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Data Analysis: Evaluating the Impact of the Professional Formation of Engineers Program on Career Development

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Data Analysis: Evaluating the Impact of the Professional Formation of Engineers Program on NACE Career Competency through Ambition Levels and Completion Rates

ABSTRACT

The Professional Formation of Engineers (PFE) program at the University of South Florida (USF) comprises a series of three one-credit courses designed to develop essential competencies in engineering students. This course series emphasizes the application of ethical principles and the impact of ethical engineering practices on both local and global communities, thereby preparing students for successful professional careers. The primary objective of the PFE program is to facilitate the optimal career development of USF Electrical Engineering (EE) students through engaging practical and professional experiences.

Inspired by a comparable business program, the PFE series was developed to address the professional formation of students, initially grounded in the National Association of Colleges and Employers (NACE)'s Career Readiness Competencies. The program was introduced as technical electives with small class sizes and led by a professor of practice. Within the PFE courses, students formulate action plans to enhance their professional networks and achieve specific career objectives.

This paper presents a data-driven analysis of the Professional Formation of Engineers (PFE) program. Using data collected over time, students' action plans with a focus on ambition levels, completion rates, and their correlation with career-related outcomes such as industry internships, leadership in class projects, and enrollment in external technical courses are analyzed. The findings reveal that students who set realistic goals with moderate ambition levels tend to achieve higher completion rates, while those with overly ambitious plans often struggle to meet their objectives. Specific trends are identified in the competencies of the NACE, with Teamwork and Professionalism consistently exhibiting high completion rates, while areas like Global Diversity & Awareness and Critical Thinking present opportunities for targeted improvement. The study validation is supported by faculty observations and students' results such as attainment of internships and undergraduate research positions.

Additionally, the PFE program identifies students who may be lagging in their action plans, enabling the Electrical Engineering Department to provide targeted interventions and resources. These measures aim to foster higher levels of ambition and task completion, ultimately supporting students in their professional development.

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INTRODUCTION

The preparation of engineering students for professional careers requires a robust framework that integrates academic performance with experiential learning. The evolution of engineering programs in the U.S., including Electrical Engineering (EE),has historically reflected a shift from hands-on, industry-focused training toward serving the needs of government and military research initiatives [6][4][3]. While this transition addressed critical national priorities, it also introduced a gap between academic preparation and the practical expectations of industry. In response, there is presently a renewed emphasis on developing industry-ready engineers by integrating experiential learning and professional competency development into the curriculum. The Professional Formation of Engineers (PFE) program at the University of South Florida (USF) aligns with this contemporary shift by equipping students with real-world skills, ethical foundations, and structured career development practices rooted in experiential learning. Model-Based Systems Engineering (MBSE) approaches further support this vision by enabling adaptive, scalable frameworks that simulate educational systems and facilitate personalized, competency-based learning experiences[9][12].These methods resonate with the PFE program's objectives of leveraging technology-driven innovations to enhance career readiness and competency development.

The Professional Formation of Engineers (PFE) program at the University of South Florida (USF) exemplifies this philosophy, providing students with a structured pathway to develop critical competencies essential for engineering careers. Originally developed as part of an NSF/RED award [5], the PFE program has evolved over several years, addressing gaps in engineering education by introducing an individualized PFE Qualification Plan (QP). The QP serves as a career development roadmap, emphasizing self-regulated learning, ethical practices, and targeted action plans supported by reflective assessments. Moreover, experiential learning activities within the PFE program foster a service orientation among students, significantly enhancing their social agency, academic self-confidence, and critical thinking skills, all vital for engineering success [8][1].

Initially, the QP framework relied on Excel sheets and Google Forms to collect data on students' qualification development plans. Over six years of data were refined to simplify implementation and analysis of the QP. This led to the development of the QP App, a semi-automated platform enabling students to select action items, assign competencies, set ambition levels, and track completion percentages for each activity. The creation of the QP App aligns with emerging trends in engineering education such as engineering education data generation, data mining, and ML implementations, which enhance the adaptability and accuracy of data-driven educational interventions [11][10]. This paper evaluates two semesters of data collected after the app's deployment to assess its impact on competency development and career readiness. In addition, this paper evaluates the longitudinal impact of the PFE Qualification Plan (QP) as a core component of the PFE program. The QP guided students through personalized goal-setting and competency development across three sequential courses: PFE 1 (Professionalism and Ethics), PFE 2 (Engineering Practice & Research), and PFE 3 (Innovation and Design Thinking). In Spring 2024, a significant milestone was achieved with the introduction of the QP App, a student-driven platform that modernized data collection and analysis. By focusing on two semesters of data collected through the app, this paper assesses the efficacy of the QP in fostering professional competencies and career readiness.

