Attainment of ABET Outcomes through Cooperative Education: A Student Perspective

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***Abstract*—Our mixed-methods investigation examined how co-op work terms and traditional coursework differentially contribute to ABET student outcomes in engineering and CS programs. Through surveys (n=47) and semi-structured interviews, we found that while coursework builds theoretical foundations, co-op rotations proved especially valuable for developing communication and teamwork capabilities. Notably, CS students reported the largest disparity between classroom and workplace experiences. These findings suggest opportunities for better alignment between academic and industry preparation.**

***Index Terms*—ABET, co-op, cooperative education, classroom learning, student outcomes, engineering education, computer science education, mixed-methods research**

I. Introduction

Cooperative education (co-op) has been an integral part of engineering curricula for over a century and is recognized as one of the top ten achievements in engineering education during the 20th century [1]. Research indicates that co-op programs offer several benefits to students. Academically, co-op participants tend to achieve higher grades in certain courses, especially those emphasizing soft skills [2], [3]. Co-op experiences also enhance self-efficacy, particularly in work-related activities, and contribute positively to student retention [4]. Additionally, co-op programs have been associated with a nearly 10% increase in starting salaries for graduates [5].

While cooperative education programs offer numerous generalized benefits, not all co-op experiences are equally impactful. Research highlights that factors such as socialization, mentorship, and a positive, nurturing work environment significantly influence student well-being and development [6]. These elements create a supportive atmosphere that enhances the overall co-op experience, contributing to both personal growth and professional preparedness.

At the University of Detroit Mercy, cooperative education is important in shaping students into professional engineers. To graduate, students must complete three co-op assignments, providing them with opportunities to explore careers across diverse industries and companies of varying sizes. This raises two key questions: What specific skills and practices do students cultivate during their co-op employment? And how do these align with the ABET learning outcomes for engineering and computer science?

The Accreditation Board for Engineering and Technology (ABET) accreditation serves as a benchmark of quality for engineering and computer science programs worldwide. Central to ABET accreditation are the student outcomes, which define the specific skills, knowledge, and behaviors that graduates should possess. These outcomes encompass not only technical expertise but also important professional skills like communication, ethical reasoning, and the ability to function effectively on teams.

In today's competitive and globalized engineering landscape, employers are increasingly seeking graduates who not only excel academically but also demonstrate practical experience and professional competencies. Cooperative education (co-op) programs, which provide structured work experiences integrated with academic study, have come out as a vital component of engineering and computer science education. These programs offer students the opportunity to apply theoretical knowledge in real-world settings, develop professional networks, and enhance their employability upon graduation.

While research suggests that co-op experiences enhance student learning and professional development, there is a need for a more nuanced understanding of the distinct contributions of co-op and classroom experiences to the attainment of ABET student outcomes. Specifically, it is important to investigate how different learning environments influence the development of both technical and professional skills. Furthermore, as educational institutions strive to optimize their curricula, understanding these dynamics can inform the allocation of resources and the design of programs that best prepare students for the demands of the engineering profession.

This research addresses this need by directly comparing student perceptions of how co-op and classroom learning shape their competence in key ABET areas. By utilizing a mixed-methods approach, we aim to provide a comprehensive analysis that captures both quantitative trends and qualitative insights. Our study is particularly relevant in today's rapidly evolving technological landscape, where adaptability, collaboration, and ethical decision-making are more critical than ever for engineering and computer science professionals.

The remainder of this paper is structured as follows: Section II outlines our research questions, guiding the focus of the study. Section III reviews the related literature on co-op education and its impact on student outcomes. Section IV describes our methodology, including data collection and analysis procedures. Section V presents the results and discusses their implications. Finally, Section VI concludes the paper and suggests directions for future research.

II. Research Questions

This study is guided by the following research questions:

1) How do engineering and computer science students attribute their self-perceived proficiency in ABET-defined communication skills to co-op experiences compared to classroom learning?
2) What is the perceived impact of co-op experiences versus classroom instruction on students' ethical reasoning and decision-making, as defined by ABET criteria?
3) How do students perceive the relative contribution of co-op and classroom experiences to their ability to function effectively in teams, including multidisciplinary teams, addressing the ABET teamwork outcome?
4) In what ways do students perceive that co-op experiences complement or reinforce classroom learning in achieving overall ABET student outcomes?

