The red line indicates the median, the blue circle indicates the mean, the top and bottom edges of the box indicate the 25th and 75th percentiles, and the whiskers extend to data points not considered to be outliers. Outliers are plotted as red +'s.

Table 2: Spearman rank correlation coefficients for Winter 2021 data. Values marked in red have corresponding p-values of $p < 0.05$.

	Course grade	Term GPA	Term units	Cumulative GPA	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Course grade	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term GPA	0.559	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term Units	0.131	0.119	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative GPA	0.469	0.818	0.065	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q1	-0.111	0.121	0.160	0.176	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q2	0.006	0.079	0.053	0.110	0.541	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q3	0.157	-0.105	0.048	-0.223	-0.484	-0.484	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Q4	0.087	0.119	0.281	0.047	0.161	0.299	-0.191	1.000	-	-	-	-	-	-	-	-	-	-	-	-
Q5	0.152	0.298	-0.107	0.321	0.256	0.352	-0.408	0.279	1.000	-	-	-	-	-	-	-	-	-	-	-
Q6	0.326	0.250	-0.241	0.234	0.008	0.133	0.078	-0.082	0.405	1.000	-	-	-	-	-	-	-	-	-	-
Q7	-0.108	-0.011	0.203	-0.126	0.084	-0.122	0.274	0.083	-0.252	-0.463	1.000	-	-	-	-	-	-	-	-	-
Q8	-0.202	-0.323	-0.088	-0.300	-0.118	-0.156	0.253	-0.350	-0.514	-0.246	0.279	1.000	-	-	-	-	-	-	-	-
Q9	0.384	0.324	-0.075	0.352	0.119	0.294	-0.302	0.079	0.327	0.275	-0.337	-0.107	1.000	-	-	-	-	-	-	-
Q10	0.335	0.149	-0.080	0.270	0.123	0.147	-0.272	0.128	0.397	0.265	-0.311	-0.316	0.514	1.000	-	-	-	-	-	-
Q11	0.447	0.317	-0.016	0.290	0.038	0.134	-0.228	0.235	0.402	0.393	-0.471	-0.408	0.448	0.531	1.000	-	-	-	-	-
Q12	0.364	0.140	-0.074	0.162	-0.018	0.027	-0.186	-0.178	0.317	0.391	-0.262	-0.261	0.427	0.672	0.433	1.000	-	-	-	-
Q13	0.442	0.402	-0.170	0.441	0.038	0.197	-0.278	-0.092	0.496	0.404	-0.374	-0.265	0.716	0.527	0.608	0.653	1.000	-	-	-
Q14	0.405	0.276	-0.123	0.336	0.045	0.085	-0.196	0.121	0.393	0.316	-0.315	-0.244	0.687	0.549	0.563	0.541	0.760	1.000	-	-
Q15	0.232	0.126	0.002	0.142	-0.076	-0.098	-0.156	-0.081	0.259	0.111	-0.209	-0.261	0.448	0.419	0.395	0.593	0.623	0.583	1.000	-
Q16	0.425	0.201	-0.056	0.220	0.098	0.136	-0.096	-0.006	0.249	0.297	-0.302	-0.144	0.624	0.390	0.511	0.535	0.728	0.760	0.605	1.000

Table 3: Spearman rank correlation coefficients for Winter 2022 data. Values marked in red have corresponding p-values of $p < 0.05$.