All PFE students are required to identify and track goals using the PFE Qualification Plan (QP), which serves as their undergraduate career roadmap. The QP framework emphasizes a person-

alized approach, requiring students to identify a minimum of four NACE competencies, set specific goals, and design action plans to achieve those goals. The QP data set provides a detailed view of student progress including (1) Student name, (2) Activity performed, (3) NACE Competency related to the activity, (4) Self-assigned ambition level of the activity , (5) Goal for the activity,(6) Criteria to determine success for the activity,(7) Action plan for achieving the goal, (8) Completion rate for each activity. Here the term " completion " refers specifically to the percentage of progress achieved for individual QP activities within the Qualification Plan and not refer to course or degree completion.

Building on this, the research questions/objectives of this study are as follows:

1. Correlation Analysis: Is there a correlation between higher ambition levels and completion rates? Do students with higher ambition levels tend to have higher or lower completion rates?
2. Competency Success Rates: Which National Association of Colleges and Employers (NACE) competency areas show the highest levels of success (measured by completion rates) relative to ambition levels? Which are those competencies, What might this suggest about the program's strengths in competency development?
3. Completion Rate Distribution: What is the distribution of completion rates for different ambition levels? How does the graph of "completion rates" and "ambition levels" look? Is there a pattern?

By addressing these questions, the study aims to offer actionable insights into the role of structured competency development in engineering education and explore the broader implications of potentially adopting the QP framework in other academic institutions.

RELATED WORK

Action-oriented behaviors are closely tied to student success. Research shows that action-oriented college students tend to have higher grade point averages, spend more time on coursework, and make more effort toward achieving their goals [7]. Additionally, these students are more likely to engage in extracurricular activities, contributing to their holistic development [1]. The complexity of the PFE QP aligns with framework on task complexity, which emphasizes the number of paths, activities, and interdependence between tasks. The program recognizes the extrinsic complexity of relationships between various attributes and the skills required to navigate them effectively.

PFE Course & PFE Qualification Plan (QP) Implementation

The Professional Formation of Engineers (PFE) course series is structured around a three-semester sequence designed to support students' professional and career development alongside their academic growth. A central component of this sequence is the Qualification Plan (QP) framework, a structured, student-driven tool that guides participants in setting, tracking, and reflecting on their career-related goals and activities. Students are required to identify competencies aligned with the National Association of Colleges and Employers (NACE) standards, select activities across multiple domains e.g., Career & Self-Development, Teamwork, Professionalism, and document their intended outcomes, ambition levels, and success criteria. Faculty and advisors provide general guidance during this process but allow students autonomy in designing their development paths. The QP serves not only as an action-planning platform

but also as a reflective mechanism to help students monitor their professional growth, assess their ambition against peer benchmarks, and identify actionable strategies for improving their marketability upon graduation.

In-class sessions are structured as peer-led discussions and reviews, facilitated by the instructor. Students are provided with examples of work from previous cohorts, enabling them to build on earlier ideas and approaches. This active learning environment helps students develop critical professional competencies, including collaboration and independent problem-solving.

The structure of the PFE Course Series is organized into three progressive themes. The first theme, "Professionalism and Ethics", introduces students to industry perspectives through guest lectures and guides them in creating personalized career roadmaps. It also encourages early identification of Capstone project ideas and engages students in ethical considerations through a mock ethics hearing. The second theme, "Engineering Practice & Research", exposes students to practical lab experiences and research fundamentals, while also focusing on developing essential engineering skills through external learning opportunities. This theme culminates in students creating academic research posters and organizing a technical conference, providing hands-on experience in scientific community. The final theme, "Innovation and Design Thinking", certifies students' acquired skills and competencies, and challenges them to expand their technological proposals into comprehensive business models or product plans. This theme also introduces students to real-world innovation processes through participation in the USF Technology Transfer Office and I-CORPS-assisted Design Challenge, preparing them for the practical applications of their engineering knowledge in the professional world.

Each course session is capped at 25 - 30 students to promote small-group interactions during lectures, workshops, and lab tours. Students are seated in a U-shaped arrangement to facilitate discussion and interaction. Every student is required to ask a question or share their opinion during guest lectures, workshops, or lab sessions, ensuring active participation.

Students work in teams to tackle engineering challenges with a focus on creating solutions that address societal, environmental, or global issues. Teams identify existing technologies with significant impacts, conduct patent searches, and analyze technical, societal, and political challenges, as well as unintended consequences. Some teams develop their own engineering solutions, engage with community members to refine their ideas, and prototype these solutions during Senior Design/Capstone courses. Other teams collaborate on ongoing projects or multidisciplinary initiatives defined by the Electrical Engineering Department industry partners.

This collaborative process allows students to identify Senior Design/Capstone project ideas, engage with stakeholders, and refine their concepts. The hands-on approach bridges the gap between theoretical knowledge and practical application, fostering skills essential for professional engineering practice.

A defining feature of the PFE program is the direct involvement of faculty members, who serve as primary instructors for live class sessions. While online lectures and graduate assistants can provide valuable support, the program's emphasis on face-to-face engagement ensures that faculty, administrators, and industry partners actively mentor students, encouraging their professional growth and helping them achieve their goals.

The implementation of the PFE course series included students' career planning by encouraging active participation in various professional settings and experiential learning opportunities.

