# WIP: Team Cohesion and Engineering Identity in a First-Year Engineering Program

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## Introduction

Teamwork is widely recognized as a crucial skill for success in the engineering workplace [1]. 84% of U.S. employees work in multiple teams, with teamwork recognized as a top 3 skill in recruitment and selection [2], [3]. As the application of information, communication, and automation technology advances, the demand for complex collaboration is projected to grow even further [4].

Consequently, there is a need for engineering students to develop the skills required to work effectively in teams. Collaborative learning has been codified into the 2025-2026 ABET Criteria for Accrediting Engineering Programs, to ensure that future engineers can "function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives" [5]. Beyond preparing engineering students for workplace collaboration, group-learning approaches also create an educational environment in which students earn higher grades, learn more deeply, and retain information more strongly [6].

The implementation of group work early in engineering education prepares students to succeed in future collaboration, with demonstrated improvement in capstone design courses given prior team experience [7]. Positive team experiences also foster a sense of belonging and create community among first-year students, aiding early integration into campus culture [8]. Conversely, negative teaming experiences have the potential to undermine student inclusion and belonging [9].

The first 2 years of the collegiate experience play a key role in determining students' persistence in their chosen major and in college in general [10]. In particular, cultivation of undergraduate students' engineering identities is imperative for continued pursuit of engineering education and retention leading into the engineering workforce [11].

This paper seeks to investigate a bidirectional relationship between teamwork and engineering identity in a first-year general engineering design course. This research builds upon previous investigations of the social and task cohesion, self-efficacy, and role determination in senior engineering capstone teams [12]. The goal of this study is to examine social factors impacting team performance and engineering identity in an effort to improve learning outcomes in first-year undergraduate engineering programs. The results of this study may inform team development tools for first-year engineering programs to support effective student teams and cultivate personal engineering identities. This study also has the potential to identify indicators of negative team interactions which may impact student construction of engineering identity, allowing for intervention by engineering educators.

### *Challenges in Teaming Experiences*

Numerous factors can prove detrimental to student teaming experiences and subsequent learning outcomes. Challenges in teaming include differences in goals or expectations, inequitable task allocation, exclusionary social practices, and reduced psychological safety [13], [14]. For first-year engineering students in particular, a mismatch in backgrounds and expectations can

lead to conflicts among teams, including unequal workload distribution, communication breakdowns, and freeriding [15]. Assumptions that women and students of color are less qualified influence their task allocation, validation of ideas, acknowledgement of work, self-efficacy, and feelings of belonging [6]. In first-year engineering groups, for example, studies suggest that men fulfill more technical roles while women fulfill organizational needs, limiting their opportunity to learn in particular content areas [16]. Equity in teaming experiences can improve self-efficacy, belonging, and persistence for students from underrepresented groups in engineering design teams.

*Engineering Identity*

Engineering identity refers to the degree to which students view themselves as an engineer. This identity is built on 3 core constructs: students' feeling of recognition by others; students' interest in engineering; and students' belief about their performance/competence in engineering [17]. The development of a student's engineering identity relies on participation, recognition, and belonging within the engineering space [17], [18]. Engineering identity is a strong predictor of retention and success in engineering, particularly for underrepresented students in engineering fields [11], [19]. It is thus critical to foster engineering identity formation in undergraduate programs. This paper used validated survey questions to measure the 3 constructs of engineering identity (recognition, interest, and performance/competence). These questions were developed by Godwin for quantitative engineering identity measurement in introductory engineering courses [17].

*Team Learning Belief and Behaviors Model*

The Team Learning Beliefs and Behaviors (TLBB) Model is a theoretical framework for building high performance teams by identifying social and cognitive factors in collaborative learning environments [20]. It defines 5 dimensions of building effective teams, which consist of both social-oriented (interdependence, social cohesion, group potency, and psychological safety) and results-oriented (task cohesion) team attributes. Pfluger et al. demonstrated the importance of fostering both social-oriented and results-oriented attributes in team-based courses, with student engineering teams across institutions identifying interdependence as the most important team quality [21]. This paper utilized the TLBB Model to evaluate student perceptions of their teaming experiences, and measured TLBB dimensions using scales from validated questionnaires [20].