III. Related Work

Cooperative education has been recognized as one of the top ten achievements in engineering education during the 20th century [1]. Research indicates that co-op programs offer several benefits to students, including higher grades in courses emphasizing soft skills [2], [3], enhanced self-efficacy and student retention [4], and increased starting salaries [5]. Additionally, factors such as socialization, mentorship, and a positive work environment have been shown to significantly influence student well-being and development [6].

IV. Methodology

Drawing from Watson and Schomaker's [7] framework for co-op assessment, we used a mixed-methods approach. Our study diverged from traditional evaluation methods by emphasizing student perspectives rather than employer assessments.

A. Participants

We recruited participants from a mid-sized private university in the Midwest. The sample included 47 engineering and computer science students who had completed at least one co-op rotation.

B. Data Collection

The quantitative instrument adapted validated scales from Parsons et al. [6], measuring workplace well-being and ABET competency development. Students rated experiences using 5-point Likert scales (1="strongly disagree" to 5="strongly agree").

C. Data Analysis

Survey responses were compiled and analyzed to create rankings of ABET outcomes across different learning environments. Results were segmented by program to identify discipline-specific patterns in how students valued co-op versus classroom experiences.

V. Results and Discussion

The survey data revealed patterns in student development through co-op experiences. Students reported benefits in areas of professional development and skill acquisition. These findings align with previous research that has shown co-op experiences enhance self-efficacy [4] and can lead to increased starting salaries [5].

The interview data revealed specific impacts on student development. Students consistently reported that co-op supervisor mentoring and organizational structure helped build confidence in ways distinct from classroom projects. This aligns with Reisberg et al.'s [4] findings on self-efficacy development through co-op experiences.

Students also frequently noted compensation benefits, with many indicating that practical experience from co-op directly influenced starting salary offers.

A. Quantitative Findings

The survey results revealed notable differences between co-op and classroom experiences in students' self-assessed competencies across several ABET outcomes. Co-op experiences showed higher peak ratings in professional responsibility (4.64 vs 4.25) and interdisciplinary teamwork (4.45 vs 4.33). Written communication skills peaked higher in coursework (4.50 vs 4.21), while oral communication showed equal peak ratings in both environments (4.36). These findings suggest that different learning environments may contribute distinctly to various professional competencies. This can be seen in Table I.

Analysis indicated a positive relationship between the number of co-op rotations completed and proficiency in communication and teamwork skills. These findings suggest that the extent of co-op experience is associated with higher development in certain professional competencies.

Analysis of the survey data revealed several key trends across co-op rotations:

- Communication skills showed consistent improvement with increased co-op experience, with students who completed 3+ rotations rating the importance of communication to co-op success highest (4.50/5.0) compared to those with one rotation (4.25/5.0).
- Written communication skills development showed steady progression through co-op experiences (from 3.83 for first rotation to 4.07 for 3+ rotations), while oral communication improvements were more pronounced (3.92 to 4.36).
- Interdisciplinary teamwork capabilities peaked during second rotations (4.45/5.0) before slightly decreasing in subsequent rotations (4.29/5.0), suggesting optimal timing for cross-functional exposure.

- Professional responsibility scores were notably high across all co-op experiences, with the highest ratings for students with 2 rotations (4.64/5.0) in nurturing professional responsibility.

The figures demonstrate program-specific variations in ABET outcome attainment. For instance, Figure 7 and Figure 8 illustrate the stark contrast in Computer Science students' perceived development of communication skills between classroom (3.8/5.0) and co-op environments (4.3/5.0).

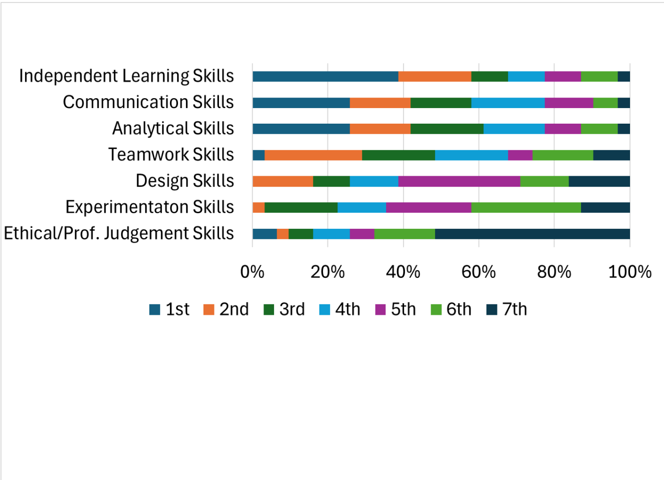

Fig. 1. Rank ordering of ABET outcomes as a measure of success in college courses

