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Work in Progress: Impact of COVID-19 and the Digital Divide on the Sense of Belonging for Undergraduate Engineering Students

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Abstract

The onset of the COVID-19 pandemic forced many institutions of higher learning across the United States to pivot to online instruction immediately or close altogether. This transition highlighted many inequities in access to education as well as the sense of community on college campuses for the students. Earlier digital divide research focused mainly on physical access, identifying patterns of hardware access by different social identities such as race, gender, and socioeconomic status. Soon after, digital divide researchers began to recognize that the divide exists even when there is physical access to hardware, because the usage and the quality of usage varies (Katz & Aspden, 1996). During the COVID-19 pandemic, many students have lost access to the free, public technology resources at their college or university. These inequities in online learning and the potential impact on student success were highlighted by our team in our prior publication (Simpson, 2020). In addition to access to education, students also lose connection with their community available on college campuses.

The purpose of our study was to understand the challenges of online learning and the relationship between the Digital Divide and Sense of Belonging in underrepresented students amid a global pandemic. Using qualitative research methods, we examined the questions "How does the Digital Divide currently impact Sense of Belonging and community in students?" and "What patterns will be revealed when we investigate Sense of Belonging across different social identities?"

We conducted 20 semi-structured interviews with current and recently graduated undergraduate engineering students. We were intentional to compose a diverse group of interview participants including students from underrepresented groups, including ethnic and gender minorities as well as first-generation students. Of the 20 participants, five self-identified as men and 15 as women; nine self-identified as Black/African American, eight as White, and three as Asian. Four were first-generation students. Four participants were rising juniors, 10 were rising seniors (one 5th year senior), and five were recent alumni (December and May 2020). We conducted first and second-cycle coding data analyses to identify themes regarding the impact of COVID-19 and Digital Divide on Sense of Belonging. Preliminary results suggest the presence of themes highlighting both victories and defeats within the realms of Digital Divide and Sense of Belonging. Digital Divide was highlighted by limitations of students' Physical Home Learning Environment, Internet Connectivity. The negative factors affecting students' Sense of Belonging included Social Isolation; Impersonal Learning; Missing Professional Opportunities, and Individual Differences. The themes highlighting factors that increased students' Sense of Belonging were: Student Organizations Impact; Togetherness in Pandemic; Group Work Benefits; and Connecting Through Tech. The COVID-19 pandemic provides a unique perspective for researchers to study the commonalities and differences among the experience of engineering students from diverse backgrounds. These findings will help to inform higher education administration of the impact of Sense of Belonging on college campuses and how it contributes to students' success.

Introduction and Background

The COVID-19 pandemic led to major changes in higher education institutions across the United States (Viet Duong, 2020). At its onset, many schools were forced to hurriedly transition to online learning or to close altogether. The pandemic introduced and exposed many stressors in the lives of students as was evident in the depressive outlook and negativity in their tweets (Viet Duong, 2020). The decision by many universities to expand online learning where possible presented an opportunity to explore and understand challenges experienced by students as a result of the unexpected shift to online learning, particularly challenges as a result of the "digital divide." Digital divide research has shown that not only is the divide due to physical and hardware access based on different social identities such as race, gender, and socioeconomic status, but it also exists even when there is physical access to hardware, because the usage and the quality of usage varies (Katz & Aspden, 1997). During the COVID-19 pandemic, many students lost access to the free, public technology resources at their college or university. Many of these institutions as well as internet providers recognized the loss of physical access and took action to remedy it, but that still did not account for the digital divide in the usage of technology as previously highlighted by our team (Simpson, 2020).

