

Exploring Professional Skill Development in Engineering Education: How Do Students Perceive Resources?

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Introduction

For some students, the motivation for obtaining and paying for an undergraduate engineering degree is justified by the expectation that they will be able to gain the skills that will prepare and provide them with job opportunities upon graduation. Engineering employers typically seek a combination of technical skills and professional skills [1]. A study that analyzed 160 job advertisements for college graduates found that “More than 92% of advertisements demand soft skills and at least three soft skills” [2, p. 6123]. These findings suggest that employers value both technical and professional skills when selecting candidates for engineering roles. Since professional skills play a critical role in engineering employability, understanding where students believe they develop these skills has become increasingly important.

Research has shown that engineering students encounter many opportunities to develop professional skills throughout their undergraduate experience. According to the study done by Bielefeldt [3], students believe they develop these professional skills in a variety of areas. The study found that within a civil engineering curriculum, students commonly pointed to four required courses that contributed to their leadership abilities, as well as an array of extracurricular activities. Other research has identified service learning [4], [5], internships [6], [7], international experiences [8], and project competition teams [9], [10] as opportunities for students to develop their professional skills. As university students have identified a variety of opportunities and resources offered by institutions, research has yet to show how undergraduate engineering students perceive these institutional resources and to what degree they support their development of professional skills.

It is critical to understand how students perceive these resources because their perception has a strong influence on whether students engage with the opportunities that are intended to develop their professional skills. These beliefs on the value and effectiveness of these resources determine how students navigate their undergraduate experiences and ultimately how they view their own competence. As a result of their experiences, these perceptions align with how well institutional experiences translate into workforce preparation as well as alignment with employers' expectations of graduates.

While universities have the funding and resources to help students develop these skills, if they do not know what students think are important, they will not know where to direct their resources. This gap has led our work to be guided by the research question: *How do undergraduate engineering students perceive the institutional resources that have been connected to supporting students' development of professional skills?* By answering this question, universities will be able to expand their support systems and resources to support more engineering students. Findings can also advocate for curricula to support these skills, which will allow more students to participate in a curriculum that supports their broader career aspirations.

Methods

This research study recruited undergraduate engineering students studying at two R1 universities. At University A, emails were sent out to student organizations to forward to members of their clubs, fliers were posted around engineering buildings, and advertisements were placed in email newsletters. This approach is supported by the researchers' familiarity with institutional communication channels for engineering departments and student organizations, which enabled broader outreach across multiple engineering disciplines. For University B, the study was advertised to multiple sections of a foundational engineering course a week before the study and also the day of. The recruitment strategies were shaped by multiple constraints. Specifically, the researchers were not located near University B and did not have access to a centralized way of contacting student organizations. As a result, recruitment was only facilitated through a faculty connection, an aerospace engineering professor, who distributed the study information within their courses. Since recruitment strategies differ across institutions, selected subjects varied between the two universities. At University A, the subjects were undergraduate engineering students from a variety of engineering majors, including mechanical, electrical, computer, and chemical engineering. At University B the subjects were all undergraduate aerospace engineering students. In total, eleven students participated across three focus groups, seven from University A and four from University B.

All focus groups were conducted with a semi-structured protocol based on Situated Expectancy Value Theory's (SEVT) subjective task value and expectation for success [11], [12]. As an exploratory study, we wanted to see what beliefs exist about professional skills. While interviews have been noted as beneficial for eliciting a wide range of perceptions [13], our previous work demonstrated that students often struggle to verbalize their thoughts about professional skills when asked to do it on the spot. Therefore, we used focus groups as a way for students to think about professional skills in a group setting where they could listen and react to their peers' ideas rather than having to verbalize their thoughts about an abstract idea, like professional skills, perhaps for the first time. In an effort to limit "group thought" that can happen in focus groups, the lead facilitator for all focus groups would often ask if what one student shared resonated with other participants and then invited others to provide alternative opinions. The protocol was looked over by other qualitative researchers and piloted before being administered at full scale to identify procedural issues and address potential problems. Despite these mitigation strategies, we recognize that focus group dynamics may have influenced individual responses, potentially highlighting shared or socially reinforced perspectives over dissenting views.

