Return to In-person Learning and Undergraduate Student Sense of Belonging during the Fall 2021 Semester

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Abstract

Currently enrolled undergraduate students have experienced multiple disruptions due to the COVID-19 pandemic and its evolving variants. As institutions react and adapt in myriad ways to maintain operations and keep students and employees safe, students have had to quickly adjust to multiple learning modalities that can change throughout a semester. Depending on when a student started, they may have spent the entirety of their undergraduate experience in remote or hybrid modalities, missing out on building important social connections during their critical first year experience. This paper examines the quantitative survey results of a Sense of Belonging scale with qualitative responses about undergraduate engineering and computer science students' experience during the COVID-19 pandemic during the Fall 2021 semester. Our results revealed that sophomores and seniors had the lowest Sense of Belonging, while first-year students (who started in-person) had the highest. Students faced many challenges during the transition to and from remote learning including isolation and difficulty establishing relationships with peers and faculty. This has implications for issues of equity for entire cohorts of students who had less opportunity and resources to develop relationships and therefore do not have the same informal information pathways that help them successfully navigate the university.

Introduction

The ongoing COVID-19 pandemic that began in Spring 2020 has continued to vex the return to 'normal' in-person instruction at colleges and universities as highly contagious variants proliferate. Prior to the start of the Fall 2021 semester, Texas experienced a surge of COVID-19 cases and hospitalizations due to the delta variant that prompted colleges and universities to consider policies and instruction modalities to ensure the safety and health of the university and surrounding community [1], [2]. As a result of this ongoing disruption, there are multiple cohorts of students who have experienced only online or hybrid teaching modalities (e.g., first and second year students) and later cohorts who had an initial in-person experience, pivoted to online/hybrid, and then returned to in-person (e.g., third year and beyond students). This type of disruption has made it more difficult for students to create and maintain crucial relationships with peers [3]–[5].

Students require a level of social connection with peers, faculty, and advisors within a university setting to persist and complete their education [6], [7]. This sense of belonging (i.e., the perceived sense of support on college campuses and how connected students feel to each other) results in higher levels of motivation, engagement, and academic performance [8]–[10]. As part of an ongoing

retention study using available institutional data and senior exit surveys, our analysis revealed that, prior to the pandemic, students reported feeling a lack of community and social experiences at their university and within their engineering and computer science majors. The pandemic, characterized by isolation and remote learning, has likely exacerbated these perceptions and had a negative influence students' sense of belonging and therefore retention [3], [5].

In order to explore this further, we designed a sequential exploratory mixed-methods study which utilizes a survey collecting qualitative and quantitative responses which informs the second stage of the research (i.e., in-person interviews). This paper will explore preliminary survey results of a quantitative Sense of Belonging scale and qualitative student responses specific to how their experience as an engineering or computer science student has changed or stayed the same as a result of the pandemic.

Background

Institutional Context

The University of Texas at Dallas is a large public research university in the Gulf Southwest region of the United States. During March 2020, the university transitioned to remote learning and the following Fall 2020 and Spring 2021 semester was a mixture of in-person, hybrid, and online learning. Campus operations returned to fully in-person operations in Fall 2021 with individual instructors being able to select their own teaching modality between (1)*Traditional*, taught entirely in person; (2) *Online*, taught asynchronously online; and (3)*Blended/Hybrid*, taught in a mixture of the traditional and online approaches. Because of the continued disruption of the pandemic on university operations, both sophomores and first year students experienced being on campus in-person for the first-time during Fall 2021. Table 1 shows how students were impacted based upon when they started at the university.

Table 1. Percentage of time spent affected by remote/hybrid learning during the COVID-19 pandemic for student cohorts at the start of the Fall 2021 semester.

Cohort	Approximate classification	Percent of time spent at the University affected remote or hybrid learning	1st year retention rate for FTIC students within ECS
Fall 2021	Freshman, 1st year students	Started in-person [0%]	NA
Fall 2020	Sophomore, 2nd year students	Entire previous university experience (1 year) [100%]	82%
Fall 2019	Junior, 3rd year students	1.5 years out of 2 years of university experience [75%]	84%
Fall 2018 and earlier	Senior, 4th year + students	1.5 years out of 3 or more years of university experience [50% or less]	77-81%

ECS has been concerned with undergraduate retention and attrition prior to the COVID-19 pandemic due to consistently low six-year graduation rates compared to the university (51% vs 71% in 2013)

and compared to national averages in engineering programs (~60%)[11]. It was anticipated that the pandemic would negatively affect enrollment. However, enrollment in some disciplines (e.g., computer science) has increased despite decline at other institutions and within other disciplines [12], [13]. While it is still too early to determine the impact of the pandemic on graduation rates within ECS, first year retention for FTIC students is similar to pre-pandemic levels (Table 1).