It focuses on increasing student engagement, retention, and diversity while boosting their potential for professional success. The series also aimed to inspire a deeper understanding of the professional and social impacts of engineering, introduce ethical considerations, and provide methods for risk evaluation and conflict resolution. Additionally, the PFE courses promoted design-oriented projects and fundamental engineering skills through hands-on training, ensuring students are well-equipped for the challenges of the engineering profession.

Purpose of the Qualification Plan: A Career-Focused Self-Reflection Tool

The primary goal of the PFE Qualification Plan (QP) is to empower students with a structured, self-reflective tool that enables them to evaluate and manage their career readiness. By tracking the ambition level and completion status of their chosen activities, students gain insight into how their professional engagement compares with peer expectations and industry standards. The QP does not prescribe or direct student actions; rather, it enables students to assess their own ambition, recognize gaps, and adjust their development path accordingly.

The underlying principle is that students who consistently complete higher ambition-level activities, such as publishing research, participating in internships, or leading professional organizations which are generally more marketable to employers than those who remain engaged only at lower ambition levels e.g., attending events or completing basic coursework tasks. A senior student still completing Level 1 activities, for instance, can visually recognize the need to stretch further and independently set more challenging goals in future semesters.

This approach mirrors the functionality of commonly used focus and productivity apps, which allow users to self-monitor, reflect, and iterate on personal behavior without external enforcement. Just as a focus-tracking app encourages users to stay on task through periodic reflection e.g., 20 minutes of focused work followed by a 5-minute break and self-assessment, the QP encourages students to periodically examine their professional development goals and adjust their actions based on where they perceive themselves in their journey.

The QP is not designed to impose outcomes or bias students' direction; instead, it is a reflective framework that supports career exploration and growth through authentic self-awareness. Students are encouraged to ask themselves: "Am I falling behind professionally?" or "What more can I do to improve my career trajectory?" The QP then helps them identify which specific high-impact actions they can pursue next to enhance their employability and confidence upon graduation.

Professional Formation of Engineers (PFE) Development Plan

The Professional Formation of Engineers (PFE) Development Plan serves as a structured roadmap for students to define, track, and achieve their professional and personal goals. Each student begins by selecting a NACE Competency such as Leadership, Career Management, Personal Portfolio, or Experimental Activity, aligning their choice with their ambitions and long-term career objectives [2].The ambition level for an activity has been set according to what we extracted from the previous six years of QP data; which activity to pursue is completely up to the students, and they may select these activities based on its level. Once a competency is chosen, students define a specific and measurable goal that reflects their desired outcome. For example, under Leadership, a student might set a goal to "Show leadership abilities through a leadership position". To ensure clarity, students then identify success criteria, i.e., measurable benchmarks that define successful goal completion. In this case, success might be described

as “Achieve a leadership position at another organization”. Following this, students create a detailed action plan, outlining the specific steps required to achieve their goal, such as “Apply myself and search for opportunities that can fulfill this task”. Progress is tracked using a completion percentage indicator, which allows students to self-report their advancements, such as marking a task 60% complete. Faculty and advisors play a key role in reviewing these plans, offering guidance, and ensuring alignment between the goal, success criteria, and the chosen competency. For instance, in an Activity Selection Example under Leadership (Level 2), a student’s goal might involve demonstrating leadership abilities in an external organization. The success criteria could include obtaining a leadership role, while the action plan might involve identifying leadership opportunities, applying for relevant positions, collaborating with peers, and reflecting on outcomes. Progress tracking ensures measurable growth, and students receive structured feedback from their advisors to refine their strategies. The selected activity also aligns with multiple NACE competencies, including Leadership, Communication, and Professionalism. Overall, the PFE Development Plan ensures students have a clear, goal-driven approach to professional growth, supported by measurable criteria, actionable steps, and continuous faculty engagement. This process not only fosters accountability but also empowers students to proactively manage their development journey.

DATA COLLECTION & VISUALIZATION

Building on the Qualification Plan’s role as a structured self-reflection and career development tool, this section details the data collected from student submissions, including selected activities, ambition levels, and completion outcomes, which form the basis for the analyses presented in this section.

The dataset used in this paper comprises two semesters of data, encompassing a total of 344 students enrolled in the PFE1, PFE2, and PFE3 courses. Each semester, two sections of both PFE1 and PFE2 courses are offered. PFE3 is currently only offered as one section per semester, with plans to split it into two sections in the future. Table 1 provides an overview of the variables in the dataset, along with their descriptions.

Table 1: Description of variables in the student dataset

Variable Name	**Description**
Name	Name of the student.
Activity	Description of the activity assigned by the student.
NACECompetency	The competency or skill category associated with the activity (e.g., Professionalism, Leadership).
Level	Ambition level assigned by the student for the activity, ranging from 1 (easy) to 5 (difficult).
Goal	The student’s stated objective or target related to the activity.
SuccessCriteria	Criteria defined by the student to measure successful completion of the activity.
ActionPlan	The detailed steps or plan to achieve the stated goal.
Complete	The percentage of completion for the activity as assigned by the student.
MyPath	The student’s overall learning path or career-related reflections.
Advisor	Name of the academic or professional advisor for the student.
PFEId	Professional Field Experience Identifier, categorizing students into groups.
GraduationDate	The expected graduation date of the student.
Major	The student’s major or field of study.