	Course grade	Term GPA	Term units	Cumulative GPA	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Course grade	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term GPA	0.736	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term units	0.188	0.202	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative GPA	0.612	0.792	0.314	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q1	0.075	0.112	0.243	0.150	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q2	0.134	0.198	0.036	0.132	0.361	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Q3	-0.150	-0.217	-0.062	-0.198	-0.083	-0.382	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Q4	0.046	0.125	0.013	0.174	0.227	0.139	-0.205	1.000	-	-	-	-	-	-	-	-	-	-	-	-
Q5	0.169	0.191	0.009	0.158	0.273	0.495	-0.248	0.216	1.000	-	-	-	-	-	-	-	-	-	-	-
Q6	0.159	0.182	0.221	0.106	0.150	0.340	-0.330	0.132	0.409	1.000	-	-	-	-	-	-	-	-	-	-
Q7	-0.246	-0.182	-0.024	-0.179	-0.019	-0.361	0.315	-0.116	-0.376	-0.354	1.000	-	-	-	-	-	-	-	-	-
Q8	-0.207	-0.182	-0.065	-0.186	-0.330	-0.094	0.220	-0.114	-0.207	-0.157	0.325	1.000	-	-	-	-	-	-	-	-
Q9	0.352	0.374	0.203	0.369	0.160	0.244	-0.206	0.150	0.138	0.206	-0.144	-0.123	1.000	-	-	-	-	-	-	-
Q10	0.240	0.215	0.263	0.291	0.119	0.266	-0.238	0.124	0.205	0.261	-0.110	0.003	0.519	1.000	-	-	-	-	-	-
Q11	0.282	0.237	0.122	0.150	0.304	0.358	-0.008	0.013	0.158	0.295	-0.194	-0.248	0.349	0.361	1.000	-	-	-	-	-
Q12	0.178	0.216	0.206	0.254	0.058	0.300	-0.228	0.034	0.175	0.241	-0.083	0.061	0.434	0.762	0.305	1.000	-	-	-	-
Q13	0.334	0.324	0.221	0.289	0.239	0.296	-0.187	-0.002	0.234	0.295	-0.258	-0.309	0.558	0.466	0.486	0.516	1.000	-	-	-
Q14	0.263	0.230	0.091	0.234	0.271	0.393	-0.203	0.118	0.323	0.254	-0.241	-0.266	0.666	0.406	0.447	0.402	0.608	1.000	-	-
Q15	0.248	0.261	0.075	0.215	0.197	0.334	-0.135	-0.015	0.254	0.184	-0.192	-0.132	0.522	0.486	0.515	0.529	0.524	0.528	1.000	-
Q16	0.383	0.359	0.106	0.281	0.249	0.371	-0.149	0.114	0.249	0.250	-0.275	-0.230	0.654	0.375	0.511	0.344	0.577	0.715	0.549	1.000

Discussion

In this section, we discuss the results presented above in the context of the four research questions R1-R4.

R1 (restated): Do undergraduate engineering students manage their time differently when learning in person versus online or in a hybrid format? R2 (restated): Do undergraduate engineering students report different levels of self efficacy when learning in person versus online or in a hybrid format?

The box and whisker plots in Figure 1 shed light on student learning strategies, time management, and self efficacy across different learning formats. While the results for both course formats are similar, there is a consistent trend of students in the remote course (W21) reporting better time management, study habits, and self efficacy than the students in the hybrid course (W22). For example, in Q6, students in the remote course reported that they attended class more frequently than students in the hybrid course. Additionally, in Q8, students in the remote course were more likely to strongly disagree that they rarely found time to review notes before an exam, though the median response for both courses was slight disagreement.

Regarding self efficacy, students in the remote course reported feeling more confident that they will receive an excellent grade in the course (Q9) and greater confidence in their ability to learn the most complex material (Q12) as compared to students in the hybrid course. This could be attributed to having more dedicated or regular study spaces and less social activities, allowing them to spend more time on assignments than in the hybrid format. The responses to Q4 and Q7 support this hypothesis: students in the remote course reported more agreement with the statement that they have a regular place set aside for studying, and students in the hybrid course reported more agreement with the statement that they often don't spend much time on the course because of other activities.

While students in the different courses responded differently to some of the survey questions, the similar response ranges, means, and medians on the box and whisker plots for Q10 and Q11 indicate that students' confidence in understanding course material did not differ between the two course formats. This suggests that perhaps students perceived differences in the way assignments were to be graded in remote versus hybrid settings or that they quantified success differently in each format. For example, students in the hybrid course worked on teams to build a functioning robot, whereas students in the remote course worked individually with a hardware kit at home. Therefore, the teamwork aspect of the hybrid course may have played a role in lowering some students' confidence in receiving a good grade, even if they reported confidence in mastering the course material as an individual.