Sense of Belonging
In our analysis of Senior Exit Surveys, we found that the most frequently listed reason for students not being able to complete their degree in four years was 'Personal Reasons'. They also reported dissatisfaction with teaching quality, a lack of social experiences within ECS, and a competitive culture focused on working hard. These results point towards a 'chilly climate' within the School. Researchers have well documented 'chilly' climates within engineering, especially for women and historically marginalized groups [14]–[16]. This climate and the factors that contribute to it have been linked to attrition from engineering programs [17]–[20]. Underrepresented and historically marginalized students at institutions with 'chilly' climates have reported a lower Sense of Belonging [16], [21].

Sense of Belonging (SB) is the perceived sense of support on college campuses and how connected students feel to each other. SB includes membership, feelings of acceptance, and being cared for or part of the group. Research shows that students who experience more student interaction, have greater sense of community, and felt valued by professors more are more likely to be committed to engineering and thus retained at greater rates [8], [10], [22]. The pandemic and the resulting transition to remote learning has complicated and hindered efforts to maintain or increase SB because students could not physically be in the same spaces with their peers or instructors. While technology-enabled remote teaching has allowed students to continue to learn, instructors and institutions have struggled to replicate the informal social interactions between faculty and students and students and their peers [23]. In a study of computing students and their sense of belonging prior to and after the start of the COVID-19 pandemic, the authors found that sense of belonging decreased for all students [3].

Depending on when a student started their engineering or computer science programs, students could have had vastly different opportunities, barriers, and resources to developing a strong SB. The first year experience is frequently cited as an important time for engineering students to develop social connections [24]. For example, students who started remotely in Fall 2020 and transitioned to in-person did not get the same opportunities and encouragement that typical first-year students get to develop connections and discover important resources on campus. The Fall 2021 Cohort, on the other hand started in-person and could have had a more 'typical' first year experience. The purpose of this study is to explore how the ongoing pandemic and transitions to and from remote learning has affected engineering and computer science students by their academic level (i.e., freshmen, sophomore, junior, senior).

Methods

We designed a sequential exploratory mixed-methods study to explore how students' intention to persist in their engineering or computer science major related to the perceived climate within the

School of Engineering and Computer Science (ECS). This study consists of a survey sent out to the undergraduate student population within ECS followed by semi-structured interviews. Past experiences surveying students within the School have yielded low survey response rates so emphasis was placed on qualitative data, which provides contextually-specific rich data that can provide better insight onto issues of climate.

Climate and Student Persistence Survey (CASPS)
The Climate and Student Persistence Survey (CASPS) was developed using the retention study results to elucidate critical experiences and timeframes within a student's undergraduate education that increase persistence. CASPS was designed to assess this climate through three factors: (1) Sense of Belonging; (2): Pedagogical Experiences; and (3) Engineering Culture. Each section contained quantitative questions and at least one free-response qualitative question. Voluntary Demographic information was also collected in the survey. Further information about the development of this survey will be described in [25]. This paper will primarily focus on the qualitative responses to the COVID-19 question within the Pedagogical Experiences section and their quantitative responses to the Sense of Belonging Scale.

Sense of Belonging Scale
The Sense of Belonging (SB) scale was adapted from [26] and included questions specific to persistence. Students were asked to rate their agreement with 11 statements on a scale of 1-5, where 1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Neutral, 4 = Somewhat Agree, 5 = Strongly Agree. These items were then combined into a composite score to give each participant an overall SB score. Only one item in the scale was reverse coded [i.e., SB-10: I wish I had selected another major] to develop the composite SB score.

COVID-19 Experience Qualitative Question
In another section of the survey, students were asked to respond to the prompt, "How has your experience as a student within ECS changed (or stayed the same) as a result of the COVID-19 pandemic?". This qualitative question was included in this analysis to better understand how the pandemic has affected SB for students.