## Experimental Methods/Materials/Project Approach

*Research Questions*

This paper will examine the following research questions:

1. How do differences in self-efficacy based on gender influence role determination and team leadership in first-year engineering design teams?
2. How do teaming experiences in the first year of college influence students' perceptions of their engineering identity?

*Site Description*

Northeastern University is a private urban R1 university in Boston, MA. Approximately 22,695 undergraduates were enrolled at the university in Fall 2024, with 3,755 undergraduate students enrolled in the College of Engineering [22]. Approximately 40.6% of the undergraduate population was white, and 57.0% identified as women [23].

*Cornerstone Course Design*

All engineering students are required to complete Cornerstone of Engineering I and II, a 2-semester course, within the first year of their undergraduate engineering education. Approximately 30 sections of the course are offered each year, with 32-36 students in each section. The curriculum integrates technical knowledge and foundational engineering concepts, introducing principles of engineering design, ethics, computer aided design (CAD), programming, and the use of microcontrollers. Beyond the individual assignments, these skills are applied and challenged in a hands-on, team-based term project to address an open-ended design problem. Teams are formed at the beginning of the term, and complete a team contract to establish agreed-upon standards for work throughout the semester.

*Data Collection*

This study involved a 15-minute voluntary survey that included questions regarding demographics, student perceptions of effective teams for current cornerstone students across multiple engineering disciplines, and engineering identity. Teaming experience questions were evaluated using the Team Learning Beliefs and Behaviors (TLBB) Model and utilized scales taken from validated questionnaires from Van den Bossche et al. (2006) [20]. Survey questions measuring engineering identity were adapted from validated studies from Godwin (2016) measuring three distinct constructions of engineering identity: recognition, interest, and performance/competence [17]. This survey received human subject research permissions by the Institutional Review Board (IRB).

**Results and Discussion**

*Work in Progress Statement*

At Northeastern University, most cornerstone courses are two-semesters in length, with Cornerstone I taking place in the fall and Cornerstone II taking place in the spring of the first year (with the exception of the “stacked” cornerstone section which condenses two semesters of material into a single semester). The pre-semester survey (pre-survey) responses for fall 2025 will be compared with the spring 2026 pre- and post-survey responses for cornerstone students for multiple timepoint comparisons across the first year. While the sample size for this preliminary study was too small to support statistical testing, future iterations of this study will attempt to acquire a higher response rate by working with professors by posting this survey as an ungraded assignment on their course pages. However, these preliminary results will inform any potential changes that need to be made with respect to the survey.

*Response Rate*

The fall 2025 pre-semester survey (pre-survey) received 8 responses, including 4 men and 4 women. These students were at the start of their Bioengineering (12.5%), Chemical Engineering (25%), Civil and Environmental Engineering (12.5%), Electrical and Computer Engineering (25%), and Mechanical and Industrial Engineering (25%) studies. Regarding cornerstone team compositions, 50% of students reported working in a mixed-gender team, 25% of students reported working in an all-male team, 12.5% of students reported working in an all-female team, and the remaining students had yet to be assigned teams. Given the low response rate, there were too few data points to determine statistically significant differences between male- and female-identifying students. Class time was allotted for the completion of this survey during the 2026 spring semester, allowing for a much higher response rate (135 pre-survey responses) to be analyzed in the next iteration of this study.

*Previous Teaming Experiences*

Prior to entering the course, 50% of students reported having previous formal classroom training in teamwork provided in a course or workshop by an instructor, while 50% of students reported having had no previous training in teamwork skills. Of these "formal classroom training," prior teamwork experience included teamwork in both STEM and non-STEM courses, as well as some experience in industry. Entering the course, students were asked to quantify their level of agreement with statements regarding their perceived personal abilities from 1 (completely disagree) to 7 (completely agree) based on previous experiences in team settings (see *Fig 1A*). On average, students most agreed that, in team settings, they contribute to their fair share of project work ($6.36 \pm 0.52$) and least agreed that they relied on teammates for technically understanding and abilities ($3.64 \pm 0.89$) or for organization and completion of deliverables ($3.41 \pm 1.30$). Furthermore, students were asked to evaluate their perceived abilities by ranking teamwork competencies in order of their confidence to lead completion of team deliverables, maintain positive interactions between teammates, set internal deadlines and assess timeline, refine and polish deliverables to a high quality, and contribute to technical knowledge and skills.

