AC 2008-821: PRELIMINARY FINDINGS FROM A QUANTITATIVE STUDY: WHAT ARE STUDENTS LEARNING DURING COOPERATIVE EDUCATION EXPERIENCES?

Olga Pierrakos, James Madison University

OLGA PIERRAKOS is an Assistant Professor in the School of Engineering at James Madison University. Dr. Pierrakos holds a B.S. in Engineering Science and Mechanics, an M.S. in Engineering Mechanics, and a Ph.D. in Biomedical Engineering from Virginia Tech. Her research interests are cardiovascular fluid mechanics and engineering education research, which includes engineering assessment, undergraduate research, design education methodologies, epistemologies of interdisciplinary education, and K-12 engineering education.

Maura Borrego, Virginia Polytechnic Institute and State University

MAURA BORREGO is an assistant professor of Engineering Education at Virginia Tech. Dr. Borrego holds an M.S. and Ph.D. in Materials Science and Engineering from Stanford University. Her current research interests center around interdisciplinary collaboration in engineering and engineering education, including studies of the collaborative relationships between engineers and education researchers. Investigations of interdisciplinary graduate programs nationwide are funded through her NSF CAREER award.

Jenny Lo, Virginia Polytechnic Institute and State University

JENNY LO is an advanced instructor in the Department of Engineering Education at Virginia Tech. Dr. Lo is the co-coodinator of the first semester engineering course at Virginia Tech, and her research interests include undergraduate research, curriculum development and engineering ethics instruction.

Preliminary Findings from a Quantitative Study: What are Students Learning During Cooperative Education Experiences?

Abstract

Since most of our engineering students follow careers in industry, of particular importance is how cooperative experiences help to make better *engineers*. Although cooperative experiences are well-known to have many benefits to students and employers as well as have great potential for bringing active learning to the undergraduate level, there is limited empirical evidence of students' learning outcomes as a result of these experiences. Preliminary findings from a validated survey instrument, National Engineering Students' Learning Outcomes Survey (NESLOS), derived from ABET criteria, are presented. Key findings of what students learned and valued, insight into variations across female and male students, and student career path goals are presented. These findings can aid engineering departments, cooperative education professionals, career service offices at institutions, and industry representatives to improve co-op experiences and assessment efforts.

Introduction

Undergraduate engineering students who participate in cooperative (co-op) experiences can benefit greatly from their industrial work experience. Co-ops not only provide a meaningful experience for engineering students, but also create an opportunity for them to begin the process of workplace adaptation. Participation in co-op experiences also deepens a student's understanding of the profession and promotes the communication and teamwork needed to solve complex problems. Other well-known benefits of co-op students include: (a) gaining real-world experience in an engineering professional environment, (b) having the opportunity to apply skills and knowledge learned in the classroom to real-world problems, (c) working with state-of-the-art processes, equipment, and tools, (d) learning how to work in teams in a professional atmosphere and adapt to different employment situations, (e) developing self-confidence and a positive attitude about future career options, and (f) improving their opportunities for post-graduation jobs. The success that cooperative education has enjoyed over many years indicates that employers can also benefit from the arrangement by hiring high-performance individuals.

Although some studies have looked into the overall positive impact (such as earnings and grade point average) of co-op experiences [1-2], the bodies-of-knowledge and learning outcomes comprising the countless ways in which students benefit from being involved in cooperative education have been insufficient and understudied. Another set of problems involves perceptions of the field and its marginalization, because of its "vocational" association, portraying co-op experiences as not always academically legitimate. Rather, it is often viewed as taking time away from the classroom [3]. So, despite the current emphasis on contextual learning, co-op experiences are not always recognized as a vehicle for learning.

Since engineering disciplines are so closely aligned with industry as a customer for our graduates, engineering educators are ideally positioned to lead contributions to the assessment of cooperative education literature. ABET accreditation criteria provide the link between industry needs, learning outcomes, and legitimate academic faculty scholarship [4-5]. It is time for cooperative education to develop and define its body of knowledge, investigate its unique phenomena-e.g., the concept of learning from experience, as well as clarify and strengthen the qualifications of cooperative education practitioners.

The purpose of this research is to focus on the learning outcomes and skills gained by engineering students as a result of co-op experiences. The specific **research questions** guiding this effort are:

1) What are engineering students' learning outcomes and skill gains as a result of participating in co-op experiences?
2) What variations (positive and negative) are discernable in the learning outcomes of male and female students participating in co-op experiences?

