Work In Progress: Influences of Team-Based Activities on Engineering Students' Identities and Careers in University and Co-op Settings

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Abstract

This work-in-progress (WIP) paper describes preliminary analyses for a qualitative study about the impact of team-based project participation on two constructs: (1) engineering students' professional identities and (2) career goals. In this paper, we describe how we are leveraging existing data from student reflections (n = 4,238) collected by the cooperative education office at a large Midwest public university to identify substantive themes and form an interview protocol to explore the two constructs of interest. We used descriptive analyses with closed-ended responses in the reflections and inductive coding with the open-ended responses. After extracting relevant insights from the reflections, the next phase will employ a phenomenographic lens to pinpoint how college and cooperative education (co-op) experiences influence engineering students' professional identities and career goals. We plan to conduct interviews with approximately 15 students. We expect that by identifying ways to better align team-based activities with real-world teamwork practices, the effectiveness of team-based pedagogies in engineering education can be improved, and students can be better prepared for their future careers.

Introduction

In today's educational settings, there is a growing emphasis on collaborative learning and practical application of knowledge. As stipulated in the accreditation requirements set forth by ABET, one of the student outcomes explicitly emphasizes the cruciality of teamwork. This outcome states that the student must attain "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives" (ABET, 2023). As a result, team-based projects have become a crucial component of engineering curricula (Najdanovic-Visak, 2017). Engineering students participate in team-based projects in various environments, including academic courses and cooperative education settings. However, considering the myriad differences between these contexts, there is an opportunity to understand the varied impacts of those team experiences to align educational practices with the evolving needs of the engineering profession.

Research Aims

This study aims to contribute to the ongoing discussion about the effectiveness of team-based assignments in university courses and co-op programs for engineering students. Thus, this study will address the research question, *"What are the impacts of participating in team-based projects in university courses and cooperative education (co-op) experiences on the formation of engineering students' professional identities and career aspirations?"* We plan to examine the effects that team-based projects have on engineering students' professional identities and career aspirations while distinguishing how the context of these teaming experiences impacts the constructs of interest. Although there is existing research linking cooperative education experiences with shifts in identity and career aspirations (Linn et al., 2004; Arthur et al., 2022), there is a notable gap in understanding the relationship between workplace teaming experiences and these shifts.

Background

Work teams represent a common aspect of navigating the ever-changing global landscape in today's dynamic environment. Cohen and Bailey (1997) define a team as "a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationships across organizational boundaries" (p.241). The collaborative nature of engineering naturally involves teams working together to develop solutions to design problems. Several studies examine the elements that impact team performance, such as having a shared goal and high-performance standards, communication, team bonding, and clear roles (Hirsch & McKenna, 2008; Ercan & Khan, 2017; Mostafapour & Hurst, 2020). In light of these findings, attention has been paid to developing methods for improving students' teamwork abilities (Seat et al. 2001; Lingard & Barkataki, 2011).

Studies suggest that teamwork is a crucial component in forming an engineering identity, and it can potentially influence students' goals within the field (Anderson et al., 2010; Colbeck et al., 2000; Wolfinbarger et al., 2021). In fact, in the context of business, McCorkle et al. (1999) suggest implementing a team-based skill development course for students before their business core and discipline-specific classes could be beneficial. However, such a course is not necessarily a reality for most students, whether they are majoring in business or engineering. Instead, many university courses are designed based on projects that need teamwork (Kay et al., 2000; Yadav et al., 2013). Despite efforts to integrate teamwork skill-building into introductory courses, not all university team-based projects prepare students for their professional endeavors. For example, Borrego et al. (2013) argue that university projects are often confined to a single major. In contrast, real engineering projects in professional settings involve a mix of individuals from different majors, emphasizing the importance of diverse skill sets in authentic, complex projects.

Outside the classroom, co-op experiences allow students to immerse themselves in a professional environment, including working in a team on projects with real business impacts. Raelin et al. (2014) results suggest that co-op experiences positively impact students' work self-efficacy. Moreover, Liu et al. (2018) argue that the co-op and university contexts provide diverse learning experiences for students, with the quality and nature of their interactions playing a pivotal role in shaping the students' overall experience and learning outcomes. Our study will investigate the effects of participating in these team-based projects on engineering students' professional identities and career aspirations. We explore the differences in these experiences between university courses and cooperative education settings, which will provide valuable insights into how team-based projects can be better structured to shape engineering students' educational and professional paths.