The Level variable mentioned in Table 1 refers to the ambition level associated with each student-selected activity, ranging from 1 (easy) to 5 (difficult). Importantly, the PFE instructional team assigned the ambition levels based on the description of the activity of the student. Students were formally instructed during in-class sessions about the ambition scale and how to interpret it. Clear examples were provided, distinguishing between activities considered lower ambition e.g., attending a club meeting or asking a question during class and higher ambition e.g., securing an internship, publishing research, leading an engineering organization. This training ensured that students across all PFE courses had a consistent understanding of ambition expectations.

Within the Qualification Plan App, students had full visibility into the ambition levels assigned to each available activity. As they selected goals for their qualification plans, students could view these ambition levels, allowing them to plan their career development activities intentionally, benchmark their progress relative to peers, and engage in structured self-reflection about their professional growth trajectory.

The Advisor variable mentioned in Table 1 refers to the individual selected by each student to serve in an advisory or mentorship capacity regarding their career development. Students are instructed to identify someone with whom they feel comfortable discussing career-related issues; while this individual is often a faculty member e.g., Dr. Yal, Dr. Moreno, Dr. Faraket, or Dr. Jung, students may also choose a graduate student, friend, or even a family member. Importantly, the selection of an advisor is entirely self-directed and does not influence the content or quantitative evaluation of their Qualification Plans (QP). The advisor's role is supportive and intended solely to provide career guidance rather than to impact the grading or assessment of the student's self-reported progress. This approach ensures that the data on competency development and action plan completion remains an independent measure of each student's performance.

In Spring 2024 (Semester 1), PFE 1, PFE 2, and PFE 3 were offered, with 147 students participating. Of these, 142 students participated in a single course, i.e., either PFE 1, PFE 2, or PFE 3. Four students participated in two courses, i.e., either PFE 1 and PFE 2, PFE 2 and PFE 3, or PFE 1 and PFE 3, and one student participated in all three courses (PFE 1, PFE 2, and PFE 3). In Fall 2024 (Semester 2), the same courses were offered, with 197 students participating. Among them, 162 students took one course, and 35 enrolled in two PFE courses, with one student participated in all three courses (PFE 1, PFE 2, and PFE 3). Figure 1 shows the student distribution across the three PFE courses for both semesters during the Spring 2024 and Fall 2024 semesters. Each bar chart represents the number of students participating in each course, excluding students who participated in more than one PFE course per semester.

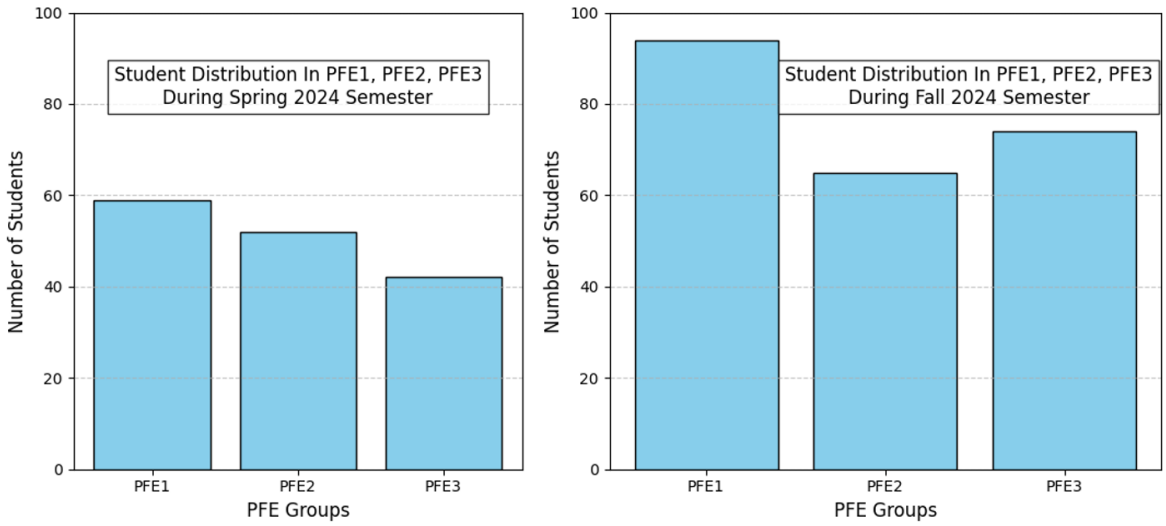

Figure 1: Students distribution across PFE1, PFE2, and PFE3 courses for Spring 2024 and Fall 2024 semesters

DATA ANALYSIS

Quantitative analysis was performed to evaluate trends in ambition levels and completion rates over time. Statistical methods, including correlation analysis and regression modeling, were used to explore relationships between variables. Competency success rates were calculated by aggregating completion rates across NACE areas, and distribution analyses were conducted to identify patterns and anomalies.

