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What leadership capabilities do students in an experiential leadership course choose to explore, and how much growth do they report?

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Introduction

Modern engineering education emphasizes the importance of creating a leadership identity alongside technical competence in order to prepare future engineers for interdisciplinary, complex professional environments. Engineers are expected to collaborate effectively, navigate ambiguity in problems, and be decision makers [1]. Experiential leadership courses have the potential to help future engineers along their leadership identity and development journeys.

This project investigates leadership capability development of students enrolled in an experiential leadership course at the University of Oklahoma, a large public university in the central United States. The course is required of students participating as Holmes Leadership Associates in the Jerry Holmes Leadership Program for Engineers and Scientists (JHLP). This study, building on work previously reported [2], identifies the leadership capabilities students chose to explore and examines the self-reported growth these students experienced in the capabilities. The course allows students to select leadership capabilities aligned with their interests and goals, creating an opportunity for researchers to examine individualized leadership development.

One hundred fifty-five (155) students majoring in engineering and related fields took the course during the study period, and 16 consented to participate. Thirty-two student-written reports—two from each student—were collected from four semesters between 2022 and 2025. These reports document students' selected leadership capabilities and self-reported levels of competence using revised Bloom's Taxonomy. We are interested in answering the following questions:

Q1: What leadership capabilities do students choose to explore?

Q2: What self-reported growth do students experience in each capability?

Q3: What factors contribute to that change?

Q4: What lessons do students describe?

This paper addresses Questions 1 and 2. Questions 3 and 4 will be discussed at a later date.

Background

The experiential leadership course

The experiential leadership course is taken by students majoring in engineering or related sciences and participating in an intense leadership development program. The program itself is open to undergraduate and graduate students, while the course is limited to undergraduate students. Students are eligible to pursue the program if they have sophomore or higher standing and at least two years left in their degree plan. Students in the program can take the course up to three times for credit.

Students taking the course create a Leadership Development Plan (LDP) where they review the program's 26 leadership capabilities and select three capabilities that they will focus on

throughout the semester. The capabilities fall under five categories: Personal Development; Interpersonal Relationships; Management and Teamwork; Generative Leadership; and Intercultural Competence.

Table 1. Leadership Capabilities by Category.

Categories	Leadership Capabilities
Personal Development	1. Developing self-awareness 2. Setting and achieving goals 3. Problem-solving and decision-making 4. Developing technical and financial expertise
Interpersonal Relationships	5. Practicing good followership 6. Building positive relationships 7. Practicing inclusivity 8. Collaboration 9. Managing conflict and negotiation 10. Communicating effectively
Management & Teamwork	11. Organizing 12. Working in a team 13. Staffing 14. Managing projects 15. Training and mentoring 16. Empowering and delegating
Generative Leadership	17. Creating a shared vision 18. Motivating and inspiring others 19. Adapting leadership styles 20. Building power and influence 21. Boundary spanning 22. Leading change
Intercultural Competence	23. Understanding cultural dimensions of leadership 24. Intercultural communication 25. Understanding the global context of engineering practice 26. Working with other professions

The LDP is a two-part assignment. In the first part, students describe their most important leadership activity for the semester; in the second, they focus on the development of the three leadership capabilities chosen. For each capability, the student 1) explains why they chose it; 2) evaluates their initial competence level using revised Bloom's Taxonomy and provides evidence for their rating; 3) sets a goal for what they intend to accomplish by the end of the semester; and 4) creates a step-by-step action plan for reaching their goal for each capability. Following submission of the LDP, students meet with the instructor to receive feedback. Students have a week to submit necessary revisions.

At the midpoint of the semester, students assess their progress in a midterm reflection and make needed additions or modifications to their action plans. At the end of the semester, students write

a final reflection where they describe their project's outcome, trace their leadership development over the semester, and evaluate their final competence level for each capability. They discuss and compare their initial self-evaluation to their final evaluation within each target capability. Throughout this course, students practice developing goals, evaluating competence levels, and self-reflection, thus providing material to answer Research Questions 1 and 2 [2].

The capabilities are based on the engineering leadership frameworks developed by MIT's Gordon Leadership Program (GEL) and Rice Center for Engineering Leadership (RCEL) [3], [4]. Both programs believe leadership is a set of learnable skills that through practice, reflection, and feedback are developed and strengthened, a core philosophy in the JHLP experiential leadership course. MIT's Gordon Leadership Program developed a foundational capability-based model that has shaped modern engineering leadership education [5]. The GEL program required students to complete a Leadership Practice Project, a team-based experience where students lead engineering projects through iteration and receive assessments [3]. Rice's Center for Engineering adapted and expanded this framework into its own domains (categories) and competencies (capabilities) emphasizing personal, interpersonal, management, and leadership development [4]. The experiential leadership course was inspired by the groundwork provided by MIT and Rice. Their lists of leadership capabilities were modified and expanded to produce JHLP's five categories and 26 capabilities (Table 1).