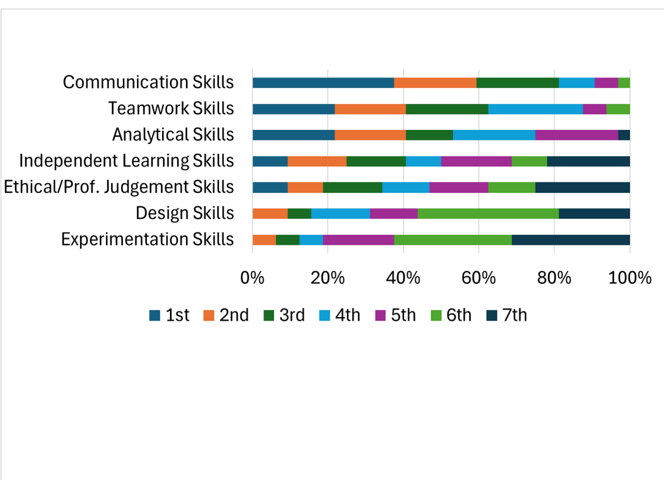

Fig. 2. Rank ordering of ABET outcomes as a measure of success in co-op employment

B. Qualitative Insights

The qualitative data provided rich contextual details explaining the quantitative trends. Students described how co-op experiences offered opportunities to engage in real-world projects requiring effective communication with team members, supervisors, and clients. One Computer Science student emphasized this importance: "Communication has been vital in my development as a computer scientist. In my classes and co-op experience, the first step of any project calls for clear, concise communication... knowing these requirements is essential for getting the project done the way that it is being requested as well as finishing it in a timely manner." This perspective aligns with our quantitative findings showing the critical role of communication skills in professional development.

The same student provided a concrete example highlighting the intersection of technical expertise and ethical decision-making during their co-op: "We were recommended to dress up the results and only showcase the best of them without much regard for the worst cases. Our co-op team thought this was a disingenuous practice, so we agreed to keep disclaimers on the best and worst case performance of our project." This experience exemplifies how co-op rotations provide unique opportunities for students to apply ethical reasoning in real-world contexts, supporting our quantitative data showing higher peak ratings in professional responsibility during co-op experiences (4.64/5.0) compared to classroom settings (4.25/5.0).

Regarding the complementarity of learning environments, the student noted: "I think classroom learning is necessary to establish a basis of knowledge, but to really understand the knowledge one must practice it." This observation reinforces our quantitative findings about the distinct yet complementary roles of classroom and co-op experiences in student development.

The exposure to diverse teams and necessity to collaborate with professionals from various disciplines appeared as key themes. Students highlighted the importance of teamwork in accomplishing project goals and the development of interpersonal skills not typically emphasized in classroom settings. As one student reflected on their co-op experience: "You learn those workplace conventions, whatever it may be in your field (for us it was progress meetings on teams and organizing tasks)."

C. Complementarity of Co-op and Classroom Learning

Students consistently reported that co-op experiences complemented their classroom learning by providing practical applications of theoretical concepts. This dynamic between co-op and classroom experiences reinforces the idea that both environments are essential for integrative student development. While the classroom provides the foundational knowledge and critical thinking skills, co-op adds depth by allowing students to apply, test, and refine these skills in professional contexts.

D. Implications for Engineering Education

The findings have important implications for engineering and computer science education. The significant impact of co-op experiences on communication, teamwork, and ethical reasoning highlights the need to integrate experiential learning opportunities into the curriculum. Educational institutions might consider expanding co-op programs, creating partnerships with industry, and incorporating project-based learning to simulate real-world challenges.

Moreover, the data suggest that co-op experiences are particularly effective in developing professional competencies that are increasingly valued in the engineering workforce. Educators should aim to create learning environments that nurture these skills, guaranteeing that graduates are not only technically proficient but also equipped to navigate the complexities of modern engineering practice.

