Work in Progress: Opportunities for Engineering Undergraduates to Develop Non-Technical Professional Skills during the COVID-19 Pandemic

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WIP: Opportunities for engineering undergraduates to develop professional skills during the COVID-19 pandemic

This work-in-progress (WIP) paper aims to elucidate how students have developed professional skills since the onset of the COVID-19 pandemic and who are the people who have provided skill development opportunities. Because of the way social distancing affected engineering education during the pandemic, developing professional skills may have been a challenge for engineering students. While online courses and virtual meetings allowed students to remain in contact with faculty and each other, the opportunities to continue having deep relationships (i.e., strong ties) were sparse. Our paper presents an early look at findings from the qualitative phase of an explanatory mixed methods study conducted with 1,234 undergraduates from 13 schools in the US. Our ongoing thematic qualitative analysis reveals that the changes that accompanied social distancing and periods of emergency remote teaching caused by COVID-19 have reinforced different opportunities to develop professional skills than prior to the pandemic. While some students expressed they had fewer opportunities to develop professional skills, participants also identified opportunities to (1) hone written communication skills when in-person discussions were reduced and (2) leverage knowledge from family members to continue developing professionally. Our next steps include finishing the qualitative analysis phase of the project and mixing the qualitative and quantitative data to develop overarching findings that the engineering education community can use to understand how students' professional skills develop and how to promote that development even during times of educational disruption.

Introduction

Opportunities to develop professional skills happen within and outside of engineering classrooms. While different operationalizations exist for professional skills, the National Academy of Engineering and ABET generally agree that students' development should focus on five specific areas: teamwork and shared leadership, effective communication, creative problem-solving, business and management principles, and professional and ethical responsibility. In engineering education, skills development often happens within courses like cornerstone and capstone design [1], as well as in cocurricular activities such as professional organizations and student design teams [2]. Specifically, professional organizations such as the National Society of Black Engineers, the Society of Hispanic Professional Engineers, and the Society of Women Engineers have been shown to provide students with connections to access opportunities for professional resources and development [3, 4].

We anticipate that the COVID-19 pandemic environment changed the opportunities available for engineering students to develop professional skills. With the onset of the pandemic in the US in March 2020, student organizations, club activities, internships, teaching modalities, course structures, and peer study group interactions all suddenly changed. Since that time, some of these interactions have returned to pre-pandemic states while others have permanently changed. Recent research has revealed that engineering students who began undergraduate studies shortly before or during the pandemic are having different educational experiences than those who already had established relationships on campus [5]. Our WIP focuses on providing preliminary findings on how students found opportunities to develop professional skills during the pandemic.

Background and Theoretical Framework

To develop professional skills, engineering students often leverage social capital. We operationalize social capital as the resources provided by relationships [6]. Relationships often provide resources related to emotional encouragement, empathy, and care, also known as *expressive social capital* [6]. Relationships can also provide more tangible resources that help students achieve a goal, known as *instrumental social capital* [6]. For our work, social capital is important because opportunities to develop professional skills are related to the relationships students have with peers, student organization connections, faculty, and staff [2], [3].

The pandemic affected students' social capital and disrupted their social networks; in particular, it affected the strength of their relationships, also known as *ties* [6]. Strong ties are frequent, intimate, and can be based on informal contact over the long term (e.g., family and close friends). On the other hand, weak ties are less frequent, less intimate, and more formal with sparse contact. In the case of engineering education (and beyond!), the pandemic caused courses, cocurricular activities, and even mentorship events to be held virtually (e.g., via Zoom), which affected students' relationships, their ties and, thus, their social capital.

Methods

The project on which this WIP is based is an explanatory mixed methods study. The quantitative piece of our work utilizes two survey instruments, the Undergraduate Study Support (USS) survey [7], [8], and the Professional Skills Opportunities (PSO) survey [9], [10]. The USS is based in our prior work on social capital in engineering education [7], [8], [11], [12]; it asks participants to identify salient people in their social network, and asks about the supports or resources those individuals as well as others provide. In particular, the USS consists of a name generator and a resource generator. The name generator portion of the USS asks participants to generate a list of people whom they consider to be relevant for their persistence and success in engineering. The resource generator portion of the USS asks participants to identify specific resources they have received related to engineering success, such as someone recommending courses or introducing them to other people in their professional network. The PSO focuses on students' opportunities to practice five professional skills (problem-solving; business and management principles; communication; professional and ethical responsibilities; and shared leadership, which is a combination of teamwork and leadership skills) [9], [10].

For the quantitative phase of the project, we collected data from undergraduates at 13 institutions to achieve a representative cross-section of engineering students across the US. Our sample included participants from minority-serving/Hispanic-serving institutions (MSI/HIS), Historically Black colleges and universities, predominantly/historically white institutions, and predominantly undergraduate institutions. For the qualitative phase of the work, we purposefully selected students who completed the USS and PSO and asked them to participate in in-depth interviews. This WIP focuses on presenting preliminary findings from the qualitative portion of the study that begin to answer the following research questions:

How do students from each cohort report using social capital to develop professional skills?

How do students describe opportunities for developing professional skills in course-based and cocurricular settings?

Participants

We purposefully selected a subset of survey participants to take part in interviews using three criteria. We sought to achieve maximum variation sampling [13] across three dimensions. First, we focused on recruiting participants who had high, medium, and low levels of social capital according to the USS survey. Second, we recruited participants from different types of institutions in our sample. Third, we defined four academic cohorts consisting of students who started at different stages of the pandemic and recruited participants from across those cohorts to better understand the pandemic's effects on the development of their professional skills. We completed interviews with 18 participants.