This course was designed in accordance with Self-Determination Theory, which proposes that people are more likely to be intrinsically motivated when the basic psychological needs of autonomy, competence, and relatedness are satisfied [6]. Autonomy reflects the need to feel control over one's actions. Competence involves feeling effective and developing proficiency through challenge. Relatedness requires the need to feel supported and connected to others. As students select their three focal capabilities, they exercise autonomy, build competence as they advanced through revised Bloom's Taxonomy, and strengthen relatedness with their teammates, professional mentors, and the course instructor.

Students' perceptions of leadership

Over the years, universities have expanded the scope of curricular and co-curricular leadership development programs, signifying the importance of student leadership development. Researchers have developed theories regarding leadership identity and how a student's lived experience reflects their own leadership identity [7].

In the past, leadership was heavily focused on productivity, efficiency, and the ability to produce. Today, relational skills are emphasized. Generally, leadership views can be separated into industrial and postindustrial paradigms [7]. The industrial paradigm of leadership is the traditional Western view of leadership, developed in the 20th century, holding that leaders are born, leadership is hierarchical, and leadership is an individual characteristic. In contrast, the postindustrial paradigm, popularized in the 21st century, says that leadership can be done by anyone, can be taught, is meant to create change, and is collaborative.

More recently, Yammarino et al. [8] wrote, "leadership is viewed as a collectivistic phenomenon that involves putting the 'we' in leadership where multiple individuals interact, through a variety of formal and informal structures, broadly defined, and take on a variety of leadership roles, both formally and informally, over time" [p. 384]. Students that begin to adopt this version of

leadership develop a more complex and mature leadership identity compared to students who view leadership as hierarchical with formal leaders [9], [10], [11].

Students' perceptions of leadership are strongly shaped by whether they see themselves as leaders. Shertzer [9] interviewed two distinguished groups of collegiate students: student leaders, defined as those who have leadership positions, and disengaged students, those who had never held leadership roles. The goals were to understand how each group perceived leadership and to identify constraining and empowering beliefs that affected their involvement. Factors such as a student's support system, frequent opportunities, and upbringing were deemed empowering beliefs. Constraining beliefs identified in disengaged students were low confidence and limited opportunities. Students across both groups adhered to the industrial paradigm of leadership.

Around the same time, Komives et al. [10], [11] found that students' views of leadership were more varied. The social environment heavily impacted their leadership identity or lack thereof. Teams, collaboration, and relationships facilitated the development of a relational leadership identity, focusing on the importance of trust, integrity, and teamwork. Students who viewed leadership as leader-centric could shift to embracing leadership as a collaborative process. Adults, peers, and organizational involvement proved to be large factors in the developmental influences in these students' lives, causing them to see their potential and consequently get involved in activities aligned with their interests. Personal growth, deepening self-awareness, confidence, and independence allowed these students to take more risks and to put themselves in uncomfortable situations that lead to growth and developing new interests. Engaging in groups, investing time in organizations, and continuously being around others shaped how the student(s) viewed teamwork, responsibilities, and leadership.

Leadership in the engineering and scientific contexts

In the 21st century, the demand for leadership education within engineering has grown significantly. While engineers are well educated in technical skills, many lack essential leadership qualities such as communication, management, creativity, and even problem solving [1]. These qualities are critical in team-based environments, an inevitable part of engineering practice. Whether collaborating with other engineers or working across disciplines, engineers must feel comfortable and confident in navigating team dynamics. Engineering leadership education, especially programs that emphasize teamwork, support the development of these competencies [12]. Modern engineers must adopt holistic views, be continuous learners, and collaborate to become versatile and adaptable engineers.

Leadership development courses and programs continue to grow [13]. To prepare future engineers for the realities of modern practice, it is essential that they engage in engineering-focused leadership education [14]. Over the last decade, researchers have explored engineers' and engineering students' understanding and practice of leadership. Engineers usually work in the technical field for the first couple of years in the workforce, then they are made project managers where they experience their first taste of formal leadership [15]. This shift can feel very uncomfortable and make some feel unprepared. Many engineers resist leadership because they feel that it does not align with their professional identities as engineers [16]. This has a lot to do with the connotation the word *leadership* carries for certain people; it can feel elitist and exclusionary, possibly because some believe that not everyone is or can be a leader [15], [17], [18]. As much as engineers might not identify as leaders, Rottmann and colleagues [15] found

that they do practice leadership through influence in everyday practices, through three orientations to engineering leadership: technical mastery, collaborative optimization, and organizational innovation. They also found that engineers' leadership identity falls along two paths. Those who hold traditional Western notions of leadership express resistance to leadership as a characteristic of engineers. In contrast, those who recognize leadership as professional forms of influence create a compound identity, that of an engineering professional and an engineering leader [15, p. 363].

