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Developing Complete Engineers: Integrating Six Non-Technical Competencies in the First-Year Experience

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Abstract

Developing engineering students as successful professionals requires establishing strong technical knowledge and cultivating a set of non-technical competencies that support professional and personal growth. Building on our earlier work of establishing the context, justification, and growth framework of the Complete Engineer® program, this study examines how the model has been integrated into the first-year engineering experience. The Complete Engineer® program emphasizes six core competencies that include Inclusive Excellence, Communication, Self-Management & Leadership, Civic Responsibility, Teamwork, and Professionalism & Ethics. We present strategies for implementation, highlight preliminary outcomes, and share lessons learned that may guide other engineering programs seeking to introduce holistic professional development into the first-year experience. The results of our study show the degree to which students' understanding of the competencies aligned with the program definitions following exposure to the program in their first-year seminar.

Introduction and Context

As part of our college's strategic plan, a goal was set to have a college culture founded in the Complete Engineer® program. This program was developed as a three-dimensional framework of technical, professional, and personal mastery that aims at developing our undergraduate students' non-technical competencies. The core, comprehensive philosophy of the program is that good engineers have well-developed technical competencies that are compulsory for their profession while also exhibiting and practicing non-technical skills required for solving problems and challenges of global importance. The Complete Engineer® competencies are Inclusive Excellence, Communication, Self-Management & Leadership, Teamwork, Civic Responsibility, and Professionalism & Ethics.

History of the program

The Complete Engineer® program was developed over several years before its official launch in the Fall of 2022. To meet our goal of developing a program with long-lasting positive impacts on our culture, we sought to answer the question, *which non-technical competencies are needed for a well-rounded engineer?* Our answer resulted in a program development plan that included:

- a strong underlying philosophy and belief that a complete engineer needs both technical and non-technical skills
- data and feedback from industry partners concerning the variability in our recent graduates' professional and personal mastery
- extensive feedback from our industry partners on non-technical competencies that are needed for our students to succeed

- discussions with alumni and guidance from our faculty and staff with student development and assessment experience
- discussions and strategic input from our college leadership and administration
- a deep dive into the literature on student development.

The full extent of our program development is well documented in our previous study [1]. This program is a direct result of the college's desire to create a formal system for assessing and credentialing students and was formalized with its incorporation into the college's strategic plan.

Literature Review

Non-technical competencies, which are commonly referred to in the literature as soft skills, professional skills, and non-cognitive skills, are increasingly identified as essential for undergraduate success both academically and professionally. This is particularly important as students transition to higher education and must navigate new academic expectations, social and learning environments, and professional and personal growth [1] – [4].

Studies show marginal yet reliable correlations between students' mastery of non-technical competencies and academic performance indicators such as first-year GPA, with a much stronger relationship observed for student persistence and graduating within expected timeframes [5], [6]. Powell [6] conducted a quantitative predictive study examining how self-management skills such as responsibility, study habits, and motivation predict student performance in the first year and found that these skills contribute meaningfully to early college success.

Despite this recognized importance, without clear, intentional, and structured systems focused on the development of non-technical skills, student growth is largely unsystematic and often left to chance [7] – [9]. Alghamdi et al. [7] found that while university students exhibit slight increases in soft skills over time, the magnitude of development is minimal and insufficient relative to institutional expectations. The literature therefore suggests a disconnect between the recognized importance of developing soft skills and the systems in place to support their growth, further emphasizing the need for intentional integration into the college experience.

This disconnect is further reinforced by Mohammed et al. [8] in their systematic literature review of soft skills in information technology education. They found that although numerous instructional approaches commonly used in colleges of engineering, such as project-based learning and team-based learning, show promise in developing these competencies, there is little evidence of their systematic integration within curricula, with most efforts remaining isolated or ad hoc. Their findings highlight the need for coordinated and programmatic approaches to intentionally develop industry-aligned non-technical competencies.

Intervention-based studies provide evidence for the effectiveness of structured approaches. For example, in a three-year study, students enrolled in a course focused on non-technical skill development. The students showed statistically significant improvements in their adjustment to higher education. By emphasizing self-management and professionalism, the course highlights the impact of intentionally designed first-year experiences on student success [10].