The ambition levels were standardized based on collective peer-group expectations, grading was conducted individually, focusing on each student's personal growth and effort over the semester.

For instance, a student who initially found it challenging to participate in classroom discussions might select lower-level activities e.g., Level 1 or Level 2 tasks such as speaking up during a lab session and still receive a high grade if these activities represented significant personal development. Conversely, another student who served as president of a major engineering organization e.g., IEEE and engaged in Level 4 or Level 5 activities would also receive a high grade, reflecting their continued advancement along a more ambitious professional trajectory.

Research Question 1: Correlation between Ambition Levels and Completion Rates

To address the first research question, the basic statistics for each student, including average ambition level, average completion rate, and total number of activities were calculated. Table 2 provides data for the first 10 students from Spring 2024 and Fall 2024 semester as an example. Students were then grouped based on their ambition levels and corresponding completion rates, with the Standard Deviation (SD) and variance of completion rates included to account for variability, see Table 3.

Table 2: First 10 students' data from Spring & Fall 2024 semesters

StudentNum	avg_ambition	avg_completion	max_ambition	min_ambition	total_act
Spring 2024					
000000	2.75	0.33125	5	2	8
000001	2.16666	0.933333	4	1	9
000010	2.5	0.6	4	1	9
000011	3.555555	0.47	4	1	9
000100	2.75	0.5625	5	1	8
000101	2	0.25	3	1	4
000110	3	0.5375	4	3	4
000111	2.375	0.7875	4	1	8
001000	2.6	0.17	4	1	5
001001	3.5	0.6625	4	3	4
Fall 2024					
000000	2.85714	0.8857146	4	1	7
000001	2	0.74375	3	1	8
000010	1.4	0.92199	2	1	5
000011	1	0.95	2	1	4
000100	1.2	0.9800	2	1	5
000101	1.5	1	2	1	5
000110	2.5	1	4	1	4
000111	1.75	0.6925	3	1	4
001000	1.5	0.975	2	1	4
001001	2	0.585	4	1	4

Table 3: Students grouped based on their ambition levels and corresponding completion rates, along with completion rates (SD) & (V)

Ambition_range	Student_count	Avg_completion_rate	SD-completion_rate	V-completion_rate
Spring 2024				
1-1.5	28	0.7022	0.2402	0.0577
1.5-2	35	0.5007	0.3029	0.0918
2-2.5	35	0.7084	1.0697	1.1443
2.5-3	42	0.6139	0.2369	0.0561
3-3.5	28	0.5547	0.1942	0.0377
3.5-4	9	0.3086	0.2221	0.0494
4-4.5	7	0.5095	0.2121	0.0450
4.5-5	2	0.2850	0.2121	0.0450
Fall 2024				
1-1.5	29	0.5649	0.3629	0.1317
1.5-2	35	0.4964	0.3122	0.0974
2-2.5	36	0.5487	0.3165	0.1008
2.5-3	23	0.5103	0.3007	0.0904
3-3.5	10	0.4229	0.2726	0.0743
3.5-4	7	0.5279	0.3501	0.1226
4-4.5	7	0.5725	0.2929	0.0858
4.5-5	2	0.3562	0.1503	0.0226

As shown in Table 3, for Spring 2024, students in the lower ambition ranges (e.g., 1–2.5) achieved higher average completion rates (e.g., 0.7022 for the 1–1.5 range). As ambition levels increased (e.g., 4.5–5), average completion rates decreased significantly, with the lowest completion rate of 0.2850 observed in the 4.5–5 ambition range. Similarly, for Fall 2024 that students in lower ambition ranges (e.g., 1–2.5) generally achieved higher average completion rates (e.g., 0.5649 for the 1–1.5 range). However, as ambition levels increased (e.g., 4.5–5), average completion rates declined significantly (e.g., 0.3562).

Furthermore, variability in completion rates provided additional insights. Lower ambition ranges exhibited higher variability, i.e., greater SD and variance, suggesting that student performance in these ranges was more diverse and less correlated with ambition levels. On the other hand, higher ambition ranges demonstrated lower variability, reflecting a tighter correlation between ambition levels and completion outcomes. This consistency highlights the severity of higher ambition levels and action items, where most students with higher ambition goals have similar completion rates.

Research Question 2: Which National Association of Colleges and Employers (NACE) competency shows the highest levels of success (measured by "completion rates" vs "ambition levels"

To address the second research question, the Table 4 provides insights into the average completion rates, ambition levels, and activity counts for various NACE competencies during the Spring 2024 and Fall 2024 semesters.