Bloom's Taxonomy

The experiential leadership course described in this paper employs the revised Bloom's Taxonomy as a measure of students' progression in leadership capability development. Bloom's Taxonomy is a hierarchical framework primarily used in education for instructors to develop curricula with clear objectives [19]. For instance, a vocabulary quiz in which students must use the word in a sentence demonstrates the apply level. In other cases, with the supplemental data collected from students, educators or researchers measure where the students are in Bloom's and consequently their growth [20]. Bloom's Taxonomy was revised to demonstrate cognitive processes more accurately, as shown in Figure 1 [21]. The present study uses Bloom's Taxonomy in an unconventional way: students themselves apply the taxonomy to identify their level of performance on each focal capability. In the Initial LDP, students describe their starting level for each of the three capabilities they chose to develop throughout the semester. In their Final Report, students reflect on the growth they experienced and consequently indicate the level they reached at the end of the semester. This approach is appropriate as the students design their own timeline and developmental assignments they work towards during the semester. Students identified goals and specific measurable actions that guide them in generating personalized learning tasks rather than completing instructor-created tasks. Since Revised Bloom's Taxonomy uses verbs—action words—to describe each level and the LDP are action plans, it works as a useful tool for students to self-assess and measure their growth (Table 2).

Table 2 outlines the 6 revised Bloom's Taxonomy levels, offers a brief explanation, and examples for how instructors would use each level to build questions and exercises for students.

Table 2. Revised Bloom's Taxonomy Explained. Adapted from [22].

Level	Levels Explained	Examples
Remember	Recalling facts and basic terms	List all 50 states in the United States
Understand	Explain ideas or concepts	Explain what kinetic energy is.
Apply	Use information in new situations	Use taxonomy in a sentence.
Analyze	Draw connections among ideas	Draw a conclusion from the excerpt.
Evaluate	Make judgements	Debate which presidency had a bigger impact.
Create	Generate new and original work	Design a solution to this problem.

To demonstrate how students articulated their self-assessed growth, Table 3 provides excerpts, aligned with each cognitive level, from the students' submissions evaluated in this study.

Table 3. Revised Bloom's Taxonomy Student Examples.

Level	Student Examples
Remember	"I am gaining knowledge of facts and basic concepts. This includes unfamiliar verbiage and diction used in financial literacy, basic concepts and functions of foundational economic models…"
Understand	"I know what effective communication looks and sounds like, and I can even tell others how to effectively communicate. However, I have a difficult time applying these ideas to my own life."
Apply	"I understand the basic principles of effective collaboration, such as clear communication, task delegation, and maintaining a positive team dynamic, and I'm able to apply these concepts in real-world scenarios."
Analyze	"I have now been able to experiment, test and compare the two languages I know, Python and Java, when working on projects to determine the best one to use given the situation."
Evaluate	"I can not only apply and analyze my contribution to the team, but also argue why I believe my contributions were meaningful and defend my work."
Create	"I was able to lead my team to create a medical device design in just less than 24 hours...We bounced ideas off each other and once we had settled on a design, started working on different aspects of the project without any discussion."

Methodology

In the present phase of this study a mixed-methods approach allowing for quantitative and qualitative interpretation was used to address Research Questions 1 and 2:

Q1, What leadership capabilities do students choose to explore?

Q2, What self-reported growth do students experience in each capability?

The data consisted of reports written by students enrolled in the experiential leadership course.

This study used NVivo 15 and Excel for Microsoft 365, Version 2602, both on Windows 11, to conduct frequency and narrative analyses. NVivo was used to conduct the frequency analysis of the 48 student-written reports. 48 files were imported, and an initial codebook was created. For Question 1, *a priori* codes were established for the five leadership capability categories: Personal Development; Interpersonal Relationships; Management and Teamwork; Generative Leadership; and Intercultural Competence. During open coding, each report was reviewed to find the specific capabilities each student chose. For Question 2, the reports were imported to a separate project where revised Bloom's Taxonomy level was the focus. The initial codebook included *a priori* codes for each of the revised Bloom's Taxonomy levels (Remember, Understand, Apply, Analyze, Elaborate, and Create) and for the Initial Level and Final Level. The analysis examined each student's initial and final Bloom's Taxonomy levels to determine the number of students reporting no growth, growth of one level, or growth of two or more levels across all capabilities, with emphasis on the three most frequently selected capabilities.

