Work in Progress: Impact of COVID-19 pandemic on a first-year engineering cohort ranging from learning methods, personal decisions and university experience.

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Work in Progress: Impact of COVID-19 Pandemic on the Learning Methods, Personal Decisions, and University Experiences of First-Year Engineering Students

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Introduction

The rapid outbreak of COVID-19 as a highly contagious respiratory disease has impacted the way every person lives day to day [1]. Specifically, this pandemic has caused educational institutions all around the world to take immediate adaptive measures. Most have closed their face-to-face learning environments and have transitioned to remote or distance learning and working from home. According to an UNESCO report, the COVID-19 pandemic affected up to 85% of total enrolled learners with more than 150 countries confronting school closures during the initial months of the pandemic [2]. At this stage it is too early to tell what the fallout of this pandemic will be; however, it is safe to say that colleges and universities have been forced to adapt to these new conditions.

Within engineering departments and STEM departments more generally, in-person laboratories are essential to a student's perception and understanding of course material and the specific topics at hand. Engineering departments are well-known to be "hands-on" departments as most core courses require laboratory experiences. Thus, distance learning was rarely used for engineering-related curriculum. Possible advantages from online education include the ability to access material and notes at the student's own pace at any time, which in turn, may help students to grasp concepts more efficiently. Moreover, the information and content of courses is starting to become widely available among multiple institutions [3]. However, many challenges exist related to the execution and delivery of online classes. The face-to-face interactions students and instructors had become accustomed to have suddenly transitioned into minimal interactions where mostly the instructor is doing all the talking [4], [5]. The substantial efforts from universities and instructors, compel us to evaluate the impact that this pandemic has had on our students.

This study focuses on the perceptions of engineering majors in introductory engineering courses that have been affected by the pandemic, in some cases shifting completely to online or virtual lab activities. First-year engineering students started college amid a pandemic and represent a unique population; having not had a traditional university experience. It has been previously reported that when looking at levels of anxiety reported among college students, freshmen were less likely to report high levels of anxiety, and females showed a higher perceived stress than others [6]. Available literature examining the impact of the COVID-19 in the United States is limited and mostly focuses on students involved in health professions [7]–[9]. Research that focuses on the effects of COVID-19 on learning methods, personal decisions, and university experiences of students is even narrower. Furthermore, little is known about contributing factors that lead to worsening of students' social and psychological well-being and how these factors are related to demographic information.

The focus of the current investigation is on first-year engineering students at a Historically Black University (HBU) in the Southeastern U.S. The objective of the study is to examine the effects of the pandemic on freshman engineering students by asking them to compare various aspects of their academic and personal life to before and during the pandemic. Questions ranging from current schoolwork, to future plans and well-being are addressed. This information may inform both long-term and immediate changes that universities and instructors may be able to take to improve student learning outcomes and experiences within engineering programs.

Methods

An initial online survey was sent to 383 students among eight different sections of a first-year engineering course that was being conducted in a 100% remote learning environment during the Fall 2020 semester. The online questionnaire included a total of 10 COVID-related questions, each on a 5-point Likert scale. The questionnaire asks questions related to student perceptions of their living arrangements, ability to focus, relationships, learning environment, future plans, and overall well-being regarding the pandemic situation. Below we discuss descriptive findings from the survey. We first present findings on the impact of COVID-19 across all student demographics for each of the survey items. Next, we look at the overall impact of COVID-19 as measured across all survey items by specific student demographic groups. Last, we focus specific attention on the relationship between gender and the different COVID-19 impacts assessed by the survey.