Within the context of engineering colleges, much of the emphasis on integrating professional skills into the curriculum can be attributed to the 1996 ABET Board of Directors decision to implement a set of forward-looking criteria as core to ABET's operating philosophy. These criteria, now known as ABET criteria, include a variety of skills, many of which align with the Complete Engineer® program, including communication, professionalism and ethics, teamwork, and civic responsibility [11] - [12]. Shuman and Besterfield-Sacre [1] argued that these skills are best developed through integrated, experience-based approaches.

Engineering and computing fields have long recognized that professional skills are crucial to students' success. In fact, a 40-year scoping literature review by Chadha and Heng [9] demonstrates broad consensus among educators regarding their importance. However, the same review also highlights a lack of a coherent approach to integrating these skills, resulting in fragmented implementation across programs. This lack of systematic integration may stem from differences in how faculty, industry, and students conceptualize these competencies, dependence on varying institutional practices, and persistent challenges in assessing long-term impact due to limited robust evaluation methods [8] - [9], [11] - [12].

As a result, researchers have increasingly examined the impact of integrating non-technical competencies within computing and engineering programs, particularly in the first year. While these studies further emphasize the need for systematic integration, they also demonstrate a range of approaches institutions can use to support skill development. One common approach is to use stand-alone courses delivered in a traditional format. For example, a first-year computer science intervention study in which researchers implemented a dedicated seminar. Results showed that early exposure to content on presentation, communication, and teamwork led to significantly improved individual and group performance on programming projects compared to students who did not participate in the seminar [2].

Beyond the stand-alone course structure, aligning non-technical competencies with real-world, student-led projects has also been shown to be effective. For example, Tell and Hoveskog [13] found that students engaging in industry-connected, applied projects demonstrated increased motivation, commitment, and ability to work in teams, while also developing key soft skills such as creativity and self-confidence. The authors further argue that traditional lecture-based engineering education may limit opportunities for students to develop these competencies.

Taken together, these findings reveal a clear disconnect between the recognized importance of non-technical competencies and the limited, fragmented approaches used to develop them in practice. This underscores the need for intentional, systematically designed programs that embed these competencies within the student experience, providing a foundation for initiatives such as the Complete Engineer® program, particularly in the first year.

Theoretical Framework

Grounded in Kolb's Experiential Learning theory [14], the Complete Engineer® program embodies the idea that students' experiences in and outside of classes are a central part of their learning and development. The theory provides us with a four-stage cycle where a learner starts their journey by participating in a concrete experience that requires active participation. This is followed by reflective observation where a learner examines the experience and reflects on its meaning. Then, a learner is able to use their reflection to develop an understanding through abstract conceptualization. The cycle ends with active experimentation where a learner can apply newly formed concepts in practice. Our program was developed with this theory as its foundation. Components of the program are aligned with the four-stage cycle [1].

How is the Complete Engineer® Program structured?

In its most recent form, the program takes a holistic approach to developing students. The program relies on blending pre-established technical and non-technical competencies and skills while leaving room for reflection, self-regulation, and students creating their own pathways for growth. College of Engineering students are provided opportunities to focus on and develop six core competencies that were identified in the development stage of the program and include: Inclusive Excellence, Teamwork, Civic Responsibility, Communication, Self-Management & Leadership, and Professionalism & Ethics. These competencies were deemed critical to the success of engineering, construction, and computing professionals, and they were specifically chosen because they are key domains that employers of College of Engineering graduates value.

After identifying the Complete Engineer® competencies, the college worked on establishing a competency growth framework. This framework was the direct result of our desire to create a formal system for assessing and credentialing students' participation in the Complete Engineer® program. Three levels were identified and defined. First, at the *Exposure* level, students learn about the competencies, the way they are defined in the Complete Engineer® program, and why they are relevant for professionals in engineering, computing, and construction. The second level is *Engagement*: at this stage, our students are expected to voluntarily participate in activities and experiences, largely outside of the classroom, that stimulate their growth. Students are challenging themselves, identifying strengths and opportunities for growth, and growing their understanding of the competencies and how they connect to their future profession. The third and final level is *Transformation*, where students have undergone significant changes in their behavior, knowledge, skills, and/or abilities related to the competency as a result of their many experiences as a student. They have demonstrated a commitment to growing in the competency and can describe how they have changed.

