# AC 2008-154: THE ACADEMIC VALUE OF COOPERATIVE EDUCATION: A LITERATURE REVIEW

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# The Academic Value of Cooperative Education: A Literature Review


## Abstract

Cooperative education began as an experiential education program for engineering students at the University of Cincinnati in 1906 and remains a key component of many engineering programs nationwide[1]. Cooperative education provides opportunities for students to engage in experiential education, integrating academic course work with practical work experience. While many sources have commented on the affective benefits of cooperative education, this paper examines the literature to assess the academic value of cooperative education.


## Faculty, Student and Employer Views on Cooperative Education

Relatively little is known about how engineering faculty value, account for, and integrate cooperative education based learning within their teaching practices. Contomanolis[2] conducted a study of engineering faculty at the six largest engineering cooperative education programs in the United States (Georgia Institute of Technology, Kettering University, Drexel University, University of Cincinnati, Rochester Institute of Technology, and Northeastern University) to assess their views concerning the academic value of cooperative education and the extent to which they utilized teaching activities to incorporate student co-op experiences into the classroom learning environment. The survey instrument used in the study was a questionnaire that allowed faculty respondents to use a five-point Likert scale to report their attitudes on the academic value of cooperative education and the frequency to which they used seven classroom integration activities. The survey was distributed electronically to 836 faculty members and achieved a response rate of 24%.

The findings showed that the faculty expressed positive feelings about the academic value of cooperative education and co-op students' contributions to the classroom-teaching environment. This overall positive attitude is consistent with findings of other studies[3-5]. The majority of the respondents believed the following:

- Cooperative education work experience is a significant contributor to the student's overall academic success.
- The classroom learning environment is enhanced by the presence of students with cooperative education experience.
- Students often make contributions to classroom discussions based upon their co-op work experiences.
- Students are better prepared to understand the course material presented in class as a result of their co-op experience.
- Co-op students ask more relevant and sophisticated questions in the classroom than do non co-op students.
- Co-op students are more motivated to perform well in the classroom than non co-op students as a result of their co-op experience.

Contomanolis also concluded that a positive faculty attitude about the academic value of cooperative education did not translate into extensive use of classroom integration activities identified in his study. However, about 51.8% of the faculty respondents agreed that it was their responsibility as faculty members to find a way to relate coop experiences into classroom learning. These data suggest a mismatch between faculty members' attitudes about the utility of cooperative education and their level classroom activities in leveraging cooperative education experiences. While they believe cooperative education is a significant part of students' academic development, they do not actively incorporate cooperative education experiences into their teaching practices.

In another study[6], a team within the College of Engineering at Iowa State University, in conjunction with constituents and assessment professionals, identified 14 workplace competencies that could be assessed in order to demonstrate students' levels of attainment of the ABET (3a-k) student learning outcomes. Constituent involvement included representation from employers, engineering faculty, staff, administrators, alumni, students who participated in cooperative education, parents, and international faculty from partnering institutions. As part of the validation survey, constituents assessed the probability that a student would have the opportunity to develop and demonstrate the competency in various settings. The identified settings were the following:

- Full-time engineering workplace.
- Cooperative education/internship workplace.
- Traditional classroom.
- Classroom laboratory.
- Classroom capstone design.
- Extracurricular activities (engineering profession related).
- Extracurricular activities (non-engineering profession related).

The engineering workplace ranked the highest as the best setting to develop and demonstrate the competencies, followed by cooperative education/internships. The traditional classroom setting consistently ranked last. According to the constituents, engineering students spend the majority of their academic experiences in the classroom, the least likely place to develop the skills, attitudes and behaviors necessary to be successful engineers.

Very few of the studies reviewed focused on engineering students' perceptions of industrial internships. However, students' self perceptions of their skills and abilities, a concept called "self-efficacy," are a critical aspect of their ability to perform in a given situation [7]. An unpublished work by researchers at the Cambridge-MIT Institute studied how cooperative educational programs affected the self-efficacy of engineering students[8] and found that cooperative educational programs exerted a positive influence on students' self-efficacy.

**Academic and Labor Market Outcomes of Cooperative Education**

Studies have been done to investigate the positive academic and labor market outcomes resulting from cooperative educational experiences in engineering disciplines. As examples, both Gardner *et. al.*[9] and Lindenmeyer[10] found engineering majors with co-op experience earned higher cumulative grade point averages (GPAs) than engineering majors without that experience. The quantity of cooperative educational experience was also found to be positively correlated with

salary[9]. Researchers at Mississippi State University[1] performed a statistical analysis of the effects of cooperative education on grade point average, length of time in school, and starting salary. Their results showed that, compared to students who do not participate in cooperative education, students who completed the three-semester cooperative education program maintained higher grade point averages and earned higher starting salaries. Furthermore, Wessels and Pumphrey[11] found that cooperative education decreased job search time and positively influenced the likelihood of promotion and advancement once employed.