Data collection and analysis

We tailored a unique interview guide for each participant based on their responses to the USS and PSO surveys, creating a direct link between the survey and the interview data [7], [14]. For example, when a participant listed a particular person in the USS survey as being influential to their success in engineering, we asked them directly about that person's influence in the interview. Likewise, when a participant indicated in the PSO that they had opportunities to develop a particular professional skill, we asked them about those opportunities in the interview.

We used the critical incident technique [15] to elicit thick, rich descriptions about their social capital supports and opportunities to develop professional skills. We recorded the interviews through Zoom and used its transcription tool. Each interview transcript was verified and cleaned by our research members by listening to the audio recording while correcting the transcripts.

For our preliminary data analysis, we created structured analytic memos [16] as a way to understand the data we collected. We developed the memo structure based on our research questions related to social capital and professional skills development. The memos contained guiding questions that allowed us to "hear" the participants' voices as we handled the data.

Preliminary results

First preliminary finding: Students were exposed to different opportunities to develop professional skills.

The first preliminary finding from the interview data focused on the ways that students discussed their opportunities to develop professional skills. Multiple participants described developing written communication skills by writing emails when verbal communication was more limited than before the pandemic. Specifically, they described relying more heavily on emails to discuss deadlines with faculty, communicate with teammates, and understand academic resources or advising. Participants who were involved in online or remote internship opportunities also explained how they developed their communication skills via email to share work updates, which might have previously been relayed in person.

> Participant 1: [I had] to put all of my intention and meaning in one single email that was concise enough that people would read it, but expressed enough of what I needed from them that I got what I needed. So, it was like a balance of not too many words but also enough, where if it would help understand that this is important and I need you to explain.
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> [Researcher]: How did you learn that skill of writing emails that are concise and good to get information across?
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> Participant 1: So, whenever I would email someone for something, and they didn't give me what I needed, I would complain about it to my father. And he would just give me advice on like, "Well, you asked the question here, how can you do this?" instead of "How do we make this happen?", and he helped me change some of my wording around to make sure that I get across the best possible way.

Additionally, several participants referenced utilizing the Discord application and other online messaging platforms to keep in touch with classmates. These new tools allowed them to connect with others in their courses, across different academic years in their major, and in professional societies or clubs. Several students referenced using Discord as both a social and an academic tool and enjoyed the flexibility in using it for communicating. They highlighted that it allowed them to keep up with student organization updates and build community.

> Participant 2: They [my classmates] are also from same city, so they were also at home, but we were able to use Discord to communicate.
>
> [Researcher]: And what was that like? The process of engaging with them through Discord in order to do your assignments?
>
> Participant 2: Yeah, it was good. I really like using it because it's comfortable. It's a known space, because I use it for like talking to my friends, just be social, and so using it, as also an academic space where I can talk to them about studying. [. . .] I really like Discord servers for like student organizations. I follow a lot of them on Discord, because that's the best way that I can keep up with things, because it's also a great system for keeping things organized because there are different channels that you can make, and there's a lot of customizability to it.

Second preliminary finding: Students described using family members as part of their social capital to develop professional skills during the pandemic.

The second major finding from our preliminary data analysis concerns the people students described as being helpful with their professional skills development. While students tended to mention people related to their academic environments (e.g., professors, advisors, mentors), one surprising finding was the role that their family members played for some students in developing professional skills during the pandemic.

Two participants mentioned that their parents supported them in learning how to craft professional emails to their professors and internship bosses. Participant 3 said of their mother:

> Participant 3: I would say that she [my mom] is probably the one person I had through high school, and college now, that I really knew for professional development. She kind of took me through the process of like creating resumes and applying for scholarships and stuff like that, which has been very helpful for me these past couple of years.

Additionally, other participants described how their siblings with similar educational backgrounds played an important role in learning how to problem-solve. In the case of Participant 4, they asked their brother (a computer scientist) for advice on how to troubleshoot a code for a course, and he was able to provide guidance and support the participant's problem-solving development.

> [Researcher]: [Y]ou mentioned that you had the opportunity to come up with solutions [to problems]? I was wondering if you can tell me a particular time where you were able to develop such skills.
>
> Participant 4: I have the perfect example for that. So, we had this class, and our last project was a completely computing project, and we had to write a report after that but no one knew how to code it. [. . .] [M]y brother is a pro at coding. So, I kind of went to him, I'm like, "Okay, listen. We have this problem." [. . .] [E]ven though my brother helped me with the code, I kind of learned more of coding than the rest of the people [in my class], so I kind of tackle the coding part better.

Conclusion, limitations, and future work

While students faced difficulties during the pandemic, they were exposed to opportunities to develop professional skills in new ways and continued to develop social capital. In the case of our participants, they leveraged their strong ties to continue developing as engineers. A limitation of this work is the small number of participants (three of 18) from MSI/HSI institutions; we are working to recruit additional students to gain a better understanding of their perspectives. As such, our future work includes recruiting those participants, completing a more in-depth analysis of the interviews, and triangulating our qualitative findings with the quantitative portion of the study. After the triangulation, we will be able to provide more concrete recommendations for administrators and educators on how to continue supporting students' professional skill development after the pandemic.

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