Students were then asked to rank the perceived importance of various qualities for team effectiveness, such as completion of team deliverables, positive interactions between teammates, clear team organization and management, high-quality work and refinement of deliverables, and technical knowledge and skills. Students ranked these five qualities from most important (1) to least important (5). Students reported clear team organization and management as the most important ($2.14 \pm 1.03$) and technical knowledge and skills as the least important ($4.64 \pm 0.52$) quality for team effectiveness (see *Fig. 1B*).

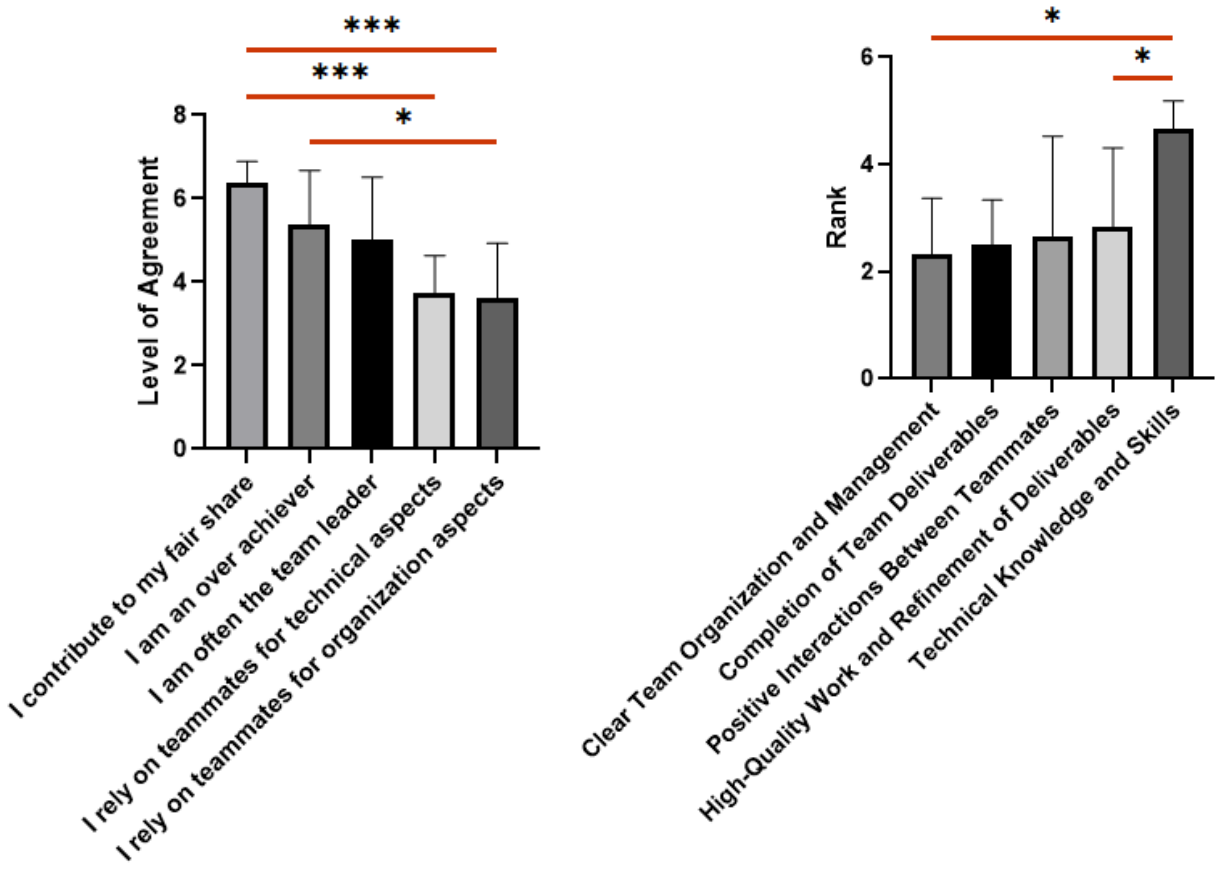


**Figure 1. A) Benchmark of student abilities and self-perception based on prior teamwork experiences. B) Student rankings for the importance of qualities for team effectiveness. Means and standard deviations displayed. One-way ANOVA performed with a tukey-kramer post hoc test. * ($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$). All other unlabeled differences were non-significant.**

