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The Role of Mentorship in Student Preparation for Impactful Internships

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abstract
Engineering students are particularly interested in attaining internships prior to completing their undergraduate studies. It is generally acknowledged that internships provide critical insight into the nature and demands of engineering roles. However, pre-internship students tend to be apprehensive about how to prepare for the internship opportunity and how to excel when in the position. Students enrolled in a Scholarships in STEM (S-STEM) program have both a faculty mentor and an industry mentor, that are important components of a process to infuse intrapreneurial competencies (*i.e.*, entrepreneurship within established firms), in addition to the discipline-specific knowledge and skills provided by an engineering education. The research presented in this paper analyzes data from the students' perspectives as well as mentors' perspectives to better understand how the mentoring experience shapes readiness for internships, as well as readiness for employment or further education. Our findings suggest that both students and mentors perceive the mentorship process to be highly beneficial.

introduction
Most engineers will begin their careers in an established company, eschewing the risks of starting a new business. However, the rapidly changing technology paradigm favors companies that bring new and sometimes transformative concepts to market. Companies especially need entrepreneurial-minded engineers who will drive change to make this possible. This is also evidenced by many established companies creating infrastructure to build internal "startups".

The Tech Intrapreneurs Program (TIP) is designed to produce intrapreneurs, people that are entrepreneurial within an existing company. Intrapreneurship is defined as different from entrepreneurship in that intrapreneurship focuses on innovation within their current established company rather than innovation driven by starting one's own company. TIP takes students beyond their typical academic coursework by providing entrepreneurial/intrapreneurial training and experiences, mentoring, and preparation for internships. Before making important contributions to a company, the engineer must be hired in the first place. Engineering internships have been important stepping-stones to future full-time employment for quite a while now. Students realize the importance of internships, but they frequently feel unprepared for the process, making it feel daunting. Mentoring relationships with faculty and industry professionals have been instrumental in students successfully competing for and completing internships. As researchers, we have been gathering and analyzing data on the mentoring process to understand better how mentors and mentees interact in ways that shape how students understand and feel prepared for internships and future workforce commitments.

Due to the multi-year, longitudinal nature of these studies, the outcomes are still to be determined for many of the TIP students. There is an ongoing process to capture data on the program participants and this article captures information regarding student-mentor discussions. Starting in the Fall of 2019, TIP has enrolled three cohorts of electrical engineering or computer engineering students that are diverse in demographics including race, gender, age, and socio-economic status. The initial enrollment in each group was: Cohort 1: 16, Cohort 2: 17; Cohort 3: 19. Students take two years of a program related seminar and receive a scholarship until

graduation as long as they are meeting a GPA threshold. To date, seven students from Cohort 1 have graduated, with five taking jobs in industry and two entering a doctoral program. Below, we articulate some of the results we have found in our research on the mentoring process and relationships. Specifically, we show the results of discourse analyses based on surveys, mentoring journals, thank you notes sent to mentors and funders, and short-answer responses from participating mentors. First though, we highlight the theoretical lens that guides our understanding of mentorship.

theoretical underpinning of mentorship

Multiple scholars have contributed to our lens on mentorship and mentoring. As noted in Nick *et al.* [1], "The word "mentor" derives from Greek mythology when Odysseus entrusted the care of his son to his friend "Mentor," to serve as guide and teacher while he went to fight the Trojan War. Since then, the concept of mentoring has evolved into a multidimensional interactive process that can be formal or informal and is guided by the needs and desires of the mentor and protégé." Mentoring consists of a dyadic relationship. One is that the mentor has a personal and unique relationship with the mentee. Two, while a new relationship, the interactions must foster trust, community, and knowledge-sharing. Third, this relationship is most beneficial if designed to support a pathway into the knowledge, skills, and dispositions previously accrued by the mentor specific to the mentee's job title or aspiring position. However, this mentorship may also provide broader job skills applicable across industries and titles.

Multiple studies have shown that mentoring can lead to positive benefits for students. For example, Kendricks *et al.* [2] showed that mentoring had a solid correlation to retaining undergraduates who were minority students. Vandermass-Peeler *et al.* [3] showed that undergraduate programs involving mentoring for undergraduate research strongly support student retention and undergraduate research skills. Varghese and Finkelstein [4] showed that mentoring programs could increase the mentee's self-efficacy. More recent research has even examined mentoring relationships in STEM + entrepreneurship. For example, Elliott, Mavriplis, and Anis [5] studied the efficacy of peer mentoring on women in STEM who were involved in entrepreneurship programs. They found mentoring to positively affect both retention in the program and feelings of community. Our research is unique in that it examines perceptions of mentoring in the context of STEM + Intrapreneurship from the perspective of the students, faculty, and industry mentors. While the research is unique, it extends the previous research mentioned above on the efficacy of mentorship.

student concerns: analysis of interactions with mentors

TIP students choose industry and faculty mentors during the program's first year. The students meet with the mentors regularly (at least once per month). Monthly, students submit written reports that summarize the discussions during their mentor meetings. Students are only given general suggestions on what to discuss during the sessions, and the mentors are not provided with any stipulations. Thus, the dialogue is deliberately flexible and determined by the mentor-mentee dyad.