These results highlight how students may have felt it natural to transition back to remote learning during Winter 2022 with study habits that became routine during the previous year of remote education, while the transition back and forth between starting in person in Fall 2021 and experiencing a hybrid format in Winter 2022 may have been disruptive and negatively impacted time management and self efficacy.

R3 (restated): Is there a relationship between students' self reported time management and their feelings of self efficacy when learning in different formats? R4 (restated): Is there a relationship *between students' academic performance (e.g., GPA) and self reported time management or self efficacy when learning in different formats?*

The results show that students' time management and self efficacy are related in both course formats, but the strongest correlations were often found in the remote course (shown in Table 2). For example, more regular class attendance (Q6) was more strongly correlated to higher self efficacy (Q9-Q16) among students enrolled in the remote course as compared to the hybrid course.

Just as is the case for relationships between time management and self efficacy, the results suggest that academic performance and self-reported time management and self efficacy are related regardless of the learning format. The strongest correlations were often found in the remote course (shown in Table 2), however, there are a greater number of significant correlations between survey responses and grades and term units for students in the hybrid format (shown in Table 3). In general, students who expected to receive a higher course grade were more likely to report confidence in understanding and mastering basic and complex course material. Analyzing term GPA revealed similar insights. Higher term GPAs were associated with having better time management skills. More specifically, respondents with higher term GPAs were more vigilant in keeping up with weekly readings and finding more time to review notes before exams. Students with higher term GPAs also indicated that they were better equipped to understand the course's basic concepts and receive better grades on homework and exams. Beyond term GPA, cumulative GPA was also examined. A higher cumulative GPA was related to having more time to review notes prior to tests, success on tests and assignments, expectations of doing well in the course and receiving a good grade, and understanding course material.

Of the institutional data analyzed, term units was least frequently correlated to time management or self efficacy. In fact, the strongest correlation with term units for the remote course was having a regular study space (Q4). This contrasts with the hybrid course data which show term units more strongly correlated to regular class attendance (Q6), higher assignment and overall grade expectations (Q9 and Q13), improved reading comprehension (Q10), and a better understanding of the most complex course material (Q12). Therefore, the number of units students are enrolled in is less related to academic performance and self efficacy for the remote course as compared with hybrid course.

Limitations

The data sets with responses from Winter 2021 and Winter 2022 have different sizes, with a much larger fraction of students enrolled in the course completing the survey in Winter 2022 as compared to Winter 2021 (see Table 1). This may lead to results that are not representative of the entire student population in Winter 2021. The difference in response rates may be partially attributed to face to face communication about survey completion between the instructor and the students. It is also possible that students were more motivated to share their experience in the hybrid format in Winter 2022 because it was another novel learning format, as compared to Winter 2021 which was fully remote just as the previous two terms. Furthermore, we only investigated responses from students in two different learning formats, namely fully remote and half remote plus half in person. Future work can compare the results from these terms with terms that are offered in different formats, including fully in person and optionally online or in person.

Conclusion and Future Work

The COVID-19 pandemic forced many higher education institutions to close their doors and offer strictly remote or hybrid classes for nearly two years. The drastic changes to how courses were delivered created major disruptions in students' routines and usage of time. Using a survey sent out to engineering students enrolled in the same course at the conclusion of Winter 2021 and Winter 2022, data were collected on students' time management, self efficacy, and academic performance. The Winter 2021 course was completely remote, while the Winter 2022 course was remote for the first half of the term and hybrid for the remainder of the term. Between the two formats, students in the remote course reported more effective time management and higher self efficacy, perhaps due to the limited alternative activities in which they could partake. Academic performance was also found to be correlated with time management and self efficacy; students with higher term and overall GPAs reported using time more efficiently and feeling more capable of learning, particularly online.

These results inform pathways for future research. Data for the hybrid course came from a more unconventional setup: a month of the course was strictly remote before becoming hybrid during the start of midterm exams. Because of the timing on the return to campus, students may have felt more stressed than if the course were fully remote, and this could have affected their self efficacy. Qualitative data from open-ended questions or interviews may shed more light on the subject. Additionally, this study can be expanded to include a fully in person term for the same class to compare more course formats. Finally, the course selected for study was an upper division course with lectures, laboratory experiments, and a team project. It would be interesting to examine how results may differ in lower division or lecture and discussion based courses.