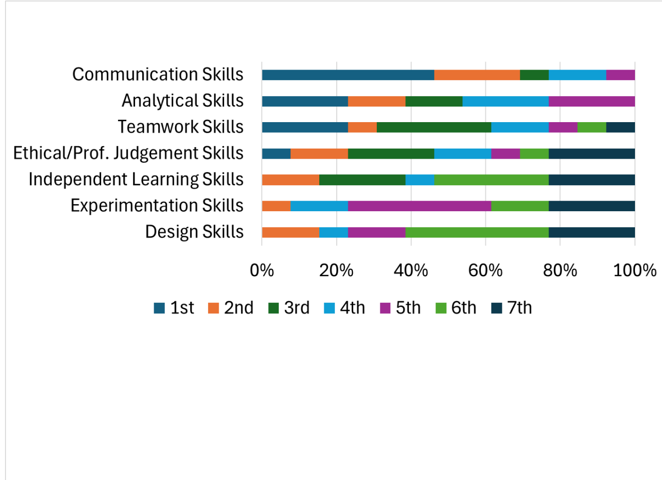

Fig. 4. Rank ordering of ABET outcomes as a measure of success in co-op employment (ME Students)

E. Program-Specific Patterns

Analysis revealed distinct patterns across disciplines. As noted in previous research [6], factors such as socialization, mentorship, and a positive work environment significantly influence student development. Our findings support this observation across different engineering disciplines.

The academic impact varied by program. While all disciplines showed improvements in professional skills, the extent and nature of these improvements differed across engineering and computer science programs, as shown in Figures 1 through 10.

1) Mechanical Engineering: Our analysis reveals interesting variations in how students from different programs perceive the impact of co-op and classroom experiences. Mechanical Engineering students showed particularly strong emphasis on technical problem-solving skills in both environments, while also rating communication skills highly in co-op settings.

2) Civil and Architectural Engineering: Civil and Architectural Engineering students demonstrated a notably different pattern, with stronger emphasis on team-based skills and project management in their co-op experiences.

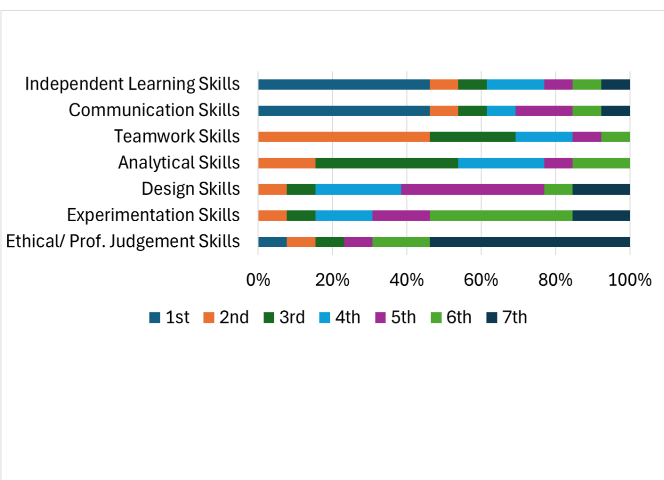

Fig. 3. Rank ordering of ABET outcomes as a measure of success in college courses (ME Students)

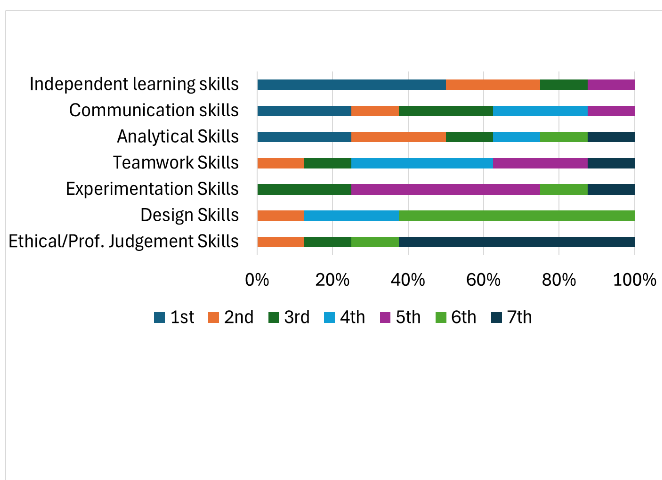

Fig. 5. Rank ordering of ABET outcomes as a measure of success in college courses (CE/AE Students)