The onset of the pandemic also forced students to leave their college campuses and return home. The concept of home is different for each individual. Home may not always be a safe space conducive for learning. Universities provide an immeasurable amount of support programs and peer groups that many students, especially those from underrepresented groups, rely on for success in college (Cheng, 2004). The loss of these support programs and peer groups could have had a negative impact on students' sense of belonging and academic success (D'Angeli & Hershberger, 1993). In higher education research, *sense of belonging* has been identified as a predictor of academic success and well-being (Waller, Costen, and Wozencroft, 2011; Litzler and Samuleson, 2013). Sense of belonging is not just the perception of inclusion, it is something that people express and experience differently depending on various social and cultural factors, and it is highly contextualized (Baumeister & Leary, 1995). Studies of sense of belonging in higher education have focused more on the sense of belonging in ethnic, socioeconomic, and other minority groups (Hausmann, Schofield, and Woods, 2007; Morrow and Ackerman, 2012; Jury, Aelenei, et al, 2019). These studies, including those that investigated sense of belonging in online learning, typically do not include external pressures on a student as a factor in determining their sense of belonging. This study is focused on the relationship between the "digital divide," or the disparities in physical access to and use of technology, and sense of belonging for students caused by the COVID-19 pandemic.

Research Questions

Both concepts of digital divide and sense of belonging, though well studied, presented new challenges in the face of online learning during a pandemic, particularly for at-risk students such as racial and ethnic minority students, low-income students, and first-generation students. Thus, the purpose of our research is to focus on how a sense of belonging is impacted for students in online learning settings.We seek to answer the following questions through this work:

1. How does the digital divide currently impact a sense of belonging and community in students?
2. What patterns will be revealed when we investigate sense of belonging across different social identities?

Methods

Previous research by Peacock and Cowan (2020) suggested that three factors are responsible for students' sense of belonging when engaged in online learning: interaction/engagement, culture of learning, and support. Additional factors, identified by Huartado and Carter (1997) as key for students' sense of belonging in a virtual course include: college selectivity, cognitive mapping, managing resources, family support/independence, experienced discrimination, campus tension, and perception of sense of belonging.

As these factors involve unquantifiable and unobservable phenomena, we chose semi-structured interviews to understand engineering students' thoughts, perspectives, and experiences (Leydens et al, 2004) of online learning during the onset of the COVID-19 pandemic-related pivot to online instruction. To gather data, we conducted 20 interviews during summer of 2021; each interview lasted between 30 and 60 minutes. For consistency, one researcher conducted all the interviews using the WebEx video conferencing platform, and two team members transcribed the interview text (the interviewer and the first author). As a starting point for transcription, we used the auto-generated WebEx transcripts, and then edited the transcripts for correctness while watching the interviews.

Interview Protocol

The semi-structured interview protocol consisted of 16 planned, open-ended questions, as well as iterative probes to elicit further information pertaining to each question. Sample questions are included below:

1. What types of teaching styles (e.g., lecture, project-based, group-based, other active learning) were you exposed to in online learning? What did you like or dislike about them?
2. What communities are you a part of at the university?
    a. What did you do to engage with each community?
    b. Has your engagement with this community changed due to the transition?
    c. What resources has your community provided?
    d. Was your academic performance impacted by losing this community?
3. What resources related to your college experience did you leverage to help you through this semester?
    a. Who did you approach if you needed a resource?
4. During this semester, in what ways has your sense of belonging inspired? In what ways has it been inhibited?

Context

Our study took place at Mississippi State University, where in 2020, the College of Engineering had a total of 4,885 students. Per university data, male undergraduates comprised 66.8% of

enrolled students, and female undergraduates comprised 18.52% of enrolled students. Of 4,885 total, 11% of students self-identified as African-American, 7% as Asian, 4% as Hispanic and 2% as multiracial. Current undergraduate engineering students and recent engineering graduates participated in this study. All were enrolled in classes during the March 2020 pivot to distance learning due to the outbreak of the COVID-19 pandemic, and all were forced to initially stay off campus. In the subsequent semesters (fall and spring 2021) many returned to campus and to traditional instruction, at least for some courses. This research protocol was reviewed by the Mississippi State University IRB and approved for exemption status (#IRB-20-477).

Participants

Twenty participants were recruited for the study as consistent with typical qualitative studies and as allowable within the grant budget (Saldana, 2018; Boddy, 2016). As we intentionally sought to understand experiences of a diverse group of students, including ethnic and gender minorities commonly underrepresented in engineering, we invited students from diversity-focused student organizations including the National Society of Black Engineers, Society of Women Engineers, and others. Additionally, introductory design students received an invitation to participate in the study from their professors. Students were informed that our study centered on sense of belonging during COVID-19 pandemic-related online education. Participants were offered a financial incentive of $50. In addition to purposive sampling, we used snowball sampling, and asked participants to let their friends know about our study. After contacting us to indicate their interest in participating in our research, students were asked to complete an online pre-interview survey containing demographic questions and scheduled the interview.