While all students meet Exposure through their major coursework, especially through the first-year seminar, submitting to the Engagement and Transformation levels is optional. Engagement and Transformation levels require students to self-initiate participation in activities that would promote their growth and then submit written reflections and supporting artifacts that detail their experiences and how they have grown in the competency. The reflections and artifacts are reviewed by a group of Complete Engineer® Fellows that determines if each student has demonstrated the growth expected for that level. If the Fellows decide that a student has not yet met expectations for the growth level, they provide the student with feedback on how to expand or revise their reflection, and the student is able to submit revisions.

The Exposure level is the stage of development that we are focused on for this paper and the one that has the largest impact on our first-year student population. Exposure to the Complete Engineer® competencies happens in the curriculum and is required by the college. In contrast, the loci of Engagement and Transformation are outside of the curriculum, completely voluntary, and require students to self-initiate their growth journey.

How does the Exposure level integrate into the first-year experience?

All units offering undergraduate programs in the college have agreed to include a standardized Complete Engineer® first-year curriculum within their respective programs of study. For most majors, this is offered as ENGR 10 (Freshman Seminar, offered in the first 10 weeks of each fall semester). In other majors, the standardized Complete Engineer® curriculum is integrated in a discipline-specific introductory course. Instructors are selected from among regular faculty or, in select cases, student-services staff, with an attempt to achieve disciplinary representation mimicking the actual distribution of the first-year cohort in the college. All instructors receive a short training to orient them to the content they will be presenting and to ensure a certain level of uniformity of the curriculum. While uniformity is a goal of ours, instructors are encouraged to bring their own experiences into the classroom. For example, when discussing the importance of the *Communication* competency, a professor of practice with extensive industry experience might refer to examples from their career in industry, whereas a tenured professor might refer to examples from a research lab. Regardless of the context, our instructors are able to provide rich examples, all while using the same lectures, lesson plans, and organizational LMS (Canvas) course structure.

Each of the six Complete Engineer® competencies is allotted one week of instruction (i.e., approximately one hour of lecture) in the standardized first-year curriculum. The classroom discussion uses a common set of presentation slides across all instructors, and covers elements such as definitions of key terms, relevance of the competency to engineering practice, representative examples of application of the competency to realistic scenarios, and opportunities for think-pair-share or other interactive pedagogical methods.

Students are expected to submit several products at various points in the class. These include weekly written reflections (one for each competency) and a summative personal development plan focusing on growth in one of the six competency areas. Instructions for the assignment read:

> "*Throughout this course, you have had the opportunity to learn about the College of Engineering Complete Engineer Program. As a student in the college (Construction,*

Computing, or Engineering majors), you receive exposure to each of the six competencies. This is the first level of the program. There are two more levels that you can meet: Engagement and Transformation. You heard from speakers, discussed (on Canvas and in class) each of them, explored how industry partners are looking for these skills, and engaged in reflection. Let's take what we learned and put together a plan for how you might meet the Engagement level for a specific competency that you select."

The Canvas LMS is organized with a master course shell in which all the standardized content is developed, after which a course-copy operation is performed for all the sections in a given term, allowing instructors to customize their syllabi and add other enhancements without disrupting the shared and standardized nature of the Complete Engineer® content. The Canvas shell is organized with weekly modules, including one for each competency, as seen in Figure 1. This helps students focus on one competency at a time while they gain initial exposure.