Participants

During the study period, from 2022 to 2025, one hundred and fifty-five (155) undergraduate students majoring in engineering and scientific fields took the course. Participation in the study was voluntary; 16 students consented to participate. For each student there were 2 reports, the Leadership Development Plan (LDP), and the Final Reflection, resulting in a dataset of thirty-two student written reports. At a minimum each student had sophomore standing.

Data Analysis

Thirty-two student reports formed the dataset for this analysis. The first set of sixteen reports submitted at the beginning of the semester consisted of each student's initial Leadership Development Plan (LDP), where students identified the three capabilities they intended to develop and rated their competence for each capability on revised Bloom's Taxonomy. The remaining sixteen reports were the Final Reflections in which students described their growth and indicated which level they believed they reached at the end of the course. Using NVivo and Excel, capabilities students chose to explore and their self-reported growth were tabulated. In several reports, students identified multiple Bloom's levels for a capability. These reports were analyzed to determine one level that most accurately represented their experience described. In other cases, students initially placed themselves at one level but later, in their Final Reflections, concluded that a different level better captured their true starting point. These researcher-assigned and student-adjusted levels were used in the analysis.

Positionality

The first author is an undergraduate researcher in her second year of study in industrial and systems engineering. The second author is the director of the engineering leadership program and the course instructor. The second author designed the study and worked with the first author to discuss the analytic process and findings and to prepare the manuscripts. To protect the participants' privacy and to avoid conflicts of interest, the second author provided the course rosters and all students' submissions to another professor, who managed the informed consent process, de-identified the data, and provided the data to the first author. The second author did not know which students agreed to participate, had no access to the signed informed consent forms or de-identified data, and did not conduct data analysis.

Limitations

Of the 155 students taking the course during the study period, only 16 consented to participate; thus only 32 student written reports were collected and examined. This small sample size is problematic because it is not representative of the majority of people who have taken this course and does not accurately capture the most frequently chosen capabilities and the self-reported growth across the full cohort.

The lack of students who consented to share their reports can be explained due to our Institutional Review Board's (IRB) strong stance in protecting participants from coercion. Because the study's principal investigator is also the instructor, the IRB required the instructor to limit her involvement in speaking about the research and prevented the instructor from knowing

which students had consented. Even if students had planned to consent, they very well may have forgotten to do so.

Findings

To understand how students approached their leadership development, this section examines the categories and specific capabilities they selected at the beginning of the course. The distribution of choices provides insight into the areas students perceived as most relevant to their growth and the areas receiving less attention. These selections will also help contextualize later findings on self-reported development.

Leadership Capabilities Chosen by Students

Over half of the participants selected capabilities related to Personal Development and Interpersonal Relationships, suggesting a strong interest in strengthening these leadership skills. Figure 1 illustrates the distribution of choices at the category level. Notably, no students selected capabilities within Intercultural Competence.

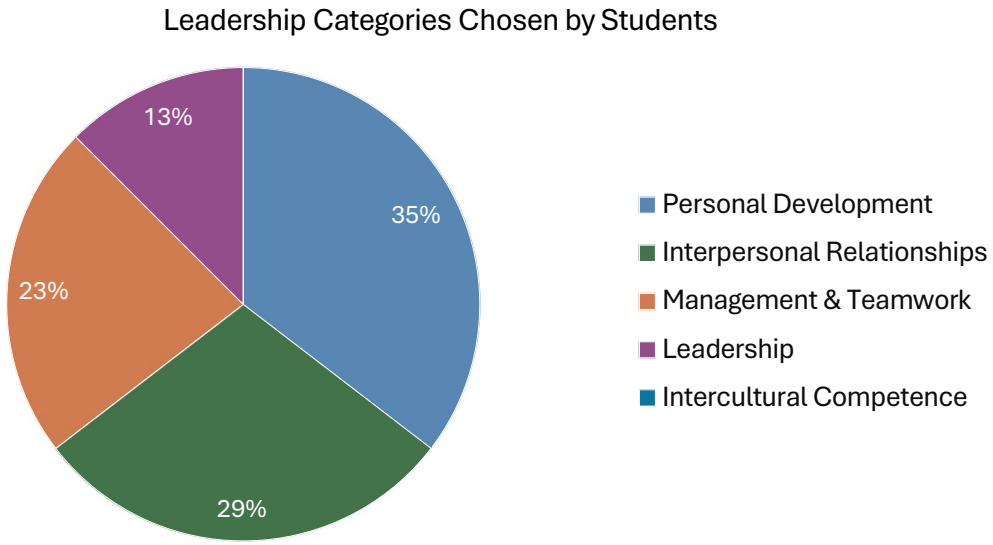

Figure 1. Leadership Categories Chosen by Students.