Table 4: Students' NACE Competency Metrics: Avg. Completion Rates, Avg. Ambition Levels, and Activity Counts for Spring and Fall 2024

NACE Competency	Avg. Completion Rate	Avg. Ambition Level	Activity Count
Spring 2024			
Global Diversity & Awareness	0.4476	2.72	25
Critical Thinking	0.5291	2.63	108
Leadership	0.5391	2.87	98
Professionalism	0.6084	2.59	128
Teamwork	0.6068	2.59	111
Fall 2024			
Global Diversity & Awareness	0.4531	3.00	16
Technology	0.4708	2.47	59
Critical Thinking	0.4884	2.38	92
Teamwork	0.5164	2.15	55
Career & Self Development	0.5200	2.17	153

In Spring 2024, "Teamwork" (0.6068 completion rate) and "Professionalism" (0.6084 completion rate) demonstrated the highest completion rates relative to their ambition levels (both at 2.59). These two competencies also had the highest activity counts, with 111 activities for "Teamwork" and 128 activities for "Professionalism", indicating a high level of student-selecting activity targeted to these competences. "Critical Thinking" (0.5291 completion rate, 108 activities) and "Leadership" (0.5391 completion rate, 98 activities) showed slightly lower completion rates. "Global Diversity & Awareness" had the lowest completion rate (0.4476) and the lowest activity count (25), with an ambition level of 2.72, suggesting that students in this area are not focusing or understating different activities that fall under these competencies and

how to work and improve it.

In Fall 2024, “Career & Self Development” (0.5200 completion rate) and “Teamwork” (0.5164 completion rate) emerged as the competencies with the highest completion rates, with ambition levels of 2.17 and 2.15, respectively. These competencies also exhibited the highest activity counts, with “Career & Self Development” at 153 activities and “Teamwork” at 55 activities. “Critical Thinking” (0.4884 completion rate, 92 activities) and “Technology” (0.4708 completion rate, 59 activities) and “Global Diversity & Awareness” (0.4531 completion rate) had the lowest activity count at 16, indicating potential areas where additional support may be needed.

Across both semesters, “Teamwork” and “Professionalism” consistently demonstrated the highest completion rates and significant activity counts, reflecting the student choices, decision process and NACE competency that require improvement such as “Global Diversity & Awareness” and “Critical Thinking” not only had lower completion rates but also lower activity counts in some cases, suggesting that students may find these competencies less accessible or more challenging. The differences in completion rates, ambition levels, and activity counts suggest that students feel more confident and supported in areas like “Teamwork”, where they set realistic goals, while they may struggle in more abstract or effort-intensive areas such as “Global Diversity & Awareness”.

Research Question 3: What is the distribution of completion rates for different ambition levels? How does the graph look?

To address the third research question, Figure 2 shows the scatter plots for Spring 2024 and Fall 2024 provides a visual representation of the relationship between ambition levels and completion rates, highlighting key patterns and differences in student behavior.

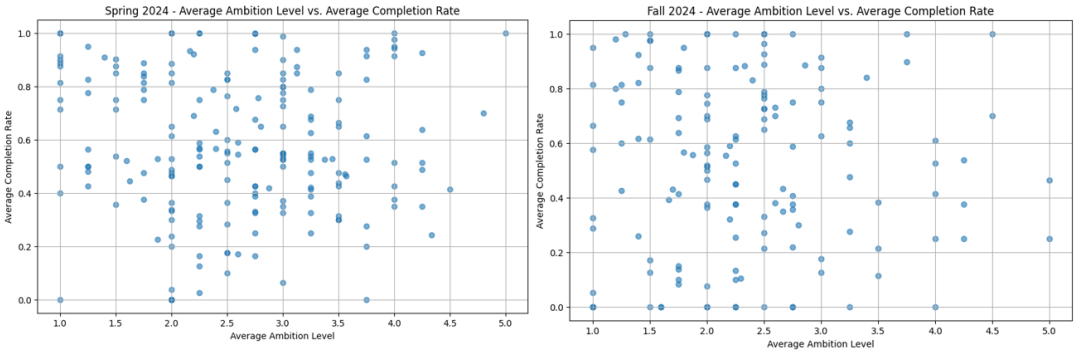

Figure 2: Scatter plots showing the relationship between average ambition level and average completion rate for Spring 2024 and Fall 2024 semesters.

Table 5: Variance in ambition level and completion rate, along with correlation coefficient for Spring 2024 and Fall 2024 semesters

Semester	**Variance in Ambition Level**	**Variance in Completion Rate**	**Correlation Coefficient**
Spring 2024	0.7691	0.0997	-0.0195
Fall 2024	0.7966	0.0691	-0.0463

As shown in Table 5, for the Spring 2024 and Fall 2024 semesters, interesting trends are revealed. For Spring 2024, the variance in ambition levels (0.7966) indicates a moderate spread, suggesting a range of ambition levels among participants. The variance in completion rates (0.0691), however, is quite low, showing that most participants had similar completion rates, with data points clustering tightly. The correlation coefficient (-0.046) suggests almost no linear relationship between ambition levels and completion rates, meaning ambition did not significantly influence task completion during this period.