*Team Effectiveness*

Students were prompted with Likert scale questions to evaluate their perception of team organization and management. Students were asked to rate how much they agreed with statements, including "the team leader should organize team meetings and plan internal deadlines", "all members of the group should contribute to team organization and logistics", "I should be motivated by members of my team to complete team goals", and "members of the group should be intrinsically motivated to complete team goals" to elucidate student expectations for the roles of team leaders and individual group members. No statistical significance was observed between team organization and motivation statements, though students generally agreed with all statements.

Additionally, social and task cohesion were evaluated by Likert scale questions derived from the TLBB dimensions derived from Van den Bossche et al. (2006) [20]. For social cohesion, students were asked to rate their level of agreement with statements such as "I should feel a sense of belongingness to my team." Similarly, for task cohesion, students were asked to rate their level

of agreement with statements such as “we should be united in our goal for performance.” Both sets of questions were scaled from 1 (completely disagree) to 7 (completely agree). No statistically significant differences were observed between TLBB dimensions, but students generally agreed with all statements related to both social and task cohesion (see *Fig 2A* and *2B*).

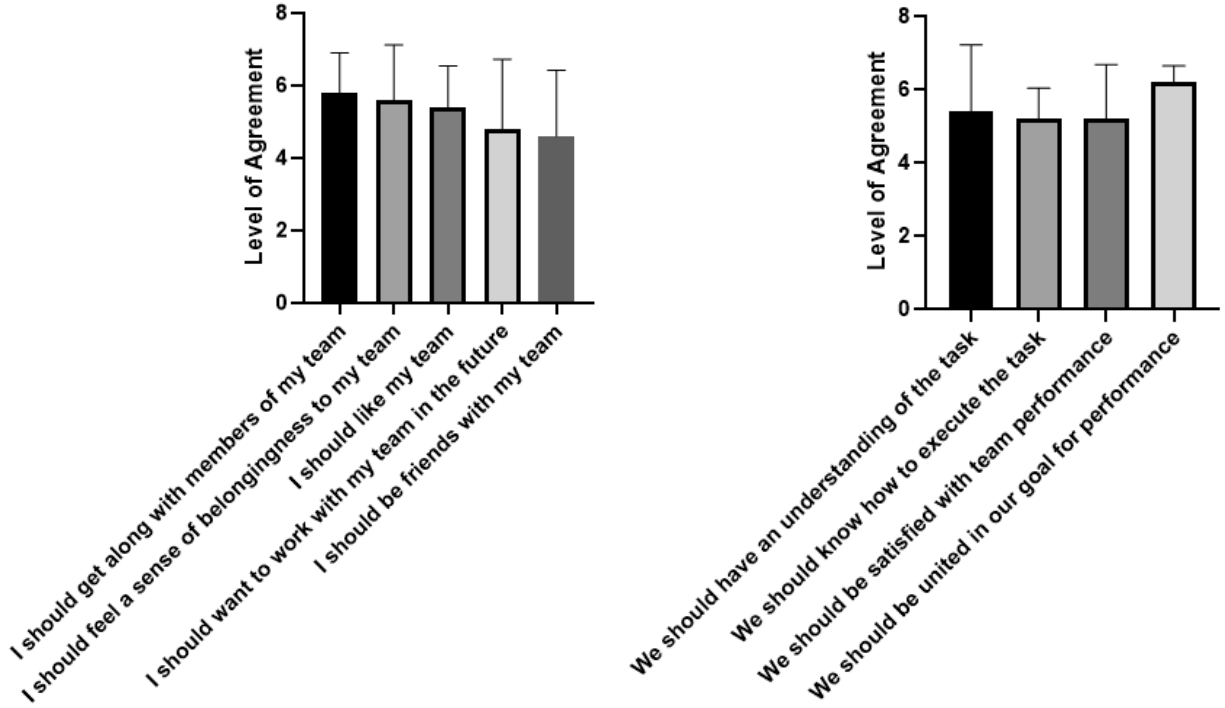


**Figure 2. A) Social cohesion Likert questions. B) Task cohesion Likert questions. Means and standard deviations displayed. One-way ANOVA performed with a tukey-kramer post hoc test. * ($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$). All other unlabeled differences were non-significant.**