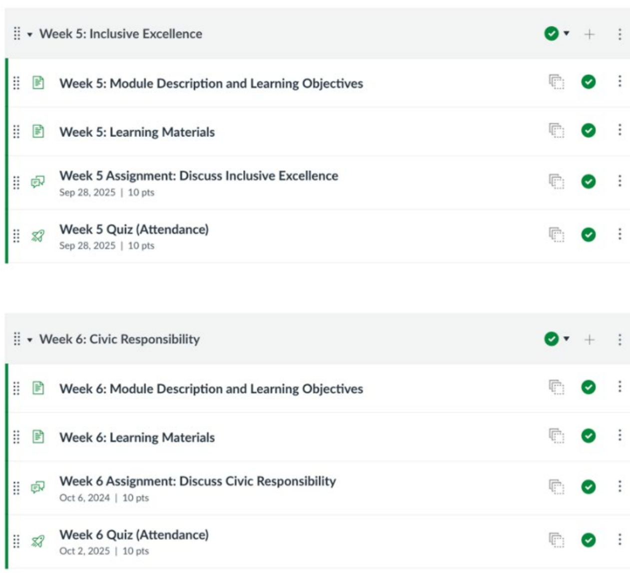

Figure 1. Sample of the Canvas course shell showing the weekly module structure used by all instructors. The sample shows weeks 5 and 6 of the course.

First, the competencies are presented to the students starting with an overview and broad definition: "*What is Civic Responsibility*?" Next, the competency is defined in engineering, construction and computing fields: "*What does Civic Responsibility mean for engineering, construction and computing fields?"* Finally, the competency is discussed as it relates to the Complete Engineer® program: "*How can you engage with Civic Responsibility as a College of Engineering student?*" This transition from broad to narrow, as seen in Figure 2, allows students to reflect on the competency while also beginning to develop an understanding of the role each of the competencies plays in their respective fields.

Figure 2. Sample slides of the Civic Responsibility competency showing the transition from broad definition to the field to within the content of a college environment as presented in the first-year seminar.

Further integration into the college

Since the official launch of the program in the Fall of 2022, the Complete Engineer® program has begun to permeate the college community in multiple ways. For example, there are two highly selective, cohort-based scholarship programs that require their students to go beyond Exposure in the program. One of the scholarship programs requires students to meet the Engagement level for two of the competencies, and the other requires that students meet the Engagement level for all six competencies. The latter program added this requirement at the time the Complete Engineer® program was officially launched, so for the first few years, the majority of Engagement submissions came from this group. Another sign of the Complete Engineer® program's integration throughout the college community has been in the communication between our college and the institutions in the region from which the majority of our transfer students come, especially community colleges. Our partners at these institutions are aware of the Complete Engineer® program, have taken steps to align language in their pre-engineering courses with the program, and in some cases have piloted integrating Complete Engineer® content from ENGR 10 in their courses. Through these efforts to expand the reach of the program, we have learned the importance of being flexible enough to successfully integrate with other contexts while maintaining the core philosophy and integrity of the program.

As a college, we are currently engaged in an education and awareness campaign in the college with the goal of increasing the number of submissions at the Engagement and Transformation stages. Early steps included clear messaging in the college that becoming a Complete Engineer® is embedded within our culture. For example, the walls in our primary teaching building have pictures of our own students with a Complete Engineer® competency as shown in Figure 3. This is one way we remind our students of how integral these competencies are to their development in the college.

Figure 3. Three images of walls in Kiewit Hall that show College of Engineering students and the names of Complete Engineer® competencies.

We have also utilized digital signage in the college to remind our students of the importance of the program as well as to convey any major updates related to the program. As seen in Figure 4, we believe in the importance of consistent, visible messaging that reinforces the Complete Engineer® competencies and integrates them into students' daily academic experiences, helping to normalize and sustain their development across contexts.