Of the 20 individuals who volunteered to participate in our study, 4 were rising juniors, 10 were rising seniors, and 5 were December and May 2020 graduates. There were 4 first generation students. Five participants self-identified as men and 15 as women; 9 self-identified as Black/African American, 8 as White, and 3 as Asian. Four students pursued Computer Engineering, 1 student was enrolled In Electrical Engineering, 11 in Biomedical Engineering, 2 in mechanical Engineering, 1 in Industrial Engineering, and 1 in Chemical Engineering.

Planned Data Analysis

For data analysis, we will employ first and second cycle analysis (Saldaña, 2010). The first cycle coding aims to capture and name the general characteristics of statements made by participants, while the second cycle coding is used to coherently analyze and categorize trends in participant data. As the pivot to online learning was implemented on an emergency basis, student sense of belonging and digital divide experiences in this situation may not have been captured by Peacock and Cowan's (2020) and Huartado and Carter's (1997) theoretical frameworks. Therefore, we will not use their themes as starting points in our analyses.

At least two authors will independently code one interview to generate the initial code list using descriptive coding (Saldaña, 2010). The authors will discuss, define and agree on codes to use as they proceed. Using the resultant codes, they will code a second interview to align interpretation of codes and calculate inter-rater reliability (via intraclass correlation). All transcripts will be analyzed by a minimum of 2 researchers. Upon completion of first cycle coding, the authors

together will organize the codes into larger, conceptually related categories. We will then compare the emergent themes with the themes identified by Peacock and Cowan (2020) and Huartado and Carter (1997).

To ensure validity in our interpretive research, we have made an effort to employ the Walther et al (2013) strategies for quality in qualitative research. For example, literature regarding the digital divide and sense of belonging informed the development of our interview protocol, providing *theoretical validation.* The protocol was reviewed by a focus group of undergraduates for *communicative validation*. Focus group participants were asked to reflect on the questions, consider the meaning and clarity. Participants were also asked to suggest additional and/or alternative questions to be included. Once the interview protocol was revised, at least 20 students were recruited to be interviewed from various relevant student organizations (e.g. TRiO, NSBE, SHPE, SWE), representing a diversity of respondents to capture the critical diverse voices (*pragmatic validation)*. Participants were offered a financial incentive of $50 gift card. All interviews were completed remotely through an online platform, following the interview protocol (*process reliability)*. All interviews were recorded and transcribed with participant consent (*process reliability)*. For continued analysis, interview transcripts will be inductively coded using first cycle and second cycle coding methods, and we will also perform member checking to ensure that we have interpreted the findings as experienced by our subjects (*communicative validation)*.

Positionality

The first author, a Polish immigrant and US-educated educational psychologist, assisted with transcription of the interviews, and will assist with data analysis and interpretation. While she is an outsider to engineering, she is both an undergraduate faculty member and an undergraduate advisor at the institution where the study took place, thus is attuned to the institutional "reality" of the undergraduate students during the COVID-19 pandemic.

The second author is an Asian-American female who is a first generation American from a middle class upbringing. She is an engineering professor who has been committed to identifying ways to transform higher education to meet the postgraduate needs of today's student. She has also been committed to exploring how microenvironments preclude inclusion.

The third author is an African-American female who is a first-generation college graduate from a working class upbringing in the rural south. She is an engineering professor committed to biomedical research and integrating those endeavors with improving the engineering student experience and exploring factors that facilitate success for minority engineering students.

The last author is an African-American female who is a first-generation college graduate from a low-income, rural, southern upbringing. She is an engineering professor and serves as advisor and mentor to numerous minority student groups on campus. She conceptualized the idea for this project with the second and third authors and will assist with data analysis and interpretation.

Conclusion

We plan to analyze the interviews to identify any themes in relation to the digital divide and sense of belonging and to determine how that impacted students. We would like to use our findings to

inform university administration on the importance of the campus community for students' sense of belonging and implore them to consider this in the chance of another possible pandemic and/or university shutdown.