Results and Discussion

Overall findings of survey items

A total of 226 completed and usable surveys were submitted by the students. Overall enrollment in the GEEN 100 courses was 383 producing a Response Rate (RR=59%). Table 1 includes information on student response to each of the COVID-19 impact items across all demographic groups. For analytical purposes we have divided the items into two categories based on whether the item was assessing short-term or long-term impacts. In regard to short-term impacts, a very large majority of students reported that their ability to (Q2) focus on schoolwork during the Pandemic is worse (27.5%) or much worse (40.2%) than it was before the pandemic. A similarly large majority reported that their (Q4) learning environment was worse during the pandemic with 24.1% reporting it was much worse and 50.9% reporting it was worse. A majority of students reported feeling worse or much worse (60%) about their (Q5) current coursework during that pandemic than before. A majority of students reported feeling worse or much worse about their (Q9) psychological well-being (52.1%) during the pandemic than before it. A majority of students also reported feeling worse or much worse about their (Q10) social well-being (55.3%) during the pandemic than before it. Nearly half of students reported feeling worse or much worse about their (Q3) connection and relationships with others (49.6%) during the pandemic than before it. Despite the substantial impacts reported by students in these areas, a majority of them reported feeling about the same, better, or much better (75.6%) about their financial well-being (Q8) during the pandemic than before it. Additionally, a large majority

reported feeling about the same, better or much better (87%) about their (Q1) living arrangements during the pandemic as they did before.

In regard to the more long-term impacts assessed by the items, 77.5% of students reported feeling about the same, better, or much better about their future academic plans (Q6), and 82.7% of students reported feeling about the same, better, or much better about their future career (Q7). It is likely that we are seeing a strong impact of socio-economic class as it relates to the items assessing financial well-being, living arrangements, future academic plans, and future career. On each of these items, the overwhelming majority of students we surveyed reported having not been impacted. However, this is likely because 61.6% of students reported household annual incomes that are likely above the current national median household income, which in 2018 was $63,179.

Table 1: Valid percentage and frequency values for COVID-19 related questions.

	Valid Percentage (Frequency)				
Compared to before the COVID-19 pandemic, how do you feel in general about:	*Much Worse*	*Worse*	*About the same*	*Better*	*Much Better*
Q1. Your living arrangements?	*1.7* *(4.0)*	*11.3* *(26)*	*74.3* *(171)*	*7.0* *(16)*	*5.7* *(13)*
Q2. Your ability to focus on schoolwork?	*27.5* *(63)*	*40.2* *(92)*	*19.7* *(45)*	*11.4* *(26)*	*1.3* *(3.0)*
Q3. Your connection and relationships with others?	*13.5* *(31)*	*36.1* *(83)*	*37.8* *(87)*	*9.1* *(21)*	*3.5* *(8.0)*
Q4. Your learning environment?	*24.1* *(55)*	*50.9* *(116)*	*17.1* *(39)*	*5.7* *(13)*	*2.2* *(5.0)*
Q5. Your current coursework?	*22.2* *(51)*	*37.8* *(87)*	*32.6* *(75)*	*6.5* *(15)*	*0.9* *(2.0)*
Q6. Your future academic plans?	*4.8* *(11)*	*17.4* *(40)*	*66.1* *(152)*	*9.1* *(21)*	*2.3* *(6.0)*
Q7. Your future career?	*2.6* *(6.0)*	*12.7* *(29)*	*71.6* *(164)*	*9.6* *(22)*	*3.5* *(8.0)*
Q8. Your financial well-being?	*5.7* *(13)*	*18.8* *(43)*	*60.3* *(138)*	*10.9* *(25)*	*4.4* *(10)*
Q9. Your psychological well-being?	*21.7* *(50)*	*30.4* *(70)*	*40* *(92)*	*3.9* *(9.0)*	*3.9* *(9.0)*

Q10. Your social well-being?	*19.6*	*35.7*	*35.7*	*5.7*	*3.5*
	(45)	*(82)*	*(82)*	*(13)*	*(8.0)*