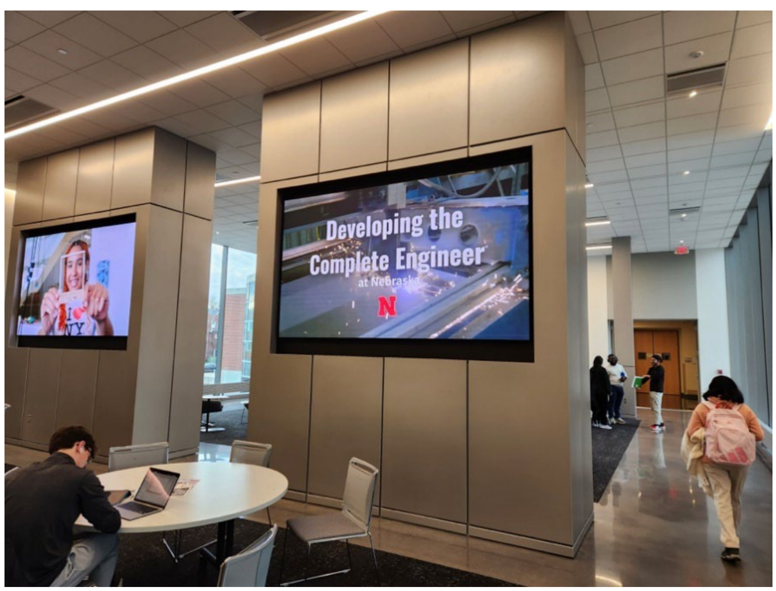

Figure 4. Picture of digital signage in the college with Complete Engineer® information.

Significance of the study and research question

Integrating the Complete Engineer® competencies into the first-year curriculum allows us to inform our students early, in their first semester, that we value both technical and non-technical skills. As an example, in the Fall of 2025 we had 29 sections taught by 26 instructors. The instructional decisions made in this course impact over 900 students every fall. As such, the significance of this study is presenting our model for integrating non-technical competencies into the first-year curriculum, evaluating our processes and analyzing data to learn where we can improve, and generating evidence to inform iterative refinement so the course more effectively supports student learning, engagement, and long-term development as Complete Engineers across sections and instructors.

Our assumption is that intentionally structuring the course where each Complete Engineer® competency is presented as its own topic provides students with sustained and focused exposure to the Complete Engineer® program and its defined competencies. This design directly supports the stated course goal of introducing students to the full scope of the Complete Engineer® framework, while also allowing students to engage with each competency individually rather than encountering them as an abstract or aggregated set of ideas. Embedding the competencies throughout the first-year seminar further emphasizes their importance as integral components of what it means to be a Complete Engineer®, positioning these competencies not as ancillary skills, but as essential dimensions of forming their engineering identities.

The purpose of this study is to examine students' structured exposure to the Complete Engineer® program in their first-year seminar. Our central phenomenon of interest is the degree to which students' understanding of the competencies aligned with the program's definitions. To that end, our research questions are:

1. In what ways do first-year engineering students' reflections on the competencies demonstrate alignment between their understanding of the Complete Engineer® competencies and the program's intended definitions following participation in a first-year seminar structured around individual competencies?
2. What themes emerge in students' reflections that indicate alignment or misalignment with the program's definitions of the Complete Engineer® competencies?

The secondary goal of this study is to examine the degree to which first-year students' affinity for particular competencies aligns with participation thus far at the Engagement and Transformation levels. We assume that first-year students' familiarity and prior experiences with the competencies is varied (e.g., more prior experience with Teamwork, less with Professionalism & Ethics) and as a result, students' strengths and interest in the competencies might change as they progress in their academic programs.

Methodology

The study employed a qualitative case study approach using students' reflections as our primary data source [15]-[16]. Following the recommendations of Creswell [15], a case study research approach is appropriate due to the defined instructional context that serves a single bounded system. The system is defined by a specific course (first-year seminar), in a defined period of time (students in their first year of college), and a specific population (first-year engineering students). In addition, our approach to data gathering and analysis resulted in claims that are analytic and interpretive and not reported as generalizable, which is aligned with the qualitative case study research approach. The case study methodology supports our approach of analyzing students' reflections as contextualized artifacts meant to provide interpretations of first-year engineering students' understanding of the Complete Engineer® competencies and the program's intended definitions.

Written documents, including student reflections, are widely accepted by qualitative methodologists as suitable forms of qualitative data when the purpose of the data is to deduce meaning and interpretations in educational contexts. Examples of reflections as a data source are broadly reported in the literature [17]-[19]. Reflections were coded individually by two researchers through the process of inductive coding and thematic analysis [8]. Inductive coding relies on pulling meaning from qualitative written sources without any predefined coding frames or preconceptions. Then, thematic analysis was applied to identify and analyze patterns from the codes. In our study, we aimed to draw and report on meaningful insights towards the predefined phenomenon. Each researcher identified themes based on their codes [20]. The researchers discussed the emergent codes and themes, and the final themes are presented in this study.