For Fall 2024, the variance in ambition levels (0.7699) is slightly lower than in Spring 2024, showing a similar moderate spread. However, the variance in completion rates (0.0997) is higher than Spring 2024, indicating greater variability in participants' task completion. The correlation coefficient (-0.0195) for Fall 2024 is even closer to zero, reaffirming the lack of a meaningful linear relationship between ambition levels and completion rates. This slight negative correlation, though insignificant, is consistent with the Spring 2024 data.

When comparing both semesters, ambition levels displayed consistent variability across both periods. However, completion rates in Spring 2024 were more tightly clustered, whereas Fall 2024 showed greater dispersion. In both cases, there was no significant linear relationship between ambition and completion, highlighting that other factors may play a more critical role in determining completion rates. This comparison provides insight into participant behavior across the two semesters, offering a basis for exploring additional variables that might impact task performance.

At higher levels of ambition and completion rate, the scattered plot reveals increased variability and inconsistency in the relationship between ambition levels and completion rates among students. This suggests several patterns. Firstly, the scattered points reflect the diversity in student behavior, motivation, and ability to execute their plans. While some students with moderate ambition levels succeed consistently, others at similar ambition levels struggle to complete their tasks. Secondly, at higher ambition levels, the scatter becomes more pronounced, suggesting that students' ability to achieve their goals varies widely. This variability could be due to external factors like time management, resource availability, or personal motivation.

Additionally, the spread at higher ambition levels (above 3.0) shows that some students excel with high ambitions (high completion rates), while many others struggle (low completion rates). This indicates that ambitious goals are challenging to achieve without adequate support, guidance, or preparation. The scattered data also suggests a possible misalignment between ambition levels and the resources or skills needed to complete the activities. Students may set overly ambitious goals without fully considering their capacity or the effort required to meet them.

Finally, the scatter emphasizes the need for targeted interventions to help students align their ambition levels with achievable outcomes. Structured support, such as mentoring, skill-building workshops, and feedback mechanisms, could reduce the variability in outcomes and improve overall consistency.

The statistical analyses conducted in this study, including correlation and variance analyses, were based on student-reported data collected through the Qualification Plan (QP) App. While basic exploratory analysis was performed to confirm general distribution characteristics, formal statistical tests (e.g., Shapiro-Wilk for normality, Durbin-Watson for independence) were not applied to the dataset. Given the self-reported and behavioral nature of the data, and the primary goal of identifying broad behavioral patterns rather than predictive modeling, assump-

tions such as strict normality and linearity were not enforced. Instead, analysis focused on descriptive trends, variability, and relative comparisons across ambition levels. This limitation is acknowledged, and future studies may incorporate more rigorous statistical assumption testing to further validate these findings.

DATA VALIDATION

The data analysis and insights derived from this study were thoroughly validated by the course instructor, who provided valuable contextual feedback and qualitative observations regarding student behavior and performance.

The instructor's involvement ensured that the interpretation of the data aligned with real-world classroom dynamics and individual student experiences. For instance, the instructor noted specific cases of students who, despite not excelling in classroom discussions or assignments, demonstrated significant progress and consistency in completing their qualification plans. These anecdotal insights highlighted the strengths and limitations of the self-reported QP data, helping to confirm patterns observed in the analysis. Moreover, the instructor emphasized the importance of understanding the intrinsic motivation of students, as well as external challenges that may have influenced completion rates and ambition levels. This validation process not only lent credibility to the findings but also helped identify areas where the program could introduce targeted interventions to better support students in achieving their goals. By integrating both quantitative metrics and qualitative expertise, the study achieved a balanced and accurate interpretation of the dataset, ensuring that the insights were grounded in the practical realities of the PFE program.

The PFE QP process is entirely self-reported by the students, with no intervention or guidance from the course instructors. As the instructor mentioned, "We are not trying to improve anything with the process. The students are basically using the app on their own. There's no intervention process right now. We don't even tell them to focus on any specific NACE competency such as technology, communication, or professionalism, they just have the app, and they're supposed to set their own plan. They have to take responsibility on their own, and this data shows what they are doing by themselves."

This analysis is valuable in understanding how students are currently managing their learning process, the challenges they are facing, and how future interventions can be designed to better support them in achieving their goals. Quantitative analysis was performed to evaluate trends in ambition levels and completion rates over time. Statistical methods, including correlation analysis, were used to explore relationships between variables. Competency success rates were calculated by aggregating completion rates across NACE areas, and distribution analyses were conducted to identify patterns and anomalies.

Qualitative data from student reflections were coded to extract themes related to motivation, barriers, and perceived benefits i.e, In the early stages of the Professional Formation of Engineers (PFE) program development, qualitative data from student reflections and action plans was systematically reviewed to establish the foundation for the Qualification Plan (QP) framework. Initially, students documented activities related to career and professional development without explicitly reporting ambition levels or completion rates in a standardized format. However, through longitudinal observation of over one hundred different student activities, recurring themes were identified that reflected student motivation, perceived barriers, and achievement progression over time.