Methods

Our study includes three phases. The first two phases are based on existing data. We received students' reflective surveys collected during their co-op experience in 2023 from the cooperative education office at a large Midwest public university, which detail skills students chose that they wanted to develop during that rotation (two are chosen for each rotation), their day-to-day activities while on the co-op rotation, and the impact of co-op on their professional development. In future work, the third phase will include interviews with students to gain more insight into their experiences.

In the first phase, we analyzed close-ended questions from the reflective survey to determine students' general attitudes and outcomes of the co-op experience by comparing the responses from students who ranked teamwork as one of the two skills they wanted to develop during the co-op in the survey to those who did not. We are currently in the second phase, which involves analyzing open-ended questions from the reflective survey using inductive coding to parse specific reflections about team-based projects, professional identity, and career goals. The results from the second phase will be used to identify patterns that will inform the design of our semi-structured interview questionnaire for the third phase.

Future Work

In the third and last phase of the study, a group of students will be interviewed about their co-op experiences and the impact of co-op on their identity and career formation. To have a diverse and representative group of participants, we will use the snowball sampling method (Biernacki & Waldorf, 1981) to recruit students from the College of Engineering at the large Midwest public university. We aim to interview individuals who have completed at least three co-op rotations since, at that point, they would have been given the appropriate responsibilities to interact in team-based projects. Participants will be interviewed via Zoom using a semi-structured interview format. We plan to use a phenomenographic approach (Dringenberg et al., 2015) to analyze how participants experienced team-based projects in academia and industry and what impact these experiences had on their professional identity and career goals. The semi-structured format provides flexibility and allows participants to elaborate on their unique perspectives (Horton et al., 2004). Our findings will be valuable for academic institutions and industry partners involved in co-op programs.

Phase 1: In the survey, students were asked to select two skills they wished to develop through their co-op experiences. We separated individuals who prioritized "teamwork/collaboration in diverse settings" as either their first or second goal from those who did not. We then selected questions from the survey that focus on teamwork (Q1, Q2, Q3, Q4), students' professional identity (Q5), and personality (Q6, Q7). These prompts used by the cooperative education office had a 5-point (Never, Rarely, Sometimes, Often, Always) and 7-point (Strongly Disagree to Strongly Agree) scale, depending on the prompt, to have students rank how often they had the opportunity to develop certain competencies.

Q 1: Effectively collaborating with others to accomplish a goal (5-point).
Q 2: Recognizing and appreciating differences within your team (5-point).
Q 3: Identify your personal biases and ask questions to understand perspectives different from your own (5-point).
Q 4: The degree to which your personal values align with the values of the organization (5-point).
Q 5: Demonstrate a professional attitude (5-point).
Q 6: Demonstrate self-confidence (5-point).
Q7: My personality is a good match for this experience (7-point).

Subsequently, we analyzed the responses of those who chose teamwork as their first or second goal and compared them to those who did not select teamwork using the seven prompts. The results from these prompts provided a first impression of the impact of the co-op experience on the students who chose teamwork as a goal, presuming their chosen skills had some effect on the opportunities infused in the co-op experiences.

Phase 2: This phase concerns the survey's open-ended questions. In particular, we are focusing on the responses to the prompt, "How has this experience influenced your career goals and/or professional identity?" by using thematic analysis to extract themes for the semi-structured interview protocol. If differences between groups were found, then we would use those differences as potential leads to dig deeper qualitatively.

Preliminary Results

For this work in progress, we will overview the findings from the descriptive analyses of phase one. Overall, 4,238 students participated in the co-op survey from different engineering majors, including Biomedical Engineering (319), Computer Engineering (263), Cybersecurity Engineering (13), Environmental Engineering (142), Mechanical Engineering Technology (280), Aerospace Engineering (327), Chemical Engineering (457), Computer Science (508), Electrical Engineering (309), Architectural Engineering (160), Civil Engineering (290), Construction Engineering (304), Electrical Engineering Tech (54), Mechanical Engineering (808), and Unspecified (4).