Data sources and Sample population

The data in this study were drawn from two primary resources. First, we used student reflections in the ENGR 10: Freshmen Engineer seminar course. Students reflect on a Complete Engineer® competency after attending a lecture on the topic. The literature on qualitative methods recommends selecting a sample of participants that have direct experience with the central phenomenon, align with the nature of the inquiry, and that are bounded by the context and setting. For this study, any student who completed the reflection assignments and actively engaged in the course would be suitable. Twenty students were randomly selected from each academic year between the Fall of 2022 and Fall of 2025 for a total of 80 students. The second data source is general quantitative data drawn from the program and related to the stated research questions. The descriptive quantitative data are used for providing context. We also extracted data from a survey of ENGR 10: Freshmen Seminar students that includes data on students' interest in the competencies.

Results

Since the official launch of the Complete Engineer® program in the Fall of 2022 and in alignment with the college's strategic plan, the College of Engineering formalized the process for all students to have a minimum level of Exposure to each of the six Complete Engineer®

competencies. To date, over 4,200 first-year students have met Exposure for all six competencies.

To further examine our first-year students' interest in the competencies, we surveyed students (n = 673) toward the end of the Fall 2024 offering of ENGR 10: Freshmen Engineering Seminar. In the survey, students were asked to report for which competencies they had the most and least interest in reaching the Engagement level. Figure 5 shows results for all six competencies. The results of the survey indicated that Self-Management & Leadership was the competency of greatest interest, followed by Teamwork and Communication. Approximately 43% of students cast their most-interested vote for Self-Management & Leadership. In contrast, the competencies receiving the highest number of least-interested votes were Inclusive Excellence, Civic Responsibility, and Communication. The survey results also showed that for these students, Inclusive Excellence was the competency they were least interested in.

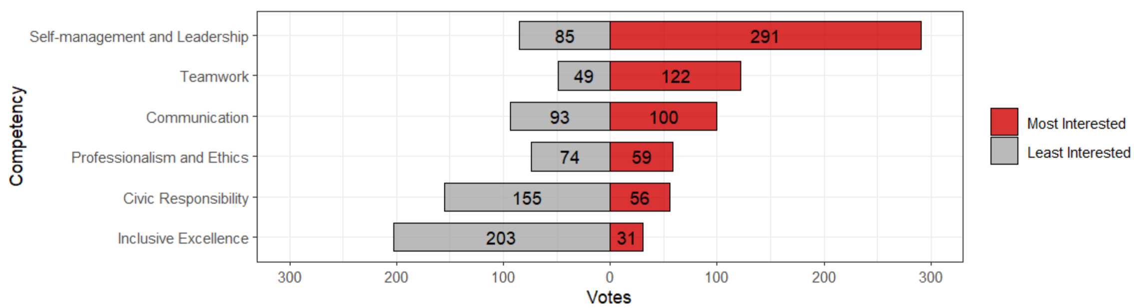

Figure 5. Count of first-year student responses for competencies of most and least interest.

For this study, we analyzed reflections from the first-year seminar course on the Self-Management & Leadership, Communication, and Teamwork competencies given that first-year students identified those competencies as being of greatest interest. Performance indicators for the Exposure level of these three competencies are given in Table 1. The study employed thematic analysis following the inductive coding process. Each competency was individually analyzed to examine if the themes that emerged from first-year student reflections on the competencies demonstrate alignment with the program's performance indicators for these competencies.

Table 1. Performance Indicators for Three Complete Engineer® Competencies.

Competency	Exposure Level Performance Indicators
Self-Management & Leadership	(1) define self-management & leadership (2) demonstrate awareness of the roles self-management and leadership play for students and for professionals in their discipline
Teamwork	(1) define teamwork (2) demonstrate awareness of what constitutes effective teamwork
Communication	(1) define communication (2) name the different types of communication (3) demonstrate awareness of what constitutes effective and respectful communication

For Communication, the strongest theme that emerged was "Listening as an Intentional Communication Practice." Students identified listening proactively as a key part of effective communication. The students also described being thoughtful and purposeful about participating when communicating with others. The student responses displayed an awareness of how their participation could be perceived by others, and that awareness allowed them to regulate when they participate in conversations and how they communicate. During the Communication week of the first-year seminar, students learn how to define communication and discuss different types of communication (written, verbal, non-verbal, etc.). However, it seems that the content that most resonated with them was related to demonstrating awareness of what constitutes effective and respectful communication.