Research participation and collected data
Data collection for the pilot launch of the survey began in the Fall 2021 semester. After receiving IRB approval, the survey was sent out to all currently enrolled undergraduates on an email list-serv, advertised on official ECS social media (i.e., Facebook, Instagram, twitter) accounts, and posted within engineering and computer science buildings on campus on flyers with a QR code. We received a total of 100 responses to this initial survey. Table 2 describes the demographics of the survey respondents. All questions were voluntary so students could choose whether to answer free-response qualitative questions. There was a total of 67 responses to the COVID-19 experience question. Qualitative questions were analyzed thematically [27], [28].

Table 2. Percentage of self-identified survey respondents by major, gender, race/ethnicity, and level compared to Fall 2021 Enrollment percentages in ECS
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Factor	% of Survey Respondents	Fall 2021 ECS Demographics
Biomedical Engineering	6%	7%
Computer Engineering	3%	8%
Computer Science	57%	52%
Electrical Engineering	12%	9%
Mechanical Engineering	16%	16%
Software Engineering	5%	8%
Freshman	13%	21%
Sophomore	15%	16%
Junior	33%	30%
Senior	36%	33%
Not Indicated	3%	0%

Results

Quantitative Sense of Belonging Scale

The survey participants were mostly ambivalent about their Sense of Belonging (SB) with a mean composite score of 3.4 out of 5. Mean scores and standard deviation for SB items is provided in Table 3. Freshmen had the highest composite SB (SB_{COMP}= 3.9). Sophomores and seniors reported the lowest overall composite SB scores (SB_{COMP}= 3.3) while juniors were lower than the freshman but higher than seniors and sophomores (SB_{COMP}= 3.5). The statements that students disagreed with the most were:

- SB-4: I feel connected and supported by my peers within ECS ($SB\text{-}4_{ALL}$=2.9).
- SB-8: At least one ECS faculty has expressed interest in me as a person ($SB\text{-}8_{ALL}$ =2.7).
- SB-9: I feel there is real sense of community within ECS ($SB\text{-}9_{ALL}$ =2.5).

Freshmen responded positively to SB scale items but were most ambivalent about the statements SB-8 (Faculty expressed interest) and SB-9 (Sense of Community). Unlike all other students, they felt a stronger connection to their peers ($SB\text{-}4_{FRESHMAN}$=3.8 vs $SB\text{-}4_{ALL}$=2.9). Sophomore SB scores were low or ambivalent across most SB items, and they disagreed the most with the statement about faculty expressing interest in them as a person ($SB\text{-}8_{SOPH}$=2.4), and feeling a sense of community within ECS ($SB\text{-}9_{SOPH}$=2.5). Sophomores had relatively higher SB related to working with their peers ($SB\text{-}5_{SOPH}$=3.8 vs $SB\text{-}5_{ALL}$=3.6. Juniors did not show the same high SB as freshman, but reported higher scores than sophomores and seniors. Like others, juniors disagreed that faculty expressed interest in them as a person, and this is the only item where they rated this lower than seniors ($SB\text{-}8_{JUNIOR}$=2.6 vs. $SB\text{-}8_{SENIOR}$=2.7). Seniors reported low SB similar to sophomores and reported the highest intention to persist within their major ($SB\text{-}11_{SENIOR}$=4.7). Seniors felt less comfortable working with their peers than other academic levels ($SB\text{-}5_{SENIOR}$=3.4) and did not feel a sense of community within ECS ($SB\text{-}9_{SENIOR}$=2.1). This was the lowest SB score out of all items on the scale. Despite low or ambivalent Sense of Belonging, students responded overwhelmingly positive to the statement that they intend to persist in their major ($SB\text{-}11_{COMP}$=4.5).

Table 3. Means and standard deviations from the Sense of Belonging scale by academic classification. Questions asked students to agree with a statement on a scale of 1-5 where 1=strongly disagree and 5=strongly agree.