**Relationship between ABET Outcomes and Cooperative Education**

Engineering programs in the United States are shifting from an 'input' (what is taught) to an 'outcomes' (what is learned) educational paradigm. Success is now based on how well students achieve desired learning outcomes, not solely on whether they have completed required course work. Many engineering programs have adopted the ABET 3(a-k) Outcomes[12]. According to ABET, engineering programs must demonstrate that their students attain:

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d) an ability to function on multi-disciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i) a recognition of the need for, and an ability to engage in life-long learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Eight of the eleven outcomes address 'an ability to,' two address 'understanding', and only one addresses 'knowledge.' The direct measurement of 'an ability to' presents challenges because it implies evaluating performance and/or application. In fact, there is no universal approach to implementing and assessing the ABET 3(a-k) Outcomes[6]. According to George Peterson, ABET executive director, "evaluating their outcomes are sophisticated activities with which most engineering educators have had little or no experience."[13]

A few studies[6, 14, 15] have investigated ways to assess ABET outcomes through cooperative-based education. As previously mentioned, one study identified workplace competencies and was able to link them to ABET 3(a-k) outcomes[6]. Another study[14] examined program efficacy of two internship programs based on the following three criteria: 1) student performance outcomes based on ABET criteria, 2) number of student participants and industry partners, and 3) industry-university collaboration. A comprehensive survey was developed based on 5-point Likert rating scale. The surveys were delivered to industry constituents by email and were also available in an online format. Of the 52 industry managers contacted, 40 responded to the survey, yielding a 77% response rate. The survey results indicated that industry managers were

extremely satisfied with the internship program, the interns, and the industry-university collaboration that it fosters. Industrial respondents also indicated they were satisfied with the academic preparation (92%) and the overall performance of the engineering interns (89.7%). Assessment also revealed that six of the ABET 3(a-k) outcomes were strengths reflected in the performance of co-op interns. Specifically, data analysis suggests that competencies a, c, d, f, g, and i were regarded as well attained by co-op students. However, competences h and j were regarded as less well attained by co-op students.

A formal survey of fifteen aerospace and defense companies concerning the perceived importance of 172 attributes related to the ABET 3(a-k) outcomes was conducted by the Industry-University-Government Roundtable for Enhancing Engineering Education (IUGREEE)[15]. The survey produced 420 voluntary responses from 15 of the 24 aerospace and defense-related companies in IUGREEE. The survey instrument listed 172 skills, knowledge descriptors, and experiences that were mapped into the ABET (3a-k) Outcomes. The respondents ranked in importance each of the 172 qualities that can be expected by engineering managers and engineers for BS entry-level engineers. The results can be used to implement curricular reform by providing an industrial viewpoint of critical outcomes to be achieved in undergraduate curricula.

## Curricular Reform to Integrate Cooperative Education

Research supports the observation that experiential engineering education programs provide the best place to directly observe and measure students developing and demonstrating engineering competencies. Moreover, experiential learning provides advantages to the employer, the academic institution, and to the student. Thus, experiential engineering education can and should be integral to the continuous curricular improvement process. The use of the classroom must be re-examined in educating future engineers, broadening the curriculum focus to include competency development. By interpreting the ABET 3(a-k) outcomes in terms of competencies, engineering curricula can be successfully reformed to incorporate competency-based learning. A study conducted by the Cambridge-MIT Institute[16] indicates that carefully structured work experiences play a greater role than previously thought in giving students the skills and confidence to become entrepreneurs—particularly if their work placements are aligned with their course content. More generally, a work placement will be of greater value if it gives students a chance to put into practice what they've learned in the classroom, and if the placement is longer, more structured, and better planned than that found in a "casual" placement such as a summer job. These results are consistent with more recent findings of the positive impact of cooperative education on student self-efficacy[17].

#### Acknowledgment

This work was partially supported with funds provided under National Science Foundation (NSF) grant HRD-0441207 which supported Dr. Baber as a Christine Mirzayan Science and Technology Policy Graduate Fellow at the National Academy of Engineering. The views expressed are those of the authors and do not necessarily reflect those of the NSF.

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