For Teamwork, the strongest theme that emerged was "Shared Responsibility and Valuing Community in Teams." Students described effective teamwork as grounded in shared responsibility. This was described as meeting deadlines and being a reliable team member for a team to succeed. The concept of trusting one another and holding others accountable was prevalent. Students framed effective teamwork as requiring intentional communication, valuing being part of the community, and sharing accomplishments. During the lecture week on Teamwork, students learn about team forming, norms of a team, handling conflict, and effective teams. They also learn about the importance of teams in their future professions. As is shown in Table 1, our primary goals for that week are for the students to be able to define teamwork and demonstrate an awareness of what constitutes effective teamwork. The reflections and emergent themes lean heavily on the latter. Students did not focus their reflections on defining teamwork; rather, the focus was on how to function as part of a team in order for that team to be effective.

In terms of Self-Management & Leadership, the theme that emerged was "Adapting to New Environments and Planning for Academic Success". Because these reflections were part of the first-year seminar course, the reflection prompt for this week focused on self-management and did not integrate the leadership part of the competency. As such, the theme that emerged from the reflections pertained only to self-management. Students reflected on the need for intentional planning and regulating learning behaviors by minimizing distractions, using planners for time management, and maintaining a regular study schedule. In addition, students repeated the sentiment of seeking help from others, forming study groups, and recognizing the need for increased personal responsibility for learning. During the lectures on this competency, students learn about time management, study strategies, definition of leadership, and its importance in engineering, computing, and construction professions. Students learn about and discuss how to grow their understanding of leadership and how to engage in effective self-management starting from the first-year seminar and throughout their professional careers. Given the theme that emerged, there is partial alignment with our intended program goals at the Exposure level (see Table 1).

In addition to students reflecting on each competency, students were asked to reflect on which competency was their strongest at that point in time and their reasoning for choosing that competency. The count of competencies they selected as their strongest were Teamwork (n = 25), Communication (n = 20), Self-management & Leadership (n = 14), Inclusive Excellence (n = 9), Professionalism & Ethics (n = 5) and Civic Responsibility (n = 1). Students cited high-school experiences as the primary place where they developed these skills, including being members of sports teams, clubs, and school projects. This qualitative sample parallels the finding from the survey data where first-year students ranked Teamwork, Communication, and Self-management & Leadership as the three competencies they were most interested in pursuing as part of the program.

These first-year students' perceived strengths and interest in competencies partially align with the Engagement and Transformation submissions of more senior students. As of the Spring of 2026, the competencies with the most Engagement-level submissions (excluding submissions from students from the scholarship program that requires submitting to all six competencies) are Self-Management & Leadership (28% of Engagement submissions), Communication (25% of Engagement submissions), and Teamwork (16% of Engagement submissions). At the Transformation level, the competencies with the most submitted reflections are Inclusive Excellence and Teamwork (21% each of Transformation submissions). As shown in Figure 5, Inclusive Excellence was rated last in terms of students' interest.

Discussion

The primary purpose of this study was to examine the extent to which first-year students' understanding of program competencies aligned with intended definitions following Exposure in a first-year seminar. A secondary goal was to examine alignment between first-year students' interest in the competencies and later participation in the higher levels of the program. This section highlights insights gleaned from the data and discusses them in the context of relevant literature.

Reflections from the first-year seminar course indicate that students are generally meeting the "demonstrates awareness" portions of the competency performance indicators. The reflection prompts used in the course did prompt students to provide a definition of the competencies, and as such, these data do not offer insight into whether students have met that performance indicator. Similarly, the reflection prompt for Self-Management & Leadership was primarily concerned with Self-Management, and as a result students did not reflect on the Leadership aspects of the competency. This partial misalignment is largely due to the fact that the Complete Engineer® program has been integrated into an existing first-year seminar course that is taught by a large number of faculty. Over the course of multiple years, the course coordinator has been making incremental changes to better integrate the program into the curriculum. The results of this study have been shared with the course coordinator along with recommendations to ensure all competency performance indicators are addressed in the course assessments.