Question key	Question Description	Mean (ALL)	Fresh	Soph	Junior	Senior
SB-1	I enjoy going to school	3.4 (1.1)	3.9 (0.9)	3.5 (0.8)	3.5 (1.1)	3.2 (1.2)
SB-2	The institution has useful resources	3.4 (1.1)	3.9 (0.9)	3.1 (1.0)	3.7 (1.0)	3.1 (1.2)
SB-3	I feel comfortable reaching out to non ECS professors	3.6 (1.1)	4.0 (0.7)	3.2 (1.3)	3.5 (1.1)	3.7 (1.2)
SB-4	I feel connected and supported by my peers	2.9 (1.3)	3.8 (1.2)	2.7 (1.4)	3.1 (1.3)	2.7 (1.2)
SB-5	I feel comfortable working with peers	3.6 (1.1)	4.2 (0.8)	3.8 (1.1)	3.7 (1.0)	3.4 (1.1)
SB-6	I have at least one friend	3.8 (1.6)	4.1 (1.6)	3.8 (1.7)	3.9 (1.5)	3.7 (1.7)
SB-7	I feel comfortable reaching out to ECS professors	3.5 (1.2)	4.2 (0.8)	3.3 (1.2)	3.7 (1.1)	3.3 (1.4)
SB-8	Faculty expressed interest in me as a person	2.7 (1.6)	2.9 (1.7)	2.4 (1.6)	2.6 (1.5)	2.7 (1.6)
SB-9	I feel there is a sense of community here	2.5 (1.3)	3.2 (1.7)	2.5 (1.4)	2.8 (1.1)	2.1 (1.1)
*SB-10	I wish I selected another major	2.4 (1.4)	2.1 (1.2)	2.1 (1.1)	2.5 (1.4)	2.3 (1.5)
SB-11	Intend to stay in my major	4.5 (0.9)	4.3 (0.9)	4.4 (0.8)	4.5 (0.9)	4.7 (1.0)
SB_COMP	Average of all SB items	3.4 (0.7)	3.9 (0.7)	3.3 (0.7)	3.5 (0.7)	3.3 (0.8)

*Reverse Coded for Composite Score

Qualitative Survey Responses

Students were asked: '*How has your experience as a student within ECS changed (or stayed the same) as a result of the COVID-19 pandemic?*' Students described struggles relating to the transition to and from remote learning, especially in their ability to build social relationships. The isolation they experienced went hand in hand with mental health issues. Freshman did not describe many issues while the other academic levels struggled greatly. Some students described losing professional opportunities and also being set back in their degree plans. Seniors also struggled, but they perceived they were close enough to graduating that they could push through. One bright spot was that some students were pleased with the increased accessibility that remote learning brought (e.g., recorded lectures).

Academic Level Differences

Freshmen students described the least number of issues related to the transition to and from remote or hybrid learning. For example, one freshman stated, "*COVID-19 hasn't affected my college life.*" (Freshman, EE, SB_{COMP}=3.0). and another stated that their experience "*[...]stayed the same*" (Freshman, CS, SB_{COMP}=3.5). Qualitatively, Sophomores and Juniors described similar experiences with difficulties adjusting academically and socially. These students were more concerned with how their professional future will be impacted. For example, one student stated, "*My experience feels wasted in a sense because of the pandemic. My lack of ability to get hands on experience within a lab in school has drastically impacted my possibilities of getting an internship. [...] [This] makes my anxiety about the future increase exponentially.*" (Sophomore, EE, SB_{COMP}=2.4). While seniors also expressed difficulties with the transitions, they were able to push through because graduation was within reach. Some described how scholarship and graduation requirements kept them from taking a 'gap year' or reducing the number of classes they were taking to avoid challenges associated with the pandemic. One student stated that the transition to remote learning made them feel "*even more lonely. [I] didn't make long-term friends before and I haven't made any during. And the study group experience that I love about CS is gone. I'm just waiting to graduate now.*" (CS, Senior, SB_{COMP}=3.5)

Difficulty Building Social Relationships

Qualitative responses indicate that students struggled with both the transition to and from remote learning. While students report various levels of adaptation to online/hybrid/in-person pedagogies, the majority of students report struggling to build relationships with their professors and peers. For example, a junior stated that, "*I've not had much opportunity to meet with professors and peers due to the change in structure post-pandemic.*" (Junior, CS, SB$_{COMP=3.1}$). This attitude was prevalent among all academic levels but less so for freshmen. Despite their experience at the university prior to the pandemic, seniors also felt isolated and marginalized. A senior student stated, "*Making friends and meaningful relationships was impossible. Professors' lack of empathy for students during this period was stressful.*" (Senior, EE, SB$_{COMP}$=2.4).