Table 4 depicts the frequency with which each of the 26 capabilities were chosen by the 16 students in the study. Thus, highlight which competencies students perceived as most relevant to their leadership growth. The most frequently selected was Capability 4, Developing technical and financial expertise, with 8 students. The second most popular was Capability 2, Setting and achieving goals, with 6 students. Following was Capability 10, Communicating effectively, with 5 students. Lastly, Capabilities 11, Organizing, 12, Working in a team, and 19, Adapting leadership styles tied with each having 4 students.

Table 4. Leadership Capabilities Chosen by Students.

Personal Development	1. Developing self-awareness	2. Setting and achieving goals	3. Problem-solving and decision-making	4. Developing technical and financial expertise
	3	6	0	8

Interpersonal Relationships	5. Practicing good followership	6. Building positive relationships	7. Practicing inclusivity	8. Collaboration	9. Managing conflict and negotiation	10. Communicating effectively
	2	3	2	1	1	5

Management & Teamwork	11. Organizing	12. Working in a team	13. Staffing	14. Managing Projects	15. Training and mentoring	16. Empowering and delegating
	4	4	0	1	1	1

Generative Leadership	17. Creating a shared vision	18. Motivating and inspiring others	19. Adapting leadership styles	20. Building power and influence	21. Boundary spanning	22. Leading change
	0	0	4	0	1	1

Intercultural Competence	23. Understanding cultural dimensions of leadership	24. Intercultural communication	25. Understanding the global context of engineering practice	26. Working with other professions
	0	0	0	0

Students who selected Capability 4 (Developing technical and financial expertise) identified one or two specific areas of focus within technical or financial expertise. They were not expected to develop both technical and financial expertise simultaneously. For instance, some students chose to learn a new coding language, while others explored investing.

Self-Reported Growth

Forty-eight (48) students reported and described their initial level while forty-three (43) students reported their final level. One participant described their growth but did not rate themselves on the revised Bloom's Taxonomy levels. Another participant reflected in their final report that their initial rating was not accurate. Across all capabilities, almost 50% of the students described their initial levels as Understand while only 10% described Understand as their final rating. Apply, with 17 students, and analyze, with 15 students, were the most common final ratings among the participants.

Among all capabilities, 29 students demonstrated growth by moving up one level on the revised Bloom's Taxonomy scale. An additional four students progressed by two levels and another four advanced by three levels, indicating substantial development. Meanwhile, seven students showed no growth between their initial and final self-assessments. One student, Student 9, experienced a decline of one level. The apparent decline, from higher-order thinking to lower, may not indicate a true decline. Instead, it likely reflects a more accurate initial self-assessment.

As seen in Table 2, Capabilities 2 (Setting and achieving goals), 4 (Developing technical and financial expertise), and 10 (Communicating effectively) were the most frequently chosen capabilities among the students. To illustrate how students described their growth within the most frequently selected capabilities excerpts of the participants' reports in these capabilities are shown in the following tables.

For Capability 2 (Setting and achieving goals) students most often described their initial level as Understand or Apply. For Capability 4 (Developing technical and financial expertise) the most common starting level was Apply, indicating students' prior experience practicing technical or financial skills. For Capability 10 (Communicating effectively) the most common starting levels were Apply and Analyze, suggesting a stronger initial foundation in communication skills.

Table 5 shows Students 2, 4, and 7 who chose Capability 2, Setting and achieving goals, initial and final levels on revised Bloom's Taxonomy. Students who selected Capability 2 demonstrated growth their ability to set goals, but especially how they understood and managed processes to achieve their goals. Across the reflections, students explained moving from vague goals with unclear timelines to structured and intentional approaches to planning their goals. Their reflections indicated an increased use of analyzing personal habits, experimenting with methods, and identifying concrete, effective techniques to make significant progress. This developmental pattern is evident in Student 2 who moved from the Understand level to Evaluate level as they developed strategies to critically assess their own progress.

Table 5. Examples of self-reported growth in Capability 2, Setting and achieving goals.