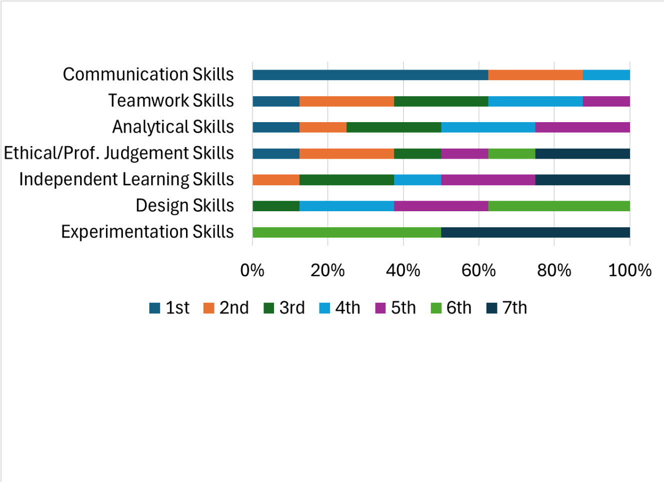

Fig. 6. Rank ordering of ABET outcomes as a measure of success in co-op employment (CE/AE Students)

3) Computer Science: Computer Science students showed the most dramatic difference between classroom and co-op experiences, particularly in the areas of communication and interdisciplinary collaboration.

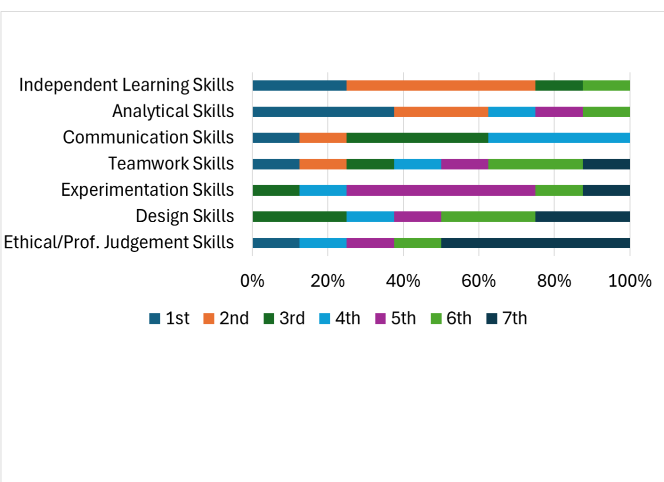

Fig. 7. Rank ordering of ABET outcomes as a measure of success in college courses (CS Students)

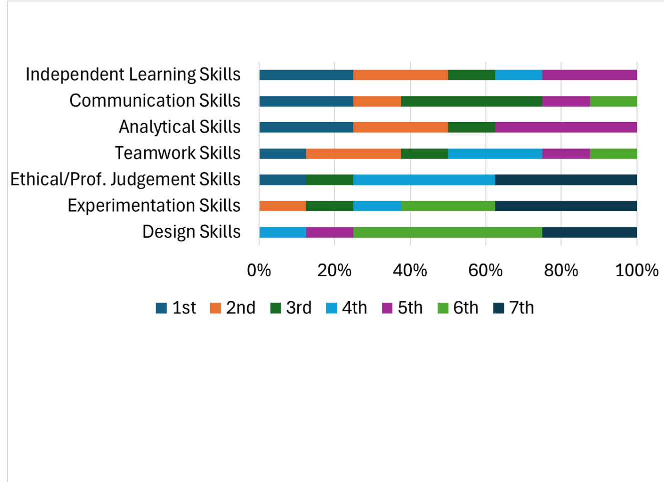

Fig. 8. Rank ordering of ABET outcomes as a measure of success in co-op employment (CS Students)

4) Electrical Engineering and Robotics: Electrical Engineering and Robotics students demonstrated a balanced distribution of competencies across both environments, with slightly higher emphasis on technical skills in classroom settings and professional skills in co-op experiences.

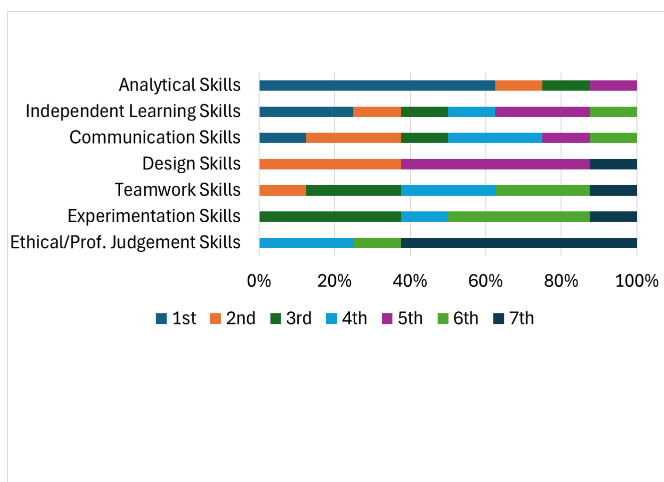

Fig. 9. Rank ordering of ABET outcomes as a measure of success in college courses (EE/RMSE Students)