Isolation and Mental Health Effects
Student responses alluded to a pre-existing problem of feeling isolated that the pandemic revealed and exacerbated. This was especially prevalent for Computer Science (CS) majors. For example, one senior stated the pandemic had "*no effect on [her] social life*" (Senior, CS, SB$_{COMP}$=2.8). While some students attempted to make light of this, they described troubling mental health concerns. For example, one stated, "*There's a joke among some of us that being told to stay at home and socially distance just validated our existing lifestyles. There was a lot of truth to that in my case, though the degree of isolation eventually worsened my depression*" (Senior, CS, SB$_{COMP}$=2.5). Another brought up how lack of social interaction and mental health issues have affected their academic performance, "*My little amount of campus engagement was slashed. Online programs were pretty awful. My mental health sharply declined and the lasting effects of that are interfering with my current studies*" (Senior, CS, SB$_{COMP}$=2.4).

Increased Accessibility
One positive impact of remote learning is that some students felt that class content was more accessible. They enjoyed the flexibility of deadlines and to be able to watch recordings of lectures. Additionally, one student described how online learning was personally helpful for them. They stated, "*I personally enjoy online classes. I have tics that will present in different ways, and it can be difficult to both focus on the lecture while trying not to embarrass myself*" (Senior, CS, SB$_{COMP}$=2.6).

Discussion

ECS students were ambivalent about their sense of belonging (SB) with the exception of first-year students. This is similar to other research which has found high SB for first-year engineering students [29], [30]. Sophomores and seniors reported the lowest SB among the academic levels while freshmen reported the highest. Freshmen qualitative responses indicate that they are having the least trouble adjusting to the teaching modality changes brought on by the pandemic. Freshmen had to do the least adjusting during their university experience which may contribute to their feelings of belongingness. However, ECS students at our institution have described the difficulties in making social connections even prior to the pandemic. This was brought up mainly by Computer Science students who felt they did not get much opportunity for social interaction within their classroom experiences. In an effort to increase the social experience for students, ECS intentionally integrated social events on campus (e.g., hosting a game night, ice-cream social, student

organization fair) during the Fall 2021 semester. Prior to the pandemic, current students were not exposed to ECS-specific social events like these. Freshmen students experienced these social events at the most opportune time to create social connections and their perceptions were not colored by previous experience at the institution.

It is troubling that many survey participants reported mental health issues that are affecting them personally and academically. The ongoing COVID-19 pandemic has had deleterious effects on students' mental health including increased anxiety [32], depression [33]. In a study of 1,124 Italian university students, Capone and colleagues found that students with lower levels of mental well-being during the pandemic also had lower self-efficacy and sense of belonging [34]. This lack of belonging could continue to strain students' academic performance and mental health, especially in light of the uncertainty of when the pandemic will reach a state where it no longer causes large-scale disruptions [35]. This is also an issue of equity. Marler and colleagues found that students who self-reported lower Socio-Economic Status reported more COVID-19-related distress and lower sense of belonging [35]. Underrepresented and historically marginalized students in STEM already experience a lower sense of belonging than their White male peers [36]. Another equity issue that may be impacting some students like sophomores is lack of knowledge of the hidden curriculum (i.e., the unspoken rules required to navigate the university successfully). Students who have started university during the pandemic have had less access to hidden curriculum knowledge because the majority of their communication come from official channels (e.g., emails, announcements) rather than informally through word of mouth (e.g., speaking to peers, second-hand recommendations) [4]. This existing inequity exacerbated by the pandemic could have further implications for persistence and retention.

The qualitative responses clearly indicate that students are struggling with feelings of isolation during the ongoing pandemic. Providing students with resources on how to cultivate social connections with their peers is critical but has proven to be difficult for instructors and staff. It is often left up to the students to do this themselves. This can depend on what social resources they bring with them. For example, during the pivot to online learning in Spring 2020, engineering students were able to describe strategies to adapt to the changes and stay academically motivated. However, they did not describe developing any new strategies to cultivate social connections because they utilized existing social networks they had already built at the start of semester [37]. Our students—and sophomores specifically—may not have existing social networks of peers to leverage.

Conclusion

The transition to and from remote learning and various modalities that the ongoing COVID-19 pandemic has necessitated has been challenging for all students. Students have struggled both academically and emotionally to pursue their degrees. Feeling a sense of belongingness can inoculate students against feelings of isolation and other negative experiences. It has been difficult for some students, especially sophomores and seniors, to feel a sense of belonging throughout the disruptions they have experienced. As students affected by the pandemic continue throughout their programs, we need to be cognizant of what social supports they may or may not have and

intentionally create opportunities in and outside of classrooms for upper-level students to build and maintain their sense of community withing engineering.

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