Discourse analysis of the reports is being used to better understand, over time, the nature of students' concerns, the nature of attitudes and expectations for future work, and what the mentor advises to better prepare for internships and permanent employment. In addition, the information

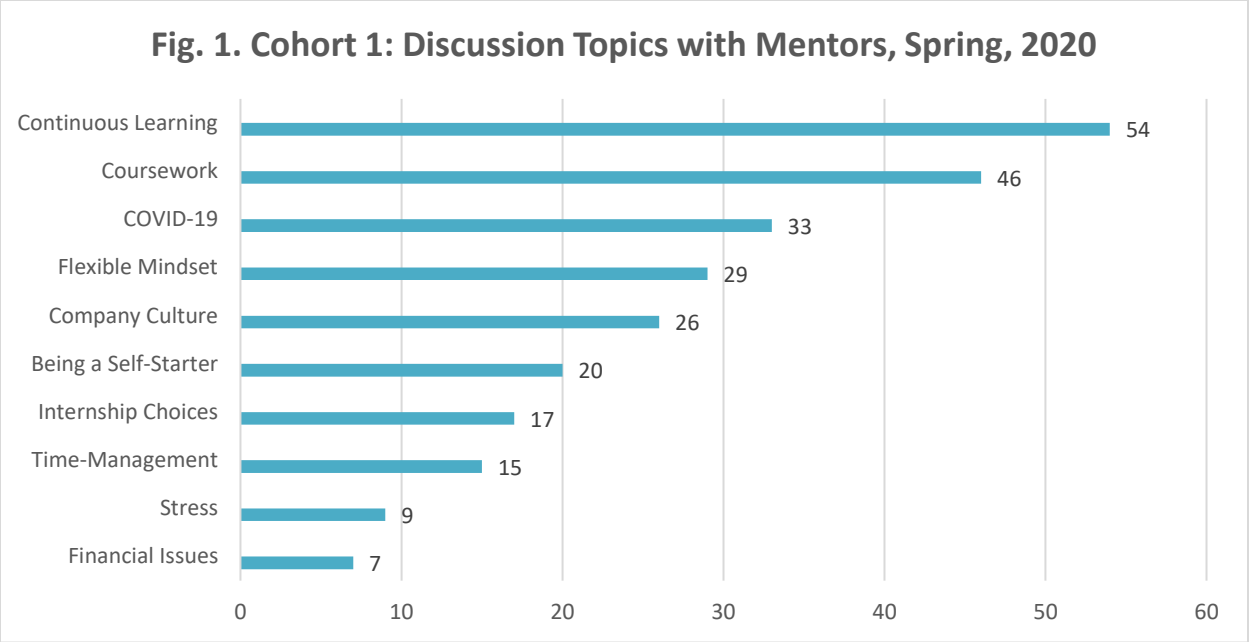
derived will be vital to the longitudinal study of how the program contributes to producing innovative and intrapreneurial workers.

Since the dialogue is deliberately flexible, the reports about the mentoring meeting dialogue show what topics arose and what was discussed as a form of naturalistic inquiry. This approach is consistent with naturalistic inquiry—where the conversation is allowed to follow from question to question and idea to idea—as a way of understanding what was of most concern to the interlocutors [6], [7]. This presented us with data—in the form of the monthly reports—that we could analyze to glean topics of importance to both the student and the mentor. Using discourse analysis and through the lens of naturalistic inquiry, we analyzed the ideas and themes that were the most influential.