Ultimately, these results indicate that students enter their undergraduate engineering studies with the belief in their personal ability to contribute to their fair share and achieve in group projects and valuing team organization and management from their teammates.

*Engineering Identity*

To evaluate how students entering into undergraduate engineering in their first year perceive their engineering identity, Likert scale questions were used to explore different aspects of the engineering identity, including recognition, interest, and performance or competence. These questions were derived from research conducted by Godwin (2016) [17]. While no statistical differences were observed between the dimensions of engineering identity, students were neutral on statements that indicate that their engineering identity was recognized by instructors, parents, and peers (see *Fig. 3A*) and were generally in agreement that they enjoyed learning engineering (see *Fig. 3B*).

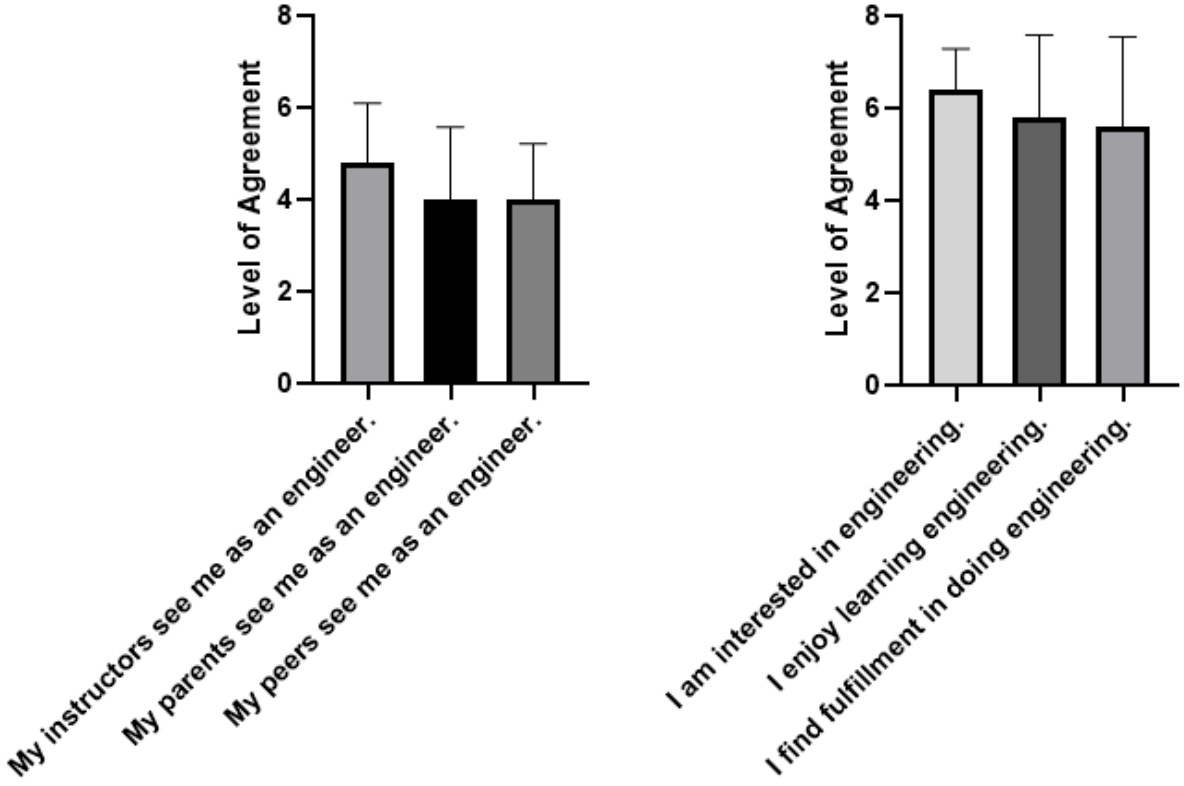


**Figure 3. Engineering identity. A) Recognition dimensions. B) Interest dimensions. Means and standard deviations displayed. One-way ANOVA performed with a tukey-kramer post hoc test. * ($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$). All other unlabeled differences were non-significant.**