Herein, we employed a survey instrument, National Engineering Students' Learning Outcomes Survey (NESLOS), derived from ABET criteria and extensive literature review, to assess students' learning outcomes as a result of participating in a co-op experience. Survey item emphasis was placed on assessing knowledge and skills pertaining to but not limited to: (1) problem-solving, (2) writing and communication skills, (3) understanding and applying knowledge, (4) teamwork, (5) confidence gains, (6) organization and management skills, and (7) interest and engagement of project. In this paper, we present key findings of what students learned and valued, insight into variations across female and male students, student career path goals, etc. The strength of the research design plan is that the results can be generalized and can be replicated across scientific disciplines and institutions. Findings can aid engineering departments, career service centers at institutions, and industry representatives to improve their co-op experiences and assessment efforts. Also, this will aid cooperative education professionals to more effectively market the benefits of co-op experiences internally to university personnel and externally to employers.

Methodology - Development and Administration of NESLOS

ABET criteria 3a-k challenges engineering institutions to produce graduates with professional as well as technical skills by outlining the desired attributes for graduating engineers. With this in mind, the development of the NESLOS was guided by ABET's "3a through k" criteria which state that: "engineering programs must demonstrate that their graduates have:

(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,
(d) an ability to function on multidisciplinary 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 and societal context,
(i) a recognition of the need for, and ability to engage in, lifelong learning,
(j) a knowledge of contemporary issues;
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.[6]"

Moreover, according to a recent NAE CASEE report, rigorous literature search revealed that the engineering education community desires four additional student outcomes [7]. Based on this report, an engineering graduate should also be able to demonstrate:

(l) an ability to manage a project, including a familiarity with business, market-related, and financial matters,
(m) a multidisciplinary systems perspective,
(n) an understanding of and appreciation for the diversity of students, faculty, staff, colleagues, and customers, and
(o) a strong work ethic.

Based on these fifteen learning outcomes, review of the literature and ABET-related sources, a survey instrument (NESLOS) was developed and included:

(a) about thirty technical learning outcomes closely linked to the ABET criteria,
(b) roughly twenty personal and professional learning outcomes pertaining to knowledge, skills, and interpersonal gains,
(c) several open-ended questions about the strengths and weaknesses of the co-op experience, and
(d) general questions about the team, demographics, etc.

More details about NESLOS, including a list of some of the outcomes, are included in a previous ASEE publication, in which NESLOS was employed to assess students' learning outcomes during capstone design projects [8]. Most of the NESLOS items were based on a 5-point Likert scale. Item analysis and survey validation procedures revealed good reliability indexes (Cronbach's alpha coefficients) varying from 0.60 to 0.90. This study took place at a research university, where students were administered a computer-based version of NESLOS at the end of their co-op or internship experience. The survey instruments and administration were approved by the Institutional Review Board (IRB) of the Office of Research Compliance.

Participant Demographics

In this section, participant demographics are discussed. In collaboration with the Career Services Office of the institution to recruit participants, sixty students (corresponding to a 40% response rate) participated in this study. Table 1 shows a break-down of the students' demographics in terms of engineering discipline, ethnicity, gender, and academic level. As can be seen, the majority of the participants were mechanical engineering students (42%), and this was expected considering the departmental culture which fosters industry experience. Furthermore, 11% and 10% were chemical engineering and computer science students. As for ethnicity, the majority of the participants were Caucasian (78%), followed by 9% Asian/Asian-American, and 8% minority students (includes African-Americans, Native American, Pacific Islander, and Hispanic). The percentage of female and male students was respectively 21% and 79% (typical of undergraduate engineering). Students' academic level was also assessed and it was found that 64% of the students were rising seniors, followed by 20% rising juniors, 14% BS graduates, and only 2% rising sophomores. It is also important to keep in mind that all participants were paid during these experiences and about 15% of them received some type of course credit. Additionally, about 55% of the students had prior industry experience.

Table 1: Student demographics in terms of discipline, ethnicity, gender, and academic level.

NESLOS Question	NESLOS Response	Percentage
What is your engineering discipline?	Aerospace Engineering	5%
	Civil Engineering	8%
	Chemical Engineering	11%
	Computer Engineering	3%
	Computer Science	10%
	Electrical Engineering	8%
	Industrial Systems Engineering	8%
	Mechanical Engineering	42%
	Other	5%
What is your ethnicity?	African American	3%
	American Indian, Native American, or Alaskan Native	2%
	Asian or