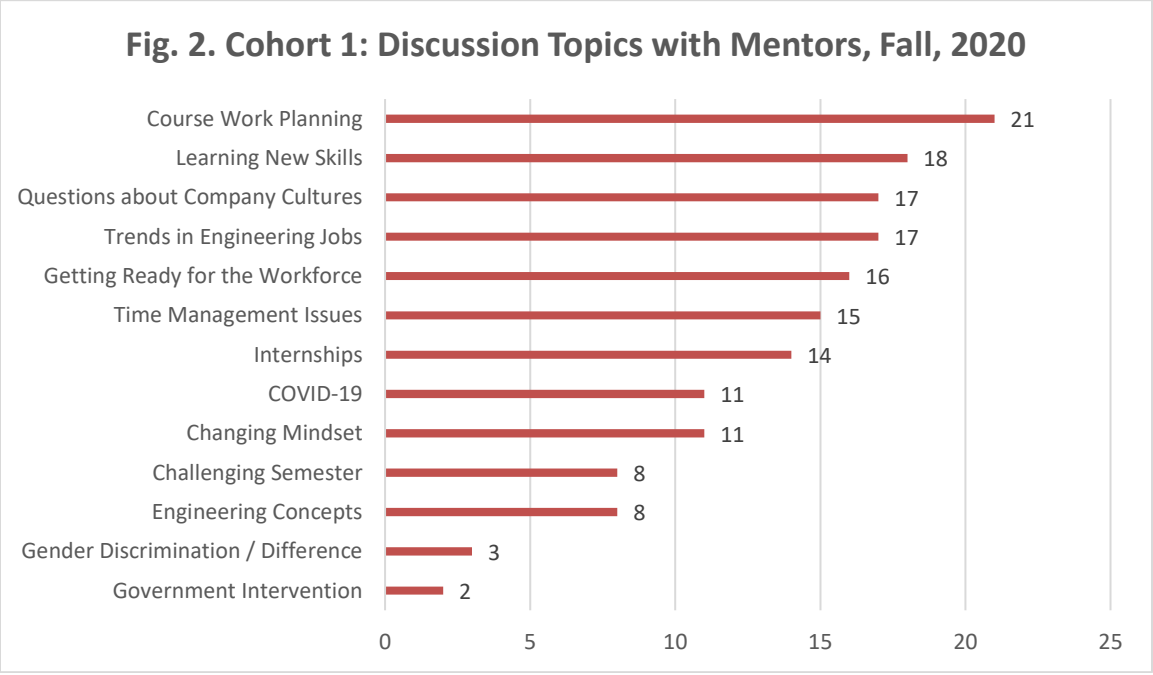
To conduct our analysis, we gathered these data in monthly reports. We collected monthly reports from each cohort during the semester(s) where they were taking an intrapreneurship course that required turning in the monthly reports as an assignment. Additionally, we gathered thank you notes from the students who sent the notes to their mentors and were also willing to share the thank you notes with us. We then used the following discourse analysis methods.

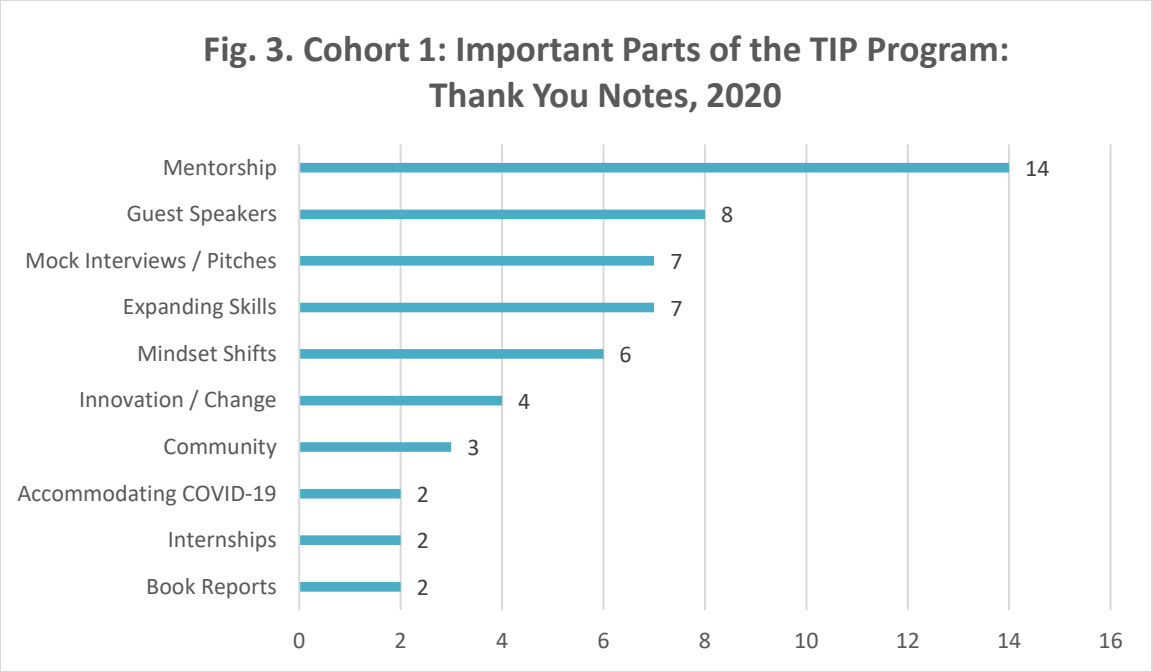
1. Open coding [8], [9], [10] was conducted to comb through the thank you notes and the mentoring reports. Each text was read multiple times, and themes were generated across each grouping of reports or thank you notes. For example, all the mentoring reports from Cohort 1 in Spring, 2020, were read as a group, coded, and then themes were generated using that grouping of texts, and that grouping alone. Thus, there were different themes that were developed in the thank you notes from Cohort 1 versus the mentoring reports from Cohort 1. Likewise, there were different themes from the mentoring reports from Fall, 2020 from Cohort 1 versus Cohort 2. We believe it is important to separate both the types of texts (mentoring reports and thank you notes) as well as the cohorts and timeframes to access possible differences among cohorts and semesters when the conversations occurred.
2. Thematic Coding [11], [12] was then done by taking the themes (created from codes) for each set, and then re-analyzing each set using the themes as a lens to re-examine the text. Repetitive analysis allowed us to hone the codes even further. After that process, the text was analyzed to count how many discrete times the code emerged in each of the reports or thank you notes within a given set.
3. Thematic Occurrence Counting [13] allowed us to generate the data that we then used to generate the bar graphs below.