A total of 736 students chose "teamwork/collaboration in diverse settings" as their first preference for the professional skill they wanted to develop through the co-op program, and 924 students selected it as their second preference. Figure 1 displays the distribution of professional skills students choose for development during co-op experience. Notably, a small proportion of students listed ethical decision-making as a prioritized skill to develop, instead opting for critical thinking and communication – followed by teamwork and innovation. The distribution of choices for the second prioritized skill was much flatter. Across these two choices, 39% of students wanted to develop teamwork skills in their co-op rotation.

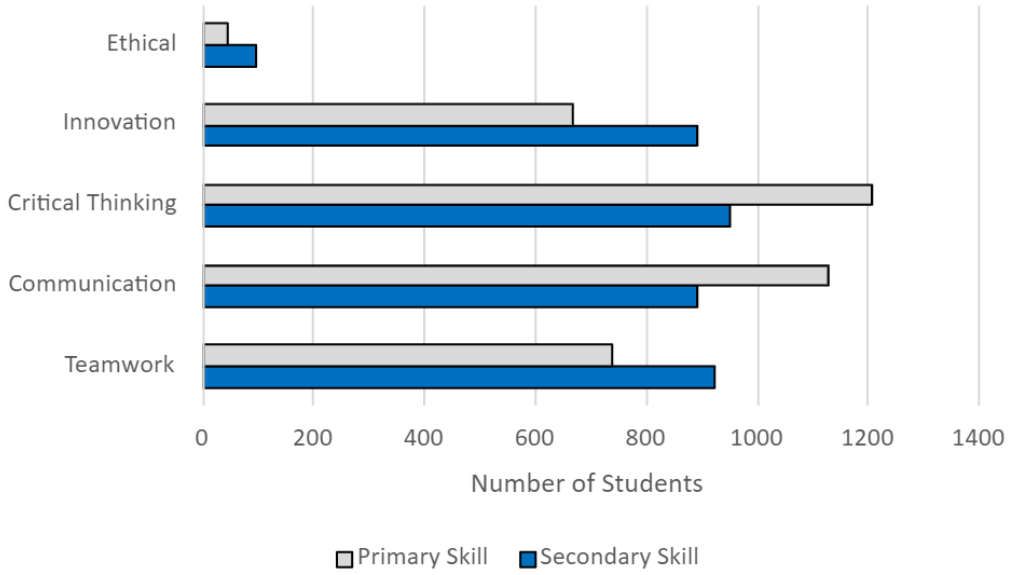

Figure 1: (Gray) Student's first choice of professional skill they wanted to develop during their co-op experience; (Blue) Student's second choice of professional skill

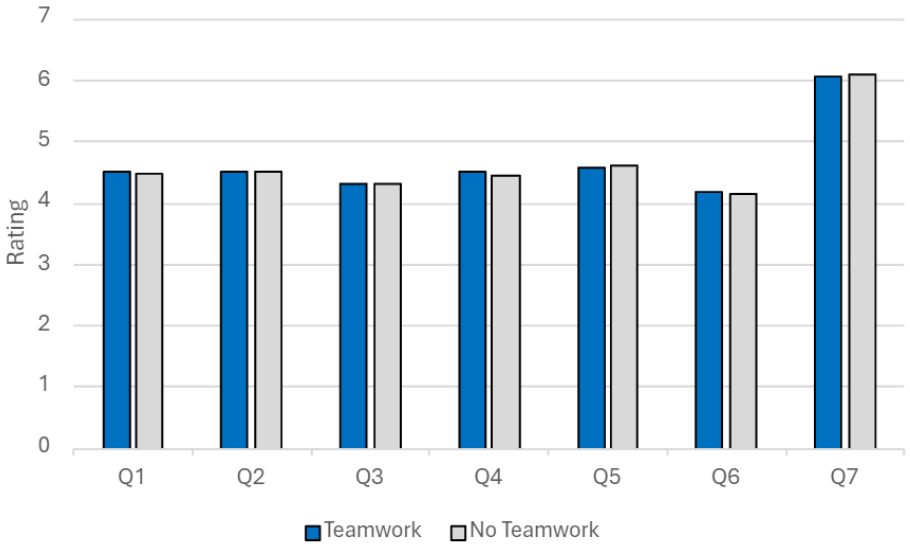

Figure 2: The results of Q1-Q7 from students who selected teamwork as their primary or secondary skill to develop and those who did not