Assessing survey impact on demographic categories

Next, we combined each of the 10 items assessing COVID-19 impacts into an additive COVID-19 impacts index (Table 2). Given that responses to each item ranged from 1 "much worse" to 5 "much better," total scores on the index for each student could range from 10 to 50. A student reporting neither positive nor negative impacts on all the items (i.e., 3 "about the same"), would score a 30 on the index. Consequently, scores below 30 on the index reflect students reporting being worse off than before COVID-19. Table 2 presents data on mean COVID-19 impact index scores by selected demographic groups. Females (24.8) reported a higher level of negative impacts from COVID-19 than Males (26.2). We found no notable difference in COVID-19 impact between Black or African American students and non-Black or African American students. The data do reflect some noticeable difference in COVID-19 impact and employment status with students who are employed full-time reporting fewer negative impacts (29.8), students who are employed part time and students who are unemployed. Students across all income categories report at least some negative impacts from COVID-19 with scores on the index ranging from a low of 24.8 for students with annual household incomes of $20,000-$39,999 to 26.4 for students with annual household incomes of less than $20,000. Similar levels of negative impacts from COVID-19 were reported, across all GPA categories where scores on the index ranged from a low of 24.8 to a high of 25.7. Lastly, students across all academic ranks reported negative impacts from COVID-19 with scores ranging from 24 to 25.7.

Self-Identified Gender Differences

The following results related to finding differences among self-identified gender for all survey questions. Recall that each of the items in the COVID-19 Impact Index is arranged on a 5-point Likert scale with lower scores indicating a student's feeling worse off than before COVID-19 and higher scores indicating a student's feeling better than before COVID-19. Consequently, average item scores for a given gender group (i.e., female, male, other), of three indicate that students in this group feel "about the same" as they did before COVID-19. Average item scores below 3 for a given group indicate that students in this group feel "worse" than they did before COVID-19, and average item scores above 3 indicate that students in this group feel "better" than they did before COVID-19.

The figures in Table 3 indicate that members of all gender groups reported feeling "about the same" in regard to their living arrangements. However, members of all gender groups on average reported feeling worse about their ability to focus on their schoolwork with females reporting the greatest negative impact in this area. Mean scores on this item for females was 2, for males 2.3, and for students identifying as other gender 2.1. Members of all gender groups also on average reported being negatively impacted in regard to their connection and relationships with others with females scoring on average a 2.6, males a 2.5, and students identifying as other gender a 2.4. Negative impacts from COVID-19 to students' learning environments were also reported across all gender groups with females (2.0) reporting the greatest negative impact, then males (2.1), and then students identifying as other gender. Similar results were found in regard to students' current coursework, with all gender groups reporting negative impacts from COVID-19. Here females again on average scored a 2.2, males a 2.3, and

Table 2: Demographic Characteristics of students who participated in the COVID-19 survey.

Demographic categories	Valid Percentage (Frequency)	Mean Index Score (Standard Deviation)
Gender		
Female	40.2 (92)	24.8 (5.8)
Male	53.7 (123)	26.2 (5.7)
LGTBQ	6.1 (14)	NA
Ethnicity		
Black or African American	79.6 (183)	25.49
Non-Black or African American	20.4 (47)	25.85
Employment Status		
Employed full-time	3.9 (9)	29.8 (8.2)
Employed part-time	30.6 (70)	25.3 (5.0)
Unemployed/looking	25.8 (59)	24.9 (7.1)
Unemployed/not looking	39.7 (91)	25.9 (4.8)
Household Income		
Less than US$20,000	8.4 (19)	26.4 (8.1)
US$20,000-$39,999	12.3 (28)	24.8 (4.6)
US$40,000-$59,999	17.6 (40)	25.4 (6.0)
US$60,000-$79,999	19.8 (45)	25.6 (5.8)
US$80,000-$99,999	10.1 (23)	26.0 (6.3)
More than US$100,000	31.7 (72)	25.7 (5.4)
GPA		
0-1.9	NA	NA
2.0-2.4	1.6 (4.0)	25.3 (2.1)
2.5-2.9	6.1 (15)	24.8 (6.2)
3.0-3.4	19.9 (49)	25.2 (6.1)
3.5-4.0	72.4 (178)	25.7 (5.8)
Academic Rank		
Freshman	76.1 (188)	25.5 (5.72)
Junior	10.1 (25)	25.2 (8.3)
Senior	4.9 (12)	25.7 (5.0)
Sophomore	0.8 (2.0)	24.0 (NA)
Total	100 (261)	25.5