Furthermore, while there were no statistically significant differences between statements regarding engineering performance or competence, students generally agreed that they are entering their engineering studies confident in their abilities to learn the engineering curriculum and overcome challenges in their coursework. Interestingly, students were least confident that peers would ask them for help in engineering coursework ($3.29 \pm 1.79$), which may have significant implications for role determination in group projects. When asked in an open-ended question "What does being an engineer mean to you?" students responded "being able to help people," "solve problems," and "Always learning and creating to make the world a better place for EVERYONE."

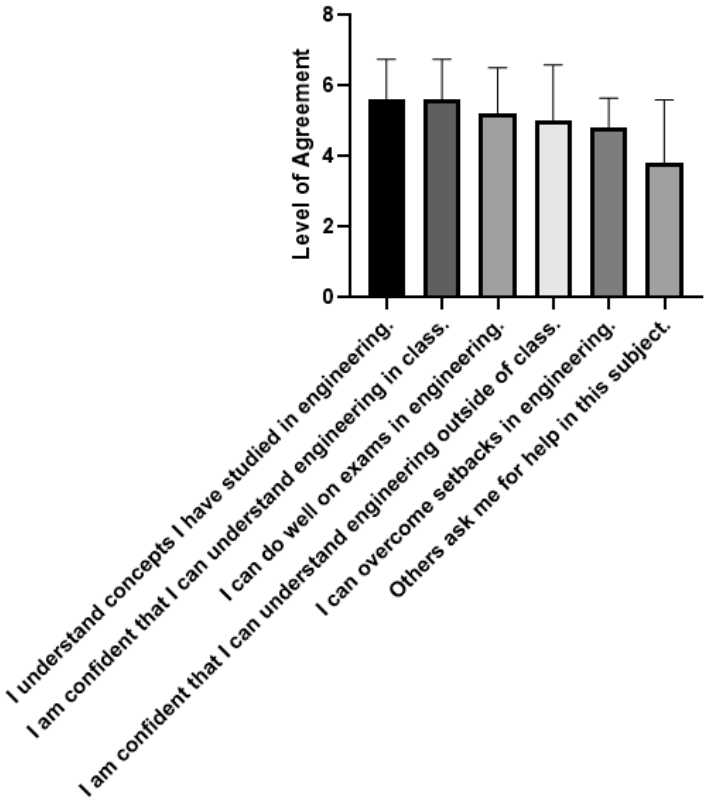


**Figure 4. Performance or competence dimensions of engineering identity. Means and standard deviations displayed. One-way ANOVA performed with a tukey-kramer post hoc test. * ($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$). All other unlabeled differences were non-significant.**

*Conclusions*

These results offer a snapshot of first-year student experiences in a team-based engineering course. When comparing student perception of important qualities for team effectiveness in first-year students with senior capstone engineering students as previously reported by Szoo & Pfluger (2025), a similar trend was observed where both groups of students most value team organization and management of internal deadlines and timelines and least value contribution to technical knowledge and skills [12]. Interestingly, as it relates to the engineering identity, students were more neutral, on average, when it came to statements regarding peer recognition of their engineering identity, as well as statements such as "Others ask me for help in [engineering]." Given that students reported valuing a sense of belonging as an important for team effectiveness, disparities in personal perception of abilities and peer recognition may be a negative factor towards social cohesion and could have important implications for retention in engineering following the first year. A greater response rate in subsequent surveys will enable true assessment of these trends. Ultimately, future work will seek to understand how gender further plays a role in social cohesion, task cohesion, and engineering identity in team settings, and how these factors may change from first-year engineering courses and senior capstone.

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