Each of the plots below show the themes for the relevant text, cohort, and timeframe.

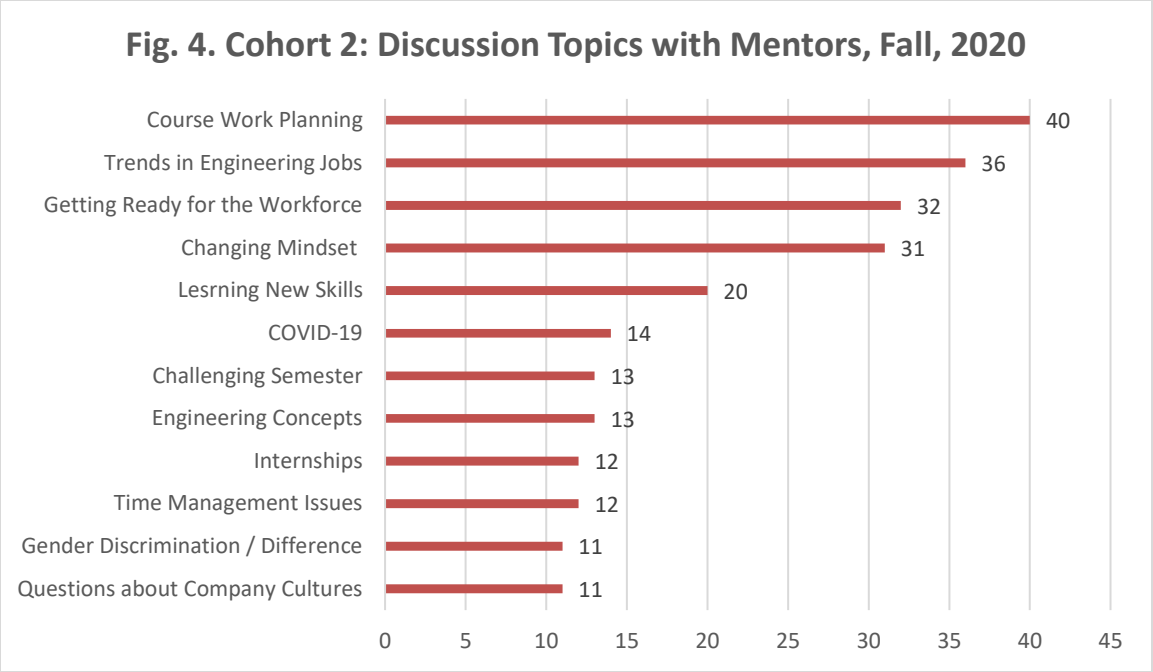


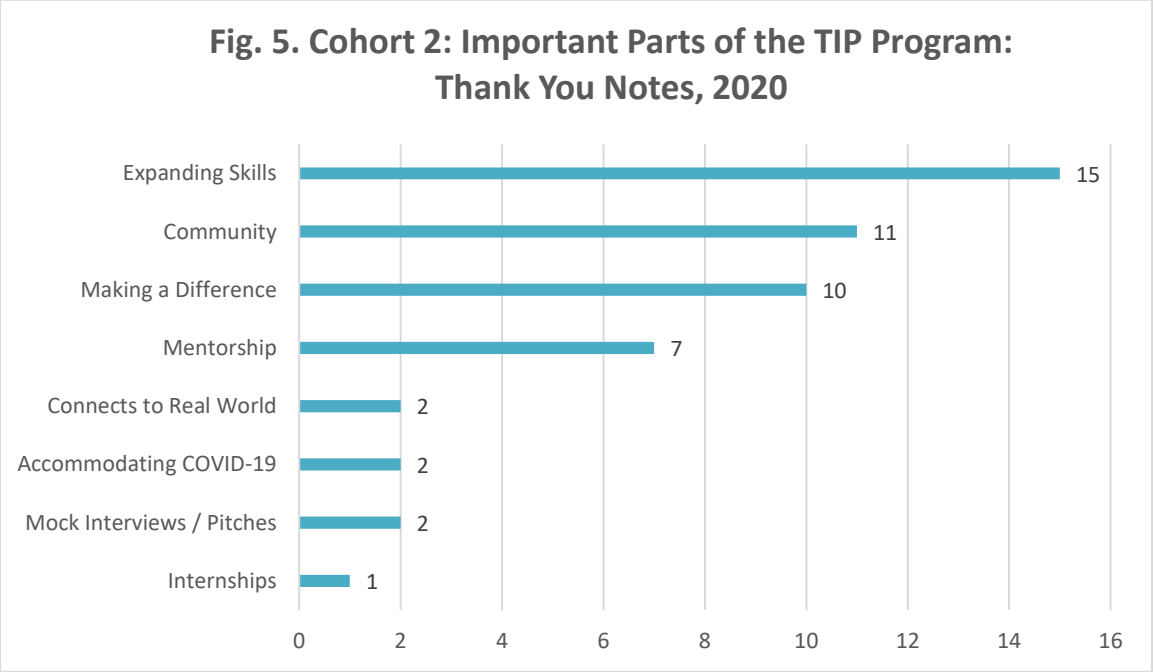
In Spring 2020, the major themes (Fig. 1) included concerns about coursework and COVID. Still, there was also a lot of discussion about the need for continuous learning and adapting dispositions, mindsets, and habits that might set the student up for success in the future. There was also a focus on preparing for internships and moving into a stable role in a company and how company culture can affect feelings of stability over time. A full-time and steady job are pre-requisites for intrapreneurial activities. During this semester, there was only one cohort; therefore, there is only one plot for that time frame.