Student ID	Initial Level	Final Level
2	"I am at the Understand level of Bloom's Taxonomy–I recognize where I need to improve and can set goals effectively. However, true growth comes from moving beyond understanding to application and achievement. My challenge lies in following through, overcoming setbacks, and developing the discipline to reach my goals. To progress, I need to shift from simply knowing what to do to actively doing it, ensuring my goals turn into tangible results."	"Now, I believe I've reached the "Evaluating" level, as I regularly assess priorities, make adjustments, and align my goals with long-term outcomes. For example, I've begun scheduling weekly Sunday check-ins to reflect on progress and make necessary changes. Going forward, I plan to carry these habits into my internship by setting clear weekly objectives, monitoring my progress consistently, and reflecting on what strategies work best–ensuring I stay accountable and continue growing professionally."
4	"For setting and achieving goals, my competence level is at "apply". I have learned a fair amount about goal-setting and different methods of goal tracking, generating personal motivation, and so on, but I usually neglect applying these concepts in an effective way in my own life. I want to make an effort to not only practice these concepts this semester to gain personal data for what strategies improve my goal setting and achieving, but to follow up and make changes accordingly during the midterm check-in. Only then I feel like I can start."	"I put my initial Bloom's taxonomy level at "apply", but now I think I have moved up to "analyze". I felt like I had the common tools to keep track of goals, but after this year getting back into school I feel I have enough raw data to identify friction points in my scheduling and bad habits that expend time. I migrated to having a paper journal to be a more flexible and accessible way of tracking progress. Slowly but surely, I get more consistent adding to it. Because of this, I feel I am more self-aware and analytical in this capability. In order to improve, I would like to see myself reset this summer and commit to new goals which I can realistically be more consistent with."
7	"My first target capability for this semester would be capability 2, "Setting and Achieving Goals". More specifically the "Plans, monitors and manages goal achievement. I have chosen this area as whilst I believe I am fairly decent at setting SMART goals I am not so good at sticking to them in the longer run. This is particularly evident when things start to get stressful such as around the exam period or when deadlines start to sync up. In terms of Bloom's Taxonomy I am about at the level of analysis, in that I have experience with managing projects but I require further experimentation and testing for it to become effective."	"I would say that now, having followed this leadership development plan, my Bloom's taxonomy level is at the evaluate level and nearly at the create level. I say this because by weighing and valuing tasks over one another, I was able to make efficient decisions as to where I should be focusing my attention and effort. In the process, I have been able to achieve all of my goals, not only associated with this ability but also the goals I set for my other 2 capabilities, such as learning Java and applying for several internships across the UK. The only reason I don't think I am quite at the create level is because there is still much more to be learnt in terms of scaling."

Table 6 shows students 9, 13, and 15 who choose capability 4, Building technical and financial expertise, initial and final levels on revised Bloom's Taxonomy. Students who chose this capability often began the semester with foundational knowledge but limited experience or confidence in applying technical and financial concepts independently. The student's reflections described a shift from basic comprehension to deeper understanding and engagement with various tools and methods.

Table 6. Examples of self-reported growth in Capability 4, Developing technical and financial expertise.

Student ID	Initial Level	Final Level
9	"I'd say my current competence level in 'building technical and financial expertise' according to Bloom's Taxonomy would be 'remember' because I do know the very basics of being financially responsible; paying off my credit card in time, not spending after my due date. I am not yet at the 'understand' level because I truly do not understand the direct logistics behind HYSA, bonds or stocks but I do wish to learn more."	"I feel much more confident now and think I would classify myself still as 'remember' because I've only mastered one part and still have a lot to work on. Reflecting on my habits [my mentor] advised I applied for an increased credit limit simply to lower the rate, which I was approved for and keeping my same habits I've been able to take that step forward. I think I'm still at the 'remember' stage as I'm still barely scraping the surface and want to focus on maintaining my current progress."
13	"I would consider myself to be in the applying tier of Bloom's Taxonomy. I say this because I have a good base level knowledge in technical areas such as coding with Python and MATLAB and 3D modeling with CAD. I have also successfully used these skills in various projects showing that I can use what I have learned."	"Now I would consider myself to have been elevated to the analyze tier. I believe I have elevated to the analyze tier because before this semester, I was able to make CAD models. However, I struggled to evaluate my models and understand what improvements could be implemented. This semester, I wanted to learn this skill which is why I had other people with and without CAD experience score my models and provide feedback."
15	"I am certainly at the most elementary level of Bloom's Taxonomy, being "remember," where I am gaining knowledge of facts and basic concepts. This includes unfamiliar verbiage and diction used in financial literacy, basic concepts and functions of foundational economic models."	"At the beginning of the semester, I self-identified at the "Remember" level of Bloom's Taxonomy. I was learning basic financial concepts, vocabulary, and tools. Now, I believe I have progressed to the "Understand" level. I can now explain key financial principles (e.g., compound interest, tax brackets, investment diversification), and I've begun applying them to my personal and professional contexts."