students identifying as other gender a 2.6. Means on the item assessing impacts to students' feelings about their future academic plans reflected slightly fewer negative feelings with females on average scoring a 2.8, males a 2.5, and students identifying as other gender reporting no

impact (3.1). Similar results were obtained in relation to students' reported feelings about their future career with all gender groups on average reporting no impact. On this item females on average scored a 3.0, males a 2.9, and students identifying as other gender a 3.3. In regard to financial well-being, females were more likely to report negative impacts from COVID-19, scoring on average a 2.7 while males and students identifying as other gender scored 3.0 and 3.1 respectively. Students across all gender groups reported negative impacts from COVID-19 in regard to their psychological and social well-being. Here females on average scored 2.1 in regard to their psychological well-being, and 2.2 in regard to their social well-being. Males on average scored 2.6 and 2.5 on these items and students who identified as other gender on average scored 2.1 and 2.4

Table 3: Average agreement for each question following the statement "Compared to before the COVID-19 pandemic, how do you feel in general about…" (1 = much worse; 5 = much better).

Compared to before the COVID-19 pandemic, how do you feel in general about:	Average Agreement		
	Female (n=90)	*Male (n=122)*	*Other (n=14)*
Q1. Your living arrangements?	*3.1*	*3.0*	*3.1*
Q2. Your ability to focus on schoolwork?	*2.0*	*2.3*	*2.1*
Q3. Your connection and relationships with others?	*2.6*	*2.5*	*2.4*
Q4. Your learning environment?	*2.0*	*2.1*	*2.6*
Q5. Your current coursework?	*2.2*	*2.3*	*2.6*
Q6. Your future academic plans?	*2.8*	*2.5*	*3.1*
Q7. Your future career?	*3.0*	*2.9*	*3.3*
Q8. Your financial well-being?	*2.7*	*3.0*	*3.1*
Q9. Your psychological well-being?	*2.1*	*2.6*	*2.1*
Q10. Your social well-being?	*2.2*	*2.5*	*2.4*

Overall, our initial analysis of the descriptive results suggests that a possible gender effect in the impact of COVID-19 on students in these introductory courses. Female students seem to be affected the most on items related to schoolwork as well as psychological and social well-being. Compared to men, females have been shown to have a higher difficulty adapting to this COVID-19 pandemic [10]. This gender effect should be explored further.

While every student has a personal relationship with how COVID-19 has impacted their education and their life, there is an overwhelming trend of students feeling worse in their current

education now than they did before the pandemic. The rapid increase of COVID-19 cases created a tremendous level of uncertainty about the daily activities and the future. The high stress levels can lead to adverse effects on overall learning and mental health of students [11]. This may be a result of the majority of students being first-year students and from above average household income levels This may suggest that the impact of this pandemic may not affect students unless it persists into the medium term. Similar results were also reported by Means and Neisler, as students in that study reported difficulty with focus as well as technical issues surrounding internet stability[12].

The aim of this Work-in-Progress was to identify the effect that the COVID-19 pandemic has had on first-year engineering students' perceptions of both short and long-term educational outcomes. Statistical analysis looking at inter-item reliability will be evaluated to determine if all survey questions were a reliable measure as an additive COVID-19 impacts index. The findings reported here will be further explored by performing small focus group interviews to determine possible differences in impacts of the pandemic between gender groups. In addition, the survey can be readministered when in-person courses are in effect to compare after COVID-19 effects.

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