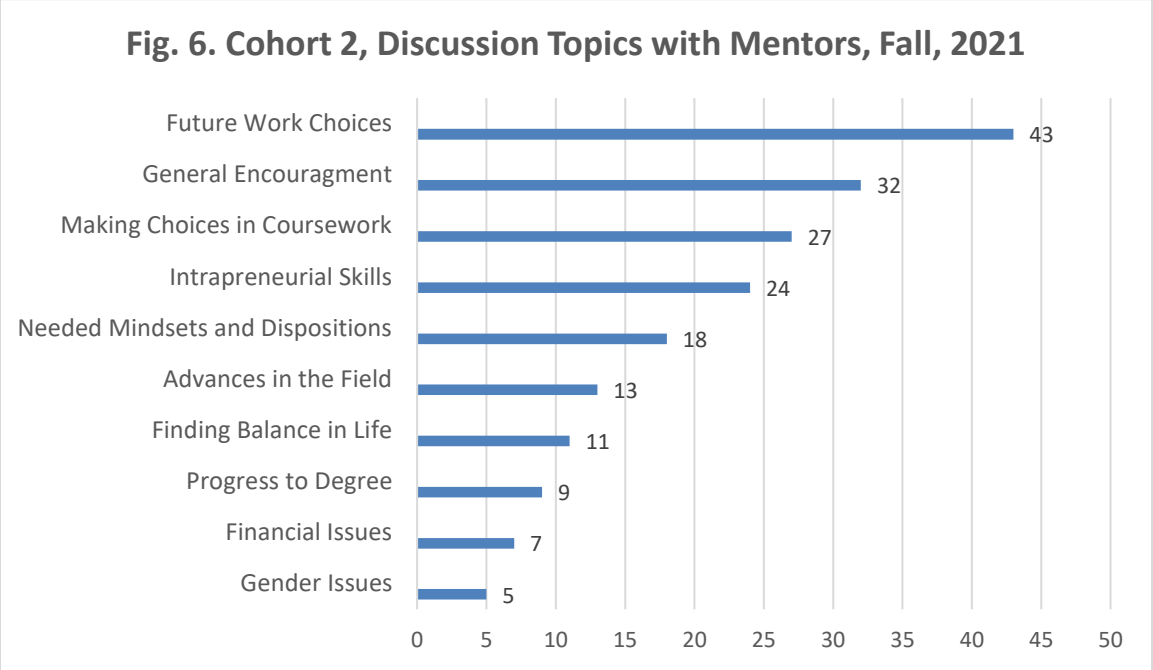
For Cohort 1, in Fall 2020 (Fig. 2), there was an increased interest in internships and a pronounced focus on future work and future employment pathways. While the focus on dispositions and mindsets and the concerns over COVID are still represented, it seems clear that students were most influenced by a need to think about their future as an employee. The themes of work culture and trends in engineering jobs came to the fore for many students. We see similar themes shown in the thank-you notes from students in the Spring (Fig. 3). The themes still focus on needs of students, internships, and the need to prepare for the workforce. However, in these notes we also see an increased focus on the value of mentorship. Students called out the benefits they felt they were receiving from mentors and from the mentorship experiences provided by the program. The fact that students saw benefits from the mentorship experience is meaningful, especially when they are combined with data below showing that additional cohorts of students and the mentors themselves felt that mentoring provided one of the strongest components of the TIP program for the benefits of the students.