Although students selected different skills to develop, the focus on these individual skills had little influence on the extent to which students reported acquiring teamwork-related competencies despite potential tailoring in the co-op experience. Both groups reported high levels of collaboration, recognition of team diversity, professionalism, self-confidence, recognizing personal biases, and seeking understanding from diverse perspectives. However, it was apparent that a qualitative perspective was necessary to understand the context of these skills being practiced so that salient questions for the interview protocol could be developed. The self-report data was generally unhelpful.

As we have analyzed the open-ended question regarding the influence of co-op on students' career goals and professional identity, we found the following preliminary themes:

1) *Formative*: Students mentioned that the co-op rotation developed their career goals and professional identity. This theme captured student experiences that solidified their career goals in some way, providing a clearer path forward. For example, one student responded:

"…. Through my work on developing software solutions for ultrasound devices, I have gained a deeper appreciation for the critical role that technology plays in the medical field. Furthermore, working in a large-scale corporation has exposed me to a variety of career paths and potential areas of specialization. This has helped me to refine my career goals and identify areas of interest that align with my skillset and professional aspirations..."

2) *Transformative*: Students also discussed how the experience was altering their goals, their attitudes, and their perspectives. Therefore, this theme related to comments about unexpected changes that arose because of their co-op experience. For instance:

"This experience actually influenced my career goals greatly and I was not expecting that. Professionally, I have only thought about being an engineer but the structure at Ethicon made me think a lot more about leadership and moving up into management. So I have thought a lot and considering getting my MBA a lot now after this term."

3) *Empowering*: For another subset of students, the co-op rotation was empowering and boosted their confidence and self-assurance. Thus, the rotation reinforced their previous plans. A student responded:

"This co op experience has showed me that I have the capability to be a successful project engineer coming out of college. I have all the experience and tools necessary. It has influence my career goals because during my time with [company] so far, the water/wastewater construction industry is very appealing to me and I love applying my knowledge to something that is essential. My career goal after this co op is still the same. I want to become a project manager in the future and continue to learn as much as I can because I am interested in it. "…"

From these initial analyses, exploring student experiences along these strands seems prudent: those whose career goods and identity were formed, revised, and reinforced. Some proposed interview questions for phase 3 using the themes from phase 2 can concentrate on how teamwork affects the student's perception of how the co-op experience influenced their career goals and professional identity. For instance, we propose the following questions:

- Reflecting on your overall experience in *(your co-op rotation, your coursework)*, what changes in your career goals or professional identity have occurred as a result of collaborating with others on a team project? (Formative)
- Can you describe a time when teamwork dynamics within your *(your co-op rotation, your coursework)* led to a shift in your perspective or approach toward your career goals or professional identity? How did this experience impact your future plans? (Transformative)
- How has teamwork in *(your co-op rotation, your coursework)* contributed to personal and professional growth? How has this influenced your understanding of your career trajectory? (Empowering)

These questions will be positioned from both academic and industry contexts to tease out differences in the impact of these team-based experiences.

We expect to extract more themes once we analyze additional responses to the open-ended survey questions. To further understand the effects of team-based projects on engineering students' professional identities and career aspirations, we will then conduct interviews that build upon the results of our survey analysis. These interviews will give us valuable insights into the qualitative aspects of the students' experiences. We plan to recruit for the interviews in the next two months.

Conclusion

From our preliminary analysis leveraging existing survey data, we have extracted possible questions to probe the impacts of team-based projects in academia and industry. Next, the remaining open-ended questions from the survey will be analyzed to identify additional themes. The identified themes and patterns from the survey responses set the stage for the next phase of our study, where in-depth interviews will offer a more comprehensive exploration of participants' firsthand experiences. These interviews aim to capture rich narratives and deeper insights into how team-based projects can impact students' professional identity and career aspirations. By comparing academic and workplace contexts, we will identify opportunities for aligning team-based activities with real-world teamwork practices. Our results will provide insights into how these experiences can positively impact students' professional journeys.

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