Once the data was collected, researchers coded the transcripts using SEVT. First, the transcripts were coded blindly by the first and second authors, which means that coders could not see other interpretations of the transcripts. This was done to ensure that themes in the transcripts were not influenced by the other coder and came straight from the data. The transcripts were initially coded in the spring following data collection and were revisited at multiple points during the

subsequent months to assess the stability of interpretations. These analytic decisions were shaped using SEVT, which provided the framework for the analysis.

Within SEVT, expectations for success refers to how well someone thinks they are going to do on a task, which can be from elements like self-efficacy or external factors such as access to necessary resources. The difference between internal and external expectations for success is that internal expectations are coming from the individual, like confidence or belief that a student can/cannot perform the skills, while external considers one's access to resources and opportunities that can help or impede them from completing a task. While internal and external factors were coded separately, they can influence each other. In the case of professional skills, if a student has access to opportunities to build their skills, it can impact what skills they believe they can develop during college. We then organized the coded excerpts into various themes to understand students' varying expectations for success.

Findings

Students identified opportunities for professional skill development across a wide range of curricular, co-curricular, and extracurricular contexts, including early development programs, such as Scouting America, traditional engineering coursework, labs and project-based classes, project teams, and ethics modules. Skill exposure through coursework and lab-based experiences was described as embedded within technical tasks, while other spaces, such as clubs and student organizations, were characterized as offering more intentional and individualized development. One student reflected on this embedded nature of professional skill development within technical coursework, noting that “Every single person in any engineering discipline definitely had multiple classes where they work as a team to either build something or write a report or even team homeworks.” Students further recognized that the engineering curriculum emphasizes technical skills alongside certain professional skills such as communication, teamwork, and problem-solving, whereas other topics, including ethics and cultural sensitivity, were described as receiving limited emphasis or depth. Notably, students rarely referenced more centralized institutional resources, such as career centers, when discussing their professional skill development, suggesting that students’ growth in these areas is shaped primarily by coursework and self-directed involvement rather than by institutional support structures.

Students also briefly touched on the presence of a navigational burden, where students must actively identify, interpret, and access institutional resources in order to benefit from them. Students did recognize that universities offer a wide range of opportunities. These opportunities and resources were often advertised across emails, courses, and informal channels, requiring individual effort to locate and engage with them. As one student explained, “I think with these set of skills... it’s something that’s not always advertised directly. But it’s something that you can find in a lot of different places. Not too difficult if you’re looking in the right places.” While some students felt confident in their ability to find resources when needed, this reliance on self-navigation may disadvantage students who are less familiar with institutional systems or less

proactive in seeking out opportunities. This suggests that the effectiveness of institutional resources is not solely determined by their availability, but also by how easily students can discover and meaningfully engage with them.

Students also described that they turned to extracurricular involvement to develop professional skills they perceived as less emphasized in their coursework, such as leadership, while also using these spaces to explore personal interests and passions. One student articulated this perception by noting that, “the reason why we strive for those things is because they aren't in classes, and we seek them outside.” Another student echoed this idea stating, “If you join a club that's there, you're gonna build up these kinds of skills. Just anything where you're collaborating with other people honestly works that muscle.” These reflections display how students view extracurricular spaces as compensating for curricular gaps and also as an environment where professional skills can be practiced on an ongoing basis through sustained participation. This suggests that extracurricular involvement serves as an alternative method for students to address the gaps they see in their coursework, while also pursuing skill development aligned with their interests and goals.