Table 7 shows students who chose capability 10, Communicating effectively, initial and final levels on revised Bloom's Taxonomy. Students' reflections revealed that growth in this capability revolved around becoming more intentional and adaptable communicators. In their initial LDPs students described what effective communication "should" look like or explained they knew methods but described struggling with to apply those principles. By the end of the semester, students reported improved confidence and clearer communication tactics.

Table 7. Examples of self-reported growth in Capability 10, Communicating effectively.

Student ID	Initial Level	Final Level
10	"According to Bloom's Taxonomy, I believe I am at the understand level. I know what effective communication looks and sounds like, and I can even tell others how to effectively communicate. However, I have a difficult time applying these ideas to my own life. Before the end of the semester, I would like to confidently complete my interview and hopefully get the job."	"I have had previous interview experience, completed interview preparation in a class, and researched interview techniques. I was able to apply this experience and knowledge to past interviews, allowing me to demonstrate my abilities to possible employers. I would consider myself at the "Apply" level. I gained further understanding of interview techniques and processes that I can later apply to future interviews. I believe I can successfully complete an interview with [company] due to previous experience and the research which I conducted during this project."
14	"My current competence level according to Bloom's Taxonomy is apply because classes such as Intro to Engineering, Leadership and Management for Engineers and Scientists, alongside Professional Development have shown me methods of effective communication which I need to practice using in team environments. Within the various organizations and courses I definitely think becoming more confident in my communication will help my leadership ability because sometimes I can be timid and not as talkative about my knowledge or perspectives."	"The competency level that I set for myself at the beginning of the semester was applying. I rated myself that way because I had to practice applying communication concepts that I already knew to build up confidence and my ability to speak effectively to others. Now, I believe my competency level is primarily evaluating but includes traces of analyzing. This is because I am continuously experimenting and distinguishing proper communication techniques that fit best within given situations. This includes communication techniques such as verbal, nonverbal, alongside professional writing that I have learned from my courses."
15	"For the target capability 10, I consider myself to be at the "analyze" level of Bloom's Taxonomy where I am drawing connections among, and juxtaposing, cause and effect scenarios regarding my optimal levels of communication versus my substandard interactions. It is this stage that I am distinguishing the actions I take that result in the strongest communication experiences and overlaying these exceptional outcomes with those of which I am not proud."	"At the start of the semester, I identified my Bloom's level as "Analyze," but in hindsight, I was likely operating at a lower level—perhaps "Apply" or even "Understand"—since I had not yet developed a conscious framework for evaluating and improving my communication habits. Now, I believe I have grown into the "Analyze" level. This is supported by examples such as initiating meetings with team members, refining shared digital communication tools, and adjusting my approach based on what produced the most efficient communication outcomes."

Table 8 highlights three students who reevaluated their initial level in their final reflections. Both Student 10 and 15 initially identified with a higher level but through reflection explained that their original assessment did not accurately represent their true starting point. Notably, Student 9 did not assess their true initial level but in their final reflection they did reconsider their original placement and acknowledged that their initial self-assessment was unrealistic. These cases illustrate the students' ability to reflect and demonstrate self-awareness and the growth they experience as they gain more experience in their chosen capability and simultaneously develop a clearer understanding of what each level requires.

Table 8. Evidence of students reevaluating initial level.

Student ID	Initial Report	Final Report
9	"Currently I'd say I'm at the evaluate level because I am currently evaluating every organization method I have and choosing my finalists, depending on how manageable, efficient, and easily taught they are. Especially when working in big groups I've found it better to have slightly less efficient methods if it's easier to share and teach, rather than those that have a higher difficulty rating when it comes to teaching. Of course, for my personal duties I do whatever I find fits it best. For example I have an extensive drive for [student organization], it is easy to locate and manage because different people will access it for different reasons and although I have more personalized drives with specific controls- it simply is more feasible to have an easier to learn version.	"Previously my Bloom's taxonomy level was 'evaluate', and I think I'm at 'analyze' because I chose some organizational styles that looking back just were not the most realistically possible for me. I think I was a bit overestimating myself when I chose to begin color coding everything, and I tried journaling but I already use two journals where I write things down haphazardly between the two that I've already gotten used to my own system. Although it's not really organized, it makes sense to me and I don't think I have any major issue with that. I think I should focus on things that I could actually undertake and be consistent with, like organizing emails, writing reminder sticky notes and maybe making a checklist for certain tasks."
10	"According to Bloom's Taxonomy, I believe I am at the level of evaluate for this capability. I have been tasked with working in teams all my life, whether it be in school, sports, or work. I can not only apply and analyze my contribution to the team, but also argue why I believe my contributions were meaningful and defend my work. "	"Before the project, I believe I was at the "Apply" level. I have worked in several teams before and had background knowledge about working in a team which allowed me to apply my experience and knowledge to this project. However, after the project, I believe I am now at the "Analyze" Bloom's level. I was able to examine my ability to work in a team through discussions with my manager and team lead, as well as by assessing the feedback which they provided to me."
15	"For the target capability 10, I consider myself to be at the "analyze" level of Bloom's Taxonomy where I am drawing connections among, and juxtaposing, cause and effect scenarios regarding my optimal levels of communication versus my substandard interactions. It is this stage that I am distinguishing the actions I take that result in the strongest communication experiences and overlaying these exceptional outcomes with those of which I am not proud."	"At the start of the semester, I identified my Bloom's level as "Analyze," but in hindsight, I was likely operating at a lower level—perhaps "Apply" or even "Understand"—since I had not yet developed a conscious framework for evaluating and improving my communication habits. Now, I believe I have grown into the "Analyze" level."