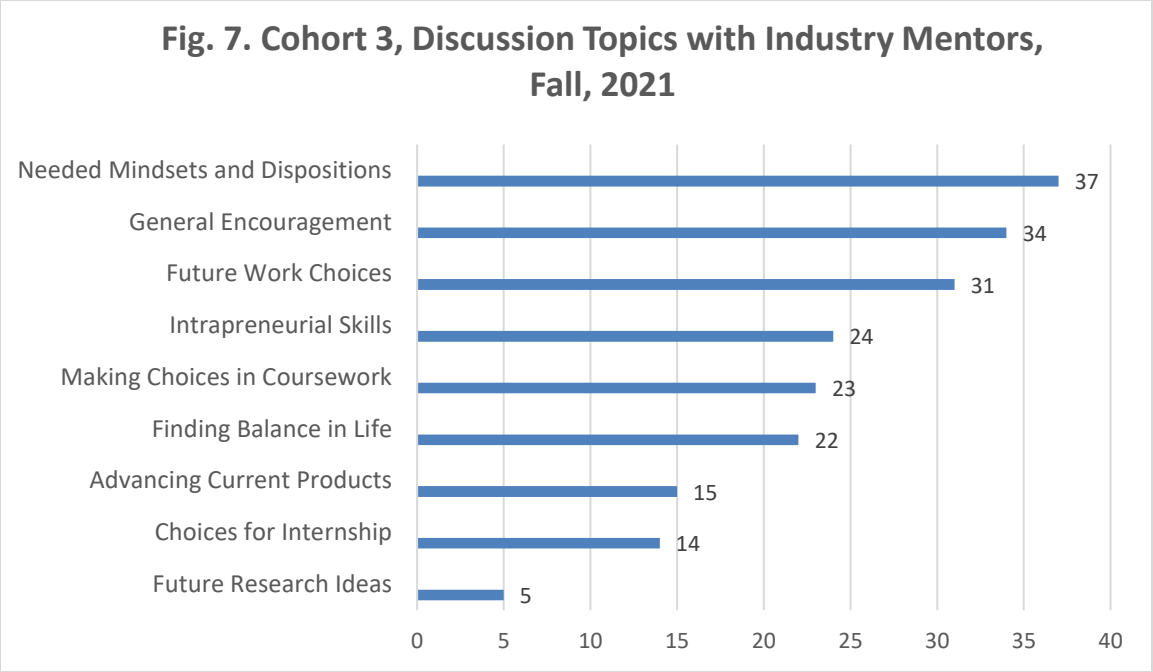


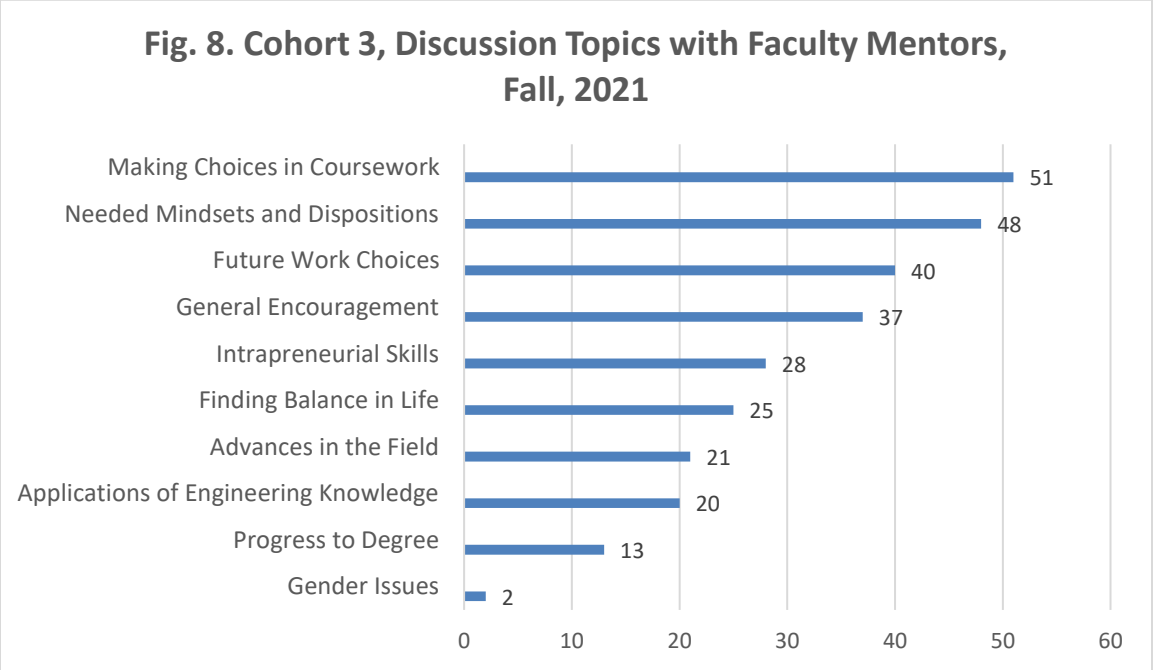
For Cohort 2, in Fall 2020, there also seems to be a concern (Fig. 4) about the future of work and pathways toward a job in engineering. For Cohort 2, there is a more pronounced focus on changing their own mindsets and adapting helpful dispositions. Additionally, there was discussion about gender in the workplace and the ways that gender intersects with the engineering profession. We see similar themes from the thank-you notes for Cohort 2 (Fig. 5). The data show that community, focus on making a difference, and mentorship were very important to these students. Students felt better prepared for the workforce because of these community-building and mentoring experiences, and clearly called out the mentoring and

community-building as important components of the program. As mentioned above, this data dovetails with what we see from cohort 1, cohort 3, and the reflections of the mentors themselves.