In addition, we plan to repeat this study at the other rural universities in the U.S. and compare the results across the different institutions. We plan to continue studying sense of belonging and use our findings to create support programs that best enhance the sense of belonging of underrepresented students.

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References

1. J. L. Viet Duong, T. Y. Phu Pham, and Y. Wang, "The Ivory Tower Lost: How College Students Respond Differently than the General Public to the COVID-19 Pandemic", in *Proc. 2020 IEEE/ACM Int. Conf. on Adv. in Social Networks Analysis and Mining*, pp. 126-130.
2. J. E. Katz and P. Aspden, "Motivations for and barriers to Internet usage: Results of a national public opinion survey"*, Internet Research: Electronic Networking Applications and Policy,* vol. 7, no. 3, pp. 170-188, 1997.
3. C.L. Simpson, C.T. Gomillion, and A. Huang-Saad, "Access and Equity in the Digital Classroom", Society for Biomaterials Forum (2020, Spring).
4. D.X. Cheng, "Students' Sense of Campus Community: What it Means, and What to do About It", *NASPA Journal*, vol. 41, no. 2, pp.216-234, 2004.
5. A.R. D'Augelli and S.L. Hershberger, "African American undergraduates on a predominantly White campus: Academic factors, social networks, and campus climate", *The Journal of Negro Education,* vol. 62, no. 1, pp. 67-81, 1993.
6. S.N. Waller, W.M. Costen, and A.J. Wozencroft, "If we admit them, will they stay? Understanding the role of social connectedness in the retention of African American students in a recreation and leisure studies program", *SCHOLE: A Journal of Leisure Studies and Recreation Education*, vol. 26, no. 1, pp. 30-48, 2011.
7. E. Litzler, C. Samuelson, "How underrepresented minority engineering students derive a sense of belonging from engineering", In *ASEE Annual Conference & Exposition*, 2013, pp. 23-674.
8. R.F. Baumeister, and M.R. Leary, "The need to belong: Desire for interpersonal attachments as a fundamental human motivation", *Psychological Bulletin,* vol. 117, no. 3, pp. 497–529, 1995.
9. L.R. Hausmann, J.W. Schofield, and R.L. Woods, "Sense of belonging as a predictor of intentions to persist among African American and White first-year college students", *Research in higher education,* vol. 48, no. 7, pp. 803-839, 2007.

10. J. Morrow, and M. Ackermann, “Intention to persist and retention of first-year students: The importance of motivation and sense of belonging”, *College student journal,* vol. 46, no. 3, pp. 483-491, 2012.
11. M. Jury, C. Aelenei, C. Chen, C. Darnon, and A.J. Elliot, “Examining the role of perceived prestige in the link between students’ subjective socioeconomic status and sense of belonging”, *Group Processes & Intergroup Relations,* vol. 22, no. 3, pp. 356-370, 2019.
12. S. Peacock, J. Cowan, L. Irvine, and J. Williams, “An exploration into the importance of a sense of belonging for online learners”, *International Review of Research in Open and Distributed Learning,* vol. 21, no. 2, pp. 18–35, 2020.
13. S. Hurtado and D.F. Carter, “Effects of college transition and perceptions of the campus racial climate on Latino college students’ sense of belonging”, *Sociology of Education,* vol. 70, no. 4, pp. 324–345, 1997.
14. J. Saldana and M. Omasta, *Qualitative Research: Analyzing Life.* Thousand Oaks, CA: SAGE Publications, 2018.
15. C. R. Boddy, “Sample size for qualitative research”, *Qualitative Market Research*, vol. 19, no. 4, pp. 426-432, 2016.
16. J.A. Leydens, B.M. Moskal, and M.J. Pavelich, “Qualitative methods used in the assessment of engineering education”, *Journal of Engineering Education,* vol. 93, no. 1, pp. 65–72, 2004.
17. J. Saldaña, “The coding manual for qualitative researchers”, Thousand Oaks, CA, USA: Sage, 2010.
18. J. Walther, N. Sochacka, and N. Kellam, “Quality in Interpretive Engineering Education Research: Reflections on an Example Study”, *Journal of Engineering Education,* vol. 102, no. 4, pp. 626-659, 2013.