While students identified numerous opportunities for professional development, they also expressed limits on the types of skills that can be taught through their coursework. Students consistently distinguished between skills they viewed as more moldable, such as communication and leadership, and skills they described as value-based, including resilience, self-confidence, moral values, and cultural sensitivity. Moldable skills were perceived as more easily modeled, practiced, and reinforced through instruction and application, whereas value-based skills were framed as developing through experience, reflection, and internal alignment. When asked where these skills are learned, one participant explained, “I don't think it's impossible to pick these up from your classes, but I'm definitely not building my interpersonal and leadership competencies by attending a lecture.” Another student reinforced this distinction, noting, “You can kind of look at how others are doing and maybe model that behavior, but you can't really model other skills like resilience that way.” This perspective was echoed by a participant who emphasized the reflective process required for these internal attributes, stating, “Those skills require self-reflection in order for you to grow in things like resilience and self-confidence...you need kind of a self-awareness to reflect upon your experiences.” Together, these accounts suggest that coursework is not viewed as irrelevant to professional development. Instead, students described formal instruction as providing exposure to different skills, while viewing the development of more internal, values-based attributes as requiring personal buy-in, reflection, and experiences beyond the classroom.

Discussion

This study examined how undergraduate engineering students perceive the institutional resources intended to support their professional skills development. The findings revealed that the availability of resources alone does not necessarily determine how students perceive these

resources, but rather students perceive them through how usable and meaningful they feel. As a result, students navigate their academic environment based on the resources they perceive as useful and aligned with their specific development goal rather than solely relying on the existence of the institutional offering.

Students' perceptions of institutional resources were also shaped by the differentiation between skills they believed could be taught and those that they believed were internally developed. While students acknowledge that classes, labs, and projects exposed them to different professional skills, they perceived limits to the extent that their formal education could shape certain value-based skills, such as resilience, self-confidence, ethics, and cultural sensitivity. This aligns with prior research, which suggests that experiential learning environments, such as student organizations and out-of-class involvement, play a critical role in developing interpersonal, identity-based, and reflective capacities that are less easily cultivated through formal coursework [14]. These skills were said to be developed through experience and reflection rather than formal instruction. Prior research similarly highlights that these environments provide opportunities for peer interaction, self-reflection, and real-world application, which contribute to the development of self-efficacy, professional identity, and sense of belonging [14]. Together, these perceptions suggest that students view their coursework as helpful for building moldable skills through exposure to them, while more internal attributes are developed through experiences that extend beyond the traditional classroom setting.

The limited mention of certain institutional resources, such as career services, may reflect how students viewed the importance of the resources to their professional skill development. Prior studies show that the effectiveness of career services depends on whether students recognize the value of the skills and support being offered, as students do not always initially perceive non-technical or job-acquisition skills as essential to their career success [15]. Additionally, students may view these resources as limited because the resources only support their development through brief and generic activities rather than through sustained, repeated practice. This perception may stem from the idea that resources designed to serve the broad student population offer less individualized engagement than smaller peer-based environments like teams and student organizations. Another key idea from literature shows that career service models often rely on students to actively engage with available resources, which may further shape how students perceive their usefulness [15]. As a result, students may navigate towards spaces where they view a clearer connection between their participation and positive skill development. These findings suggest that institutions may benefit from more clearly articulating how centralized resources contribute to specific professional skills and also designing opportunities that support individualized development rather than broad outcomes.

These findings highlight the importance of aligning institutional resources with how students perceive meaningful professional skill development. For institutions, this suggests that investing

in resources alone is insufficient; universities should also consider how resources are framed, accessed, and advertised to students. Designing opportunities that emphasize sustained engagement, individualized support, and clear connections to skill development may lead to increased utilization of institutional resources. Additionally, industry can benefit by better understanding how students are benefiting from their current institutional offerings to make more informed recruitment decisions.

Conclusion

This study explored how undergraduate students perceive institutional resources intended to support professional skill development. The findings suggest that students do not evaluate these resources based on their availability, but rather on how meaningful and aligned they feel based on students' development goals. Students' perceptions shape how they navigate institutional resources, often relying on self-directed engagement in cocurricular and extracurricular spaces. These findings suggest that institutions may benefit from aligning professional skill resources with students' perceptions of fulfilling engagement, emphasizing the elements of existing resources that students are looking for in order to engage more students. Future research can continue this work by investigating how these perceptions change throughout different stages of undergraduate education in order to examine shifts in students' reference points, motivations, and engagement with resources over time.

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