For Cohort 2, in Fall, 2021, we start to see new themes (Fig. 6) around the importance of work-life balance as well as a more specific focus on intrapreneurial skills. The topics of coursework, the future of the field of engineering, as well as productive dispositions and mindsets are still emergent. However, there is a more pronounced focus the ways that the experiences in coursework, and goals of future employment, are situated within other life issues.





For Cohort 3, in Fall 2021, students drafted separate reports for meetings with industry mentors (Fig. 7) versus meetings with faculty mentors (Fig. 8). There is a definite focus on coursework with the faculty mentors that are not as prominent with the industry mentors. Significantly, in both meetings with industry and faculty mentors, the topics of future work choices, needed mindsets and dispositions, and intrapreneurial skills were all prominent. The desire for work-life balance was also a concern that students in both mentoring groups raised.

As we review the data from the different cohorts and different time periods, we notice some differences in the themes and prevalence of the topics discussed. We are currently in the process of further data collection and analysis to get at the "why" of this phenomenon. For example, there were some differences in the GPAs, grades, and achievement levels among the different cohorts, but we are unsure whether this might have led to the differences. Additionally, there have been differences in the overall job market in the US over the last few years. So, again, we hypothesize that it may be a contributing factor.

We also note that, while discussion of internships was always an important topic, the data revealed more pressing discussion topics throughout the mentoring sessions. Naturalistic inquiry [14], [15] provided a significant opportunity to evaluate student concerns and mentor-mentee dialogue for an extended period. While internships were important, they were not nearly as important as thinking about future choices around coursework, the future of work in general, and acquiring the needed mindsets and skills to succeed as a consistent pattern of concern. It appears that the mentoring conversations were either very short-term-focused (which classes to take) or long-term-focused (the future of work or continuous learning). This finding has implications for teaching and creating messaging around how the internship process fits into those longer-term and short-term concerns. It also suggests a gap in students' concerns may need to be filled with increased education to ensure students are prepared for potential tasks and responsibilities later in their tenure at the university or in their early-career choices.

mentoring from the mentor's perspective

While gathering data on the mentoring experience from students' perspectives is essential, we also believe that we can learn a lot about the experience and effects of mentoring from the perspective of the mentors. To better understand this experience, mentors were contacted and asked to take an anonymous survey. Below are some of the results from the study.

One question on the survey asked the mentors to determine the topics that they regularly discussed with the mentee. Fig. 9 shows these results.