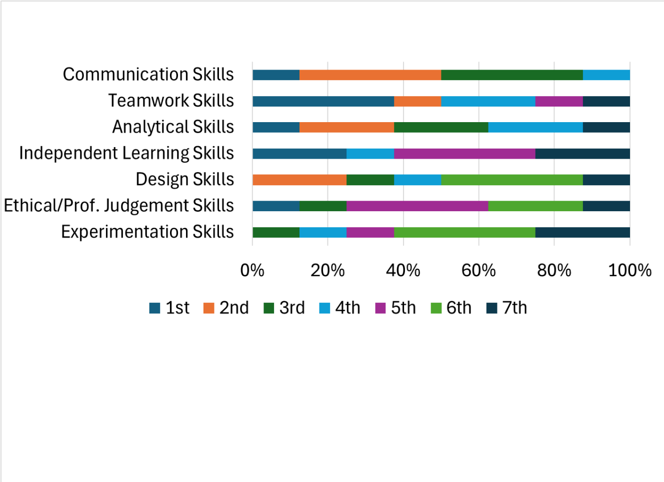

Fig. 10. Rank ordering of ABET outcomes as a measure of success in co-op employment (EE/RMSE Students)

F. Longitudinal Development Patterns

Analysis of student development across multiple co-op rotations revealed distinct patterns in professional competency development:

- **Communication Development:** Students showed marked improvement in both written and oral communication:
  - Initial self-reported communication ease was relatively low (3.35/5.0)
  - By third rotation, oral communication skills increased significantly (4.36/5.0)
  - Written communication showed steady but more modest gains (4.21/5.0 by third rotation)
- **Teamwork Evolution:**
  - Initial teamwork preference was moderate (3.22/5.0 for pre-college experience)
  - Intradisciplinary teamwork peaked in second rotation (4.64/5.0)
  - Final rotation showed balanced competency in both intra- and interdisciplinary collaboration (4.50/5.0 and 4.29/5.0 respectively)
- **Professional Responsibility:**
  - Base ethical awareness was relatively high (4.15/5.0)
  - Professional responsibility showed strongest growth in co-op settings (4.57/5.0 by third rotation)
  - College courses maintained consistent but lower impact (4.07/5.0 final rating)

G. Cross-Environment Comparison

The data reveals distinct patterns in how different learning environments contribute to ABET outcome development:

TABLE I
COMPARATIVE IMPACT OF LEARNING ENVIRONMENTS

Competency Area	**Co-op Peak**	**Course Peak**
Written Communication	4.21	4.50
Oral Communication	4.36	4.36
Interdisciplinary Teamwork	4.45	4.33
Professional Responsibility	4.64	4.25

This comparison demonstrates that while both environments contribute significantly to student development, co-op experiences generally show higher peak ratings in professional skills development, particularly in areas requiring practical application such as teamwork and professional responsibility. However, traditional coursework maintains competitive advantages in structured skill development, especially in written communication.

VI. CONCLUSION

This study provides a comprehensive analysis of the impact of co-op education on ABET student outcomes, offering valuable insights for educators, administrators, and students alike. By comparing the perceived contributions of co-op and classroom learning, we gain a deeper understanding of how these experiences interact to shape student development.

The results indicate that co-op experiences significantly enhance students' communication skills, teamwork abilities, and ethical reasoning, while classroom learning remains important for developing technical knowledge and problem-solving skills. The complementariness of these learning environments suggests that integrating co-op programs with traditional curricula can produce well-rounded graduates who are prepared for the demands of the engineering profession.

The findings are expected to inform best practices for integrating experiential learning into engineering and computer science curricula, ultimately leading to better-prepared graduates who possess both the technical expertise and professional skills necessary to thrive in the 21st-century workforce.

While this study provides valuable insights, it is important to acknowledge its limitations. The sample was drawn from a single institution, which may limit the generalizability of the findings. Future research could expand the scope to include multiple universities with diverse co-op programs. Additionally, longitudinal studies tracking students' development over time and into their professional careers would provide deeper understanding of the long-term impact of co-op experiences.

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