While no automated coding tools were used, faculty conducted an iterative review process, examining how students naturally selected activities across different academic years and how their engagement evolved. Patterns such as the progression from resume creation to career fair participation, employer engagement, and eventual internship attainment were consistently observed. From these observations, an ambition scale was created to categorize activities based on the collective challenge they presented relative to peer benchmarks. Completion rates were derived from students' self-reported progress within their action plans.

Thus, the ambition level assigned to each activity is not individualized but rather standardized based on collective student behavior and progression trends observed across cohorts. This structured yet flexible categorization enables students to benchmark their efforts while allowing the PFE program to identify developmental patterns and areas where additional support might be beneficial.

In this way, the qualitative insights gained from historical student reflections and behavior were instrumental in transforming the original open-ended action plans into a scalable, structured system for career competency development and self-assessment.

Instructor Feedback Examples

To further demonstrate the real-world impact of the Professional Formation of Engineers (PFE) program on students' career development, case studies from recent cohorts were examined. Two students, both in their third year of study, presented strong academic credentials, one maintaining a perfect 4.0 GPA and the other a 3.96 GPA, yet both struggled to secure internships despite their high academic achievements.

Upon closer review, it was found that while both students were well-rounded and possessed strong communication skills, however their resumes were poorly constructed. Their applications highlighted only their GPAs, without effectively showcasing leadership experiences, technical competencies, or engagement in career-building activities. This gap revealed a common misconception: that excellent academic performance alone is sufficient for securing career opportunities.

Through participation in the PFE program and guidance from the Course Instructor, the students were introduced to structured professional development practices, including resume building, networking strategies, and interview preparation. Using the Qualification Plan (QP) framework, they were encouraged to set actionable goals aligned with competencies such as Career & Self-Development and Professionalism. Their activities included refining their resumes to emphasize skills and experiences beyond academics, attending career fairs, and engaging more actively with potential employers.

These examples highlight that strong academic performance, while important, does not guarantee career success without complementary professional skills. The PFE program addresses this critical gap by fostering structured reflection, competency development, and realistic career planning, ultimately enhancing students' readiness for the engineering workforce.

CONCLUSION & LIMITATION

The findings from this study highlight the significant potential of the Professional Formation of Engineers (PFE) course and the Qualification Plan (QP) framework in fostering critical professional competencies and enabling students to align their ambition levels with achievable out-

comes. The PFE course and QP framework are designed to be adaptable and scalable, making them suitable for adoption by other academic institutions. By leveraging the structured goal-setting and competency development features of the QP, institutions can empower their students to take ownership of their career development plans. Moreover, the resources for the QP template will soon be made available online, enabling institutions to integrate this framework into their curricula with ease and customize it to suit their specific program requirements.

While the PFE Qualification Plan was developed specifically within the context of engineering education at the University of South Florida, its foundational principles are broadly applicable to a wide range of disciplines and institutional contexts. The core elements, structured goal setting, ambition level benchmarking, and competency-based tracking, align closely with broader educational initiatives such as the Kern Entrepreneurial Engineering Network (KEEN) focus on entrepreneurial mindset development and the National Academy of Engineering's (NAE) Grand Challenges Scholars Program, which emphasizes competencies beyond technical expertise. Institutions seeking to enhance career readiness can adapt the Qualification Plan framework by customizing ambition criteria and competency mappings to suit the needs of their students, whether in business, health sciences, or liberal arts programs. The model's flexibility supports its scalability and adaptation across different professional formation environments.

However, this study is not without its limitations. The data analyzed in this study is entirely self-reported by students, with no direct instructor intervention or guidance in setting or completing their action plans. While this self-directed approach provides valuable insights into students' independent learning behaviors, it also introduces variability in how students perceive and execute their plans. The lack of instructor involvement may result in some students struggling to identify actionable steps, maintain consistency, or fully understand how to achieve their goals. To address these challenges, future iterations of the program could incorporate targeted interventions such as mentoring, feedback sessions, or workshops to help students refine their action plans and competencies. By offering structured support alongside the self-reported framework, institutions can further enhance the effectiveness of the QP and ensure that students are better equipped to succeed in their professional journeys. These enhancements will not only improve individual student outcomes but also strengthen the scalability and adaptability of the PFE program for broader implementation.

The study relies on self-reported data from students when documenting activity selection, ambition levels, and perceived completion rates. Self-reported data can be subject to various biases, including optimism bias, social desirability bias, and varying interpretations of competency expectations. To mitigate these risks, ambition levels were pre-assigned to activities based on peer group standards, and students received standardized in-class instruction on how to interpret and apply the ambition scale.

Additionally, faculty and instructors provided ongoing qualitative observations throughout the PFE course sequence, which were used to validate patterns seen in student submissions. These instructor observations, such as noting improvements in professional engagement, communication skills, and leadership behaviors, supported the general trends identified through student-reported data. Future studies may further enhance validation efforts through triangulation with employer feedback, internship performance evaluations, or longitudinal tracking of post-graduation outcomes.

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