Consistent with the requirements of the 0-credit hour, first-year course, students' reflections were relatively brief and did not go beyond addressing the awareness level laid out in the performance indicators. In the Complete Engineer® program, the first-year seminar functions to establish students' "baseline" for the competencies, with additional growth and deeper reflection being captured at the Engagement and Transformation levels. The core of this program is individual growth, so having a recorded starting point for each student provides a reference point students can look back on. There is no requirement for students to use their first-year seminar reflections when they complete reflections at the Engagement or Transformation level, but we do encourage students to review earlier reflections as they are reflecting on and writing about their growth. If a program were to take a different approach, such as activity tracking or criterion referenced scoring, it would be less critical to have a baseline at the start of students' academic program.

Results from this study indicate that students gravitate toward competencies they already feel confident in. Competencies with the highest levels of interest included Self-Management & Leadership, Teamwork, and Communication. Students specifically cited high school experience as the primary place where they developed these skills, indicating an existing level of familiarity with these competencies. This aligns with prior research suggesting that individuals are more likely to engage with tasks where they perceive themselves to be competent, as described in self-efficacy and expectancy-value frameworks [21]-[22]. This indicates that students' prior experiences strongly shape how students interpret professional competencies. Moreover, these competencies are "skill-oriented." Competencies with lower levels of interest, such as Inclusive Excellence, Civic Responsibility, and Professionalism & Ethics, are more "value-oriented" competencies. New students may have had less exposure to these value-oriented competencies and may not yet fully understand their relationship to engineering, a pattern that reflects existing findings about the marginalization of social and ethical dimensions within engineering culture literature [23]. This suggests a need to more strongly emphasize the connections to engineering and the overall importance of value-oriented competencies in the first-year seminar.

One contradiction in the data relates to Inclusive Excellence – though students rank it as the competency they are least interested in, Inclusive Excellence sees the most submissions at the highest level of the Complete Engineer® program, Transformation. Though the reason for this contradiction is not clear, several possible explanations exist. First, there may be a selection effect, where students who pursue Transformation may already be predisposed toward Inclusive Excellence, consistent with prior identity research [24]. Alternatively, it may be related to program structure, with Inclusive Excellence having clearer pathways to completion or more accessible opportunities at high levels. Students could also take a longer time to see the importance of Inclusive Excellence as compared to other competencies; perhaps Inclusive Excellence is not seen as important at first, but those who engage more deeply begin to appreciate its importance. Finally, it is possible that students participating at higher levels may be more intrinsically motivated or values driven, as suggested in theories of motivation that distinguish between extrinsic and intrinsic drivers of engagement [25]. Broadly, though the reason behind the contradiction in the data is not clear, the findings suggest that interest alone may not fully explain student engagement in the competencies, particularly at higher levels of participation.

Overall, the results of this study indicate that students' prior experiences in high school play a role in the competencies they find most interesting in first-year engineering. Regardless, interest levels do not equate to completion patterns; misalignments between interest and engagement highlight the need for additional research into the underlying reasons for student participation and progression across competencies. This finding is consistent with prior work suggesting that student engagement is shaped by a complex interaction of prior experiences, motivation, identity, and structural factors within educational environments [26]-[27].

Future Directions

While our data analysis shows that we are on the right track, several important questions remain. For example, it would be beneficial to further investigate students' reasoning for the topmost useful competencies. Perhaps students feel these competencies are most valued by future employers, or they felt most connected with them during the first-year seminar. We also need to engage in a continuous improvement cycle on the reflection prompts presented to the students, so that we can receive a holistic response that could serve as a performance indicator.

It is our belief that the journey of developing into a Complete Engineer® does not end at the Transformation level. We believe that growing in the competencies is a continual process of learning, discovery and further development. As we improve on our program, we instill in our students that even the most senior professionals can grow skills and continue to learn – a lesson that we begin discussing in their first-year orientation course and that we hope they will carry with them as professionals long after their graduation.

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