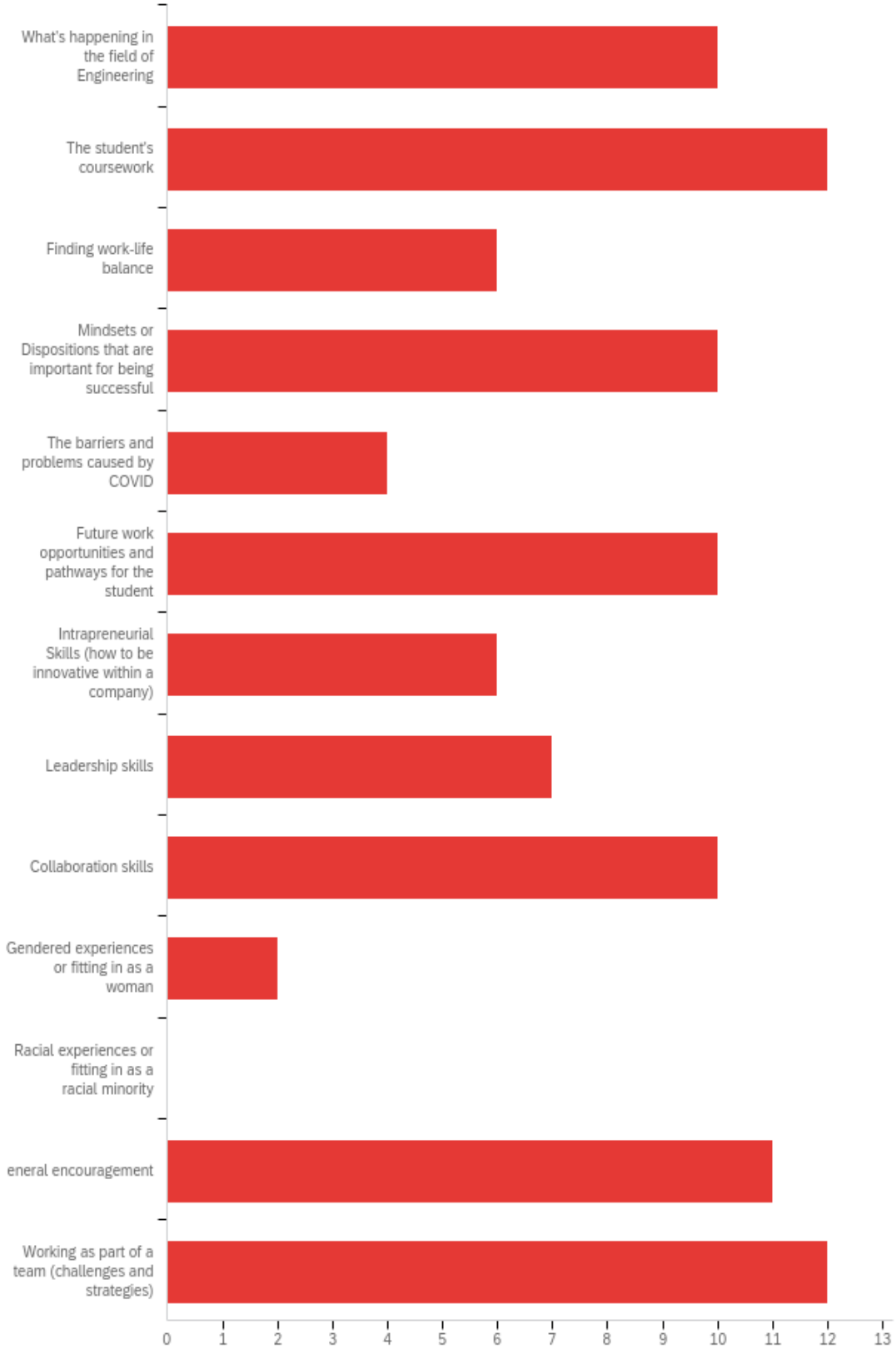


Fig. 9. Mentor reported discussion topics.

general challenges of collaborative work. Mentors also often spoke about coursework as well as work prospects and expectations within the engineering workforce.

When mentors were asked to reflect on the mentoring process, they focused on the types of actions and experiences that lead to a good mentoring relationship. The following are a few excerpts from those reflections.

> *"I think learning about a student's motivation on what they want to do and why they want to do, leads to a positive and engaging mentoring experience. It's a learning experience for me and it also helps to mentor student in a certain way rather than generic questions and answers. Different people have different life motivations and struggles and it's nice to know these to further help the students, or in certain cases help them avoid any misconceptions they have. Often time removing any mental barrier and giving them confidence in doing the right things is enough for really smart students."*

> *"I believe the students benefit from having a someone to bounce ideas off of. In my opinion, students have a lot of misunderstandings about the things that are expected of them from professors as well as industry. As an example, I have encountered countless students who are terrified of completing a master's degree, or are terrified of taking a certain job, because they feel that it is a lifetime commitment to that field. I hear things like, "If I take that job, I will have to work on embedded systems the rest of my life". Moreover, I think just forcing the student to take the time and formulate thoughts and arguments for their life-plan is invaluable. I feel like many of our engineering students get bogged down in their regular academic work to a point that they are not appropriately planning their future."*

When asked about whether or not they felt that these mentoring sessions were successful, there was an overwhelming feeling that these sessions *were* not just successful but invaluable. Many reflected on the fact that these types of mentoring experiences should be much more common. Several excerpts from the mentors' reflections are below.

> *"These mentoring experiences have been successful for students: 1) One student was really struggling in interviews for internships as he was focused on full time opportunities in future and whether he will get any job. He was the only college graduate in the family. On the other hand, he is one of the brightest students I have come across. Helping him to focus on present and unblock mental barriers about interviews and industry helped him improve his future interviews. I think he has now completed an internship and have a full-time job offer. This student also asked me lot of good questions which in the past I was struggling with as well. It really helped me answer the questions. 2) In certain cases, students are just focused on getting help on their current project and not really interested to talk or know about other things. In these situations, mentoring experiences may not be successful for students. It all depends on students' motivation in the end. It's still a good experience as hopefully they will come back and talk more when they are ready mentally for the next steps."*

> *"I do think they are successful. I think it's beneficial for students to see women (especially alumni) have engineering careers and offer advice and encouragement."*

As the researchers, we have been impressed with the types of responses from the mentors. There seems to be a consensus that these mentoring experiences are vital for students to feel like they

are becoming part of a larger community. Additionally, it was interesting to note how often the mentors talked about feeling validated or getting insights into their careers or experiences by talking with these students.

The research team will collect additional data as students graduate to gather further feedback on how the mentoring shaped the student's experience. However, at this point, while we have collected data from the seven students who graduated, the data would reveal the students' identities, which would be contrary to proper ethical research methods. Thus, at this point, only discourse analysis of student documents and survey responses from mentors were used in this paper.

conclusions

Discourse analysis was used to analyze the ideas and themes that were the most influential students, as reflected in mentoring reports and scholarship sponsor thank-you notes. The results showed that students are concerned about internships but are even more concerned about short-term and long-term pathways into the workforce. Most students inherently lack an understanding of what to expect in an internship and permanent job. Mentoring helped the students gain the necessary knowledge for competing for and expectations for working in a typical engineering industry environment. The mentoring also helped students feel belonging to the larger engineering community. Finally, mentoring helped mentors gain insight into their own careers as they reflected on their own career paths. Future research will elucidate if and how intrapreneurial activities flow from TIP graduates.

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