Table 9 demonstrate students who declared multiple revised Bloom's Taxonomy. In these cases, students were assigned a single level based on analysis of the experiences described and their explanations for spanning several levels. The excerpts shown in Table 8 came from students' initial LDPs.

Table 9. Students who chose multiple Bloom's Taxonomy levels for a capability.

Student ID	Excerpt	Level Assigned	Why?
3	"I would say that I am between understanding and applying in Bloom's Taxonomy. I can apply knowledge that I have gained to myself in some senses, but I also don't know everything I need to know yet to move on completely from understanding."	Understand	Student has not mastered Understand level.
3	"I think I range between remember, understand, and apply for the technical competencies that I am working with this semester. I don't know a whole lot, but we are already starting to learn how to apply the things we just learned to understand. As new concepts are added, and we work with more technologies I think I will make this progression many times."	Apply	Student is in the process of applying.
9	"I'd say my level according to Bloom's taxonomy would be right between understanding and apply, I can understand different leadership styles and am in the process of attempting to apply them. I've been trying different leadership tips like letting everyone talk before I say anything, having anonymous submissions, switching roles, etc."	Apply	Student is in the process of applying.
15	"I believe I am somewhere between "understand" and "apply" with respect to Bloom's Taxonomy. "Getting Things Done" left me with concepts of goal setting that, while not unfamiliar to me, will take practice to explain and recognize the application of these ideas to external situations. Once I can explain and identify these concepts in action, I believe that I will quickly be able to implement these concepts into my own organization of goals"	Understand	Student has not mastered Understand level.

This study examined leadership development among students in engineering and scientific fields enrolled in an experiential leadership course, focusing on the capabilities students chose to develop and the self-reported growth they experienced using revised Bloom's Taxonomy. Findings indicate that students most frequently selected capabilities within Personal Development and Interpersonal Relationships categories, particularly setting and achieving goals, developing technical and financial expertise, and communicating effectively. These choices suggest that students prioritize capabilities they perceive as relevant to their academic and professional success. Notably, no students selected capabilities within Intercultural Competence, highlighting the small study group which may not reflect the diversity of the capabilities picked by all students who have taken the course.

Across the semester, students reported measurable growth in their leadership capabilities, with shifts from lower-order cognitive levels (e.g., Remember, Understand) to higher-order levels (e.g., Analyze, Evaluate). This growth described in the Leadership Development Plans (LDPs) demonstrated the value of reflective learning in supporting leadership development. The use of revised Bloom's Taxonomy played a central role in this process. By framing their reflections through a shared cognitive lens, students were able to describe what they learned, how their thinking evolved, and the growth they experienced. This approach encouraged students to lead with specificity, intentionality, and honesty in their reports resulting in rich and analytical accounts of their leadership growth.

Conclusion

Despite limitations related to sample size, results offer meaningful insight into how students in engineering and related fields engage with leadership development given the autonomy to choose capabilities aligned with their goals. Students' choices in capabilities revealed how they gravitated towards specific areas that were relevant to their emerging professional identities. Through this process students not only demonstrated measurable cognitive growth but articulated their development with increased clarity and self-awareness. Thus offering honest and valuable testaments of their leadership growth.

This work establishes a foundation for the next phase of the research, a qualitative analysis of contributing factors, lessons learned, and the contribution of students' experiences to their engineering leadership identity development.

Ultimately, the findings support the role of experiential leadership courses as effective methods for fostering leadership identity and development. These outcomes highlight the potential of reflective and experience-based leadership education to form nuanced engineering leaders.

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