References

[1] J. Bourne, D. Harris, and F. Mayadas, "Online engineering education: Learning anywhere, anytime," *Journal of Engineering Education*, vol. 94, no. 1, pp. 131–146, 2005.

[2] B. J. Sottile, L. E. Cruz, Y.-A. L. Burleson, and K. McLain, "It's about time: An analysis of student activities under remote learning," in *2021 ASEE Virtual Annual Conference Content Access*, 2021.

[3] T. H. Macan, C. Shahani, R. L. Dipboye, and A. P. Phillips, "College students' time management: Correlations with academic performance and stress." *Journal of educational psychology*, vol. 82, no. 4, p. 760, 1990.

[4] E. A. Holman and E. L. Grisham, "When time falls apart: The public health implications of distorted time perception in the age of COVID-19." *Psychological trauma: theory, research, practice, and policy*, vol. 12, no. S1, p. S63, 2020.

[5] R. V. Adams and E. Blair, "Impact of time management behaviors on undergraduate engineering students' performance," *Sage Open*, vol. 9, no. 1, p. 2158244018824506, 2019.

[6] E. K. Marler, M. J. Bruce, A. Abaoud, C. Henrichsen, W. Suksatan, S. Homvisetvongsa, and H. Matsuo, "The impact of COVID-19 on university students' academic motivation, social connection, and psychological well-being." *Scholarship of Teaching and Learning in Psychology*, 2021.

[7] L. A. Gelles and A. Walker, “Return to in-person learning and undergraduate student sense of belonging during the fall 2021 semester,” in *2022 ASEE Gulf Southwest Annual Conference*, 2022.

[8] D. A. Copp and A. J. Headley, “Test anxiety and its impact on diverse undergraduate engineering students during remote learning,” in *2021 ASEE Virtual Annual Conference*, 2021.

[9] L. A. Duncan, K. A. High, D. M. Boyer, and L. McKinley, “COVID-19: Understanding the impact of societal disruption on student learning and academic progress,” in *2021 ASEE Virtual Annual Conference Content Access*, 2021.

[10] S. Orton, F. Yu, J. Milord, L. Flores, and R. Marra, “The concerns and perceived challenges that students faced when traditional in-person engineering courses suddenly transitioned to remote learning,” in *2022 ASEE Annual Conference & Exposition*, 2022.

[11] T. Esfahani and D. A. Copp, “In their own words: How engineering students adapted to disruptive transitions between online and in-person learning,” in *2023 ASEE Pacific Southwest Conference*, 2023.

[12] O. Pierrakos, M. Borrego, and J. Lo, “Assessing learning outcomes of senior mechanical engineers in a capstone design experience,” in *2007 Annual Conference & Exposition*, 2007, pp. 12–269.

[13] S. A. Wilkerson and S. A. Gadsden, “Project based capstone design projects amidst Covid-19 restrictions,” in *2021 ASEE Virtual Annual Conference Content Access*, 2021.

[14] L. L. Wu, E. Zhu, C. Callaghan, D. Irwin, D. Reinsdorf, V. Swanson, A. Zwirn, and D. Reinkensmeyer, “Rapidly converting a project-based engineering experience for remote learning: Successes and limitations of using experimental kits and a multiplayer online game.” *Advances in Engineering Education*, vol. 8, no. 4, 2020.

[15] P. R. Pintrich, D. A. F. Smith, T. Garcia, and W. J. McKeachie, “A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ),” The University of Michigan, Tech. Rep., 1991.

[16] O. Adesope, N. Hunsu, B. van Wie, B. Austin, R. Richards, and P. Dutta, “Work in progress: Assessing engineering students’ motivation and learning strategies-a psychometric analysis of the motivated strategies for learning questionnaire,” in *Proceedings of the American Society for Engineering Education Annual Conference & Exposition*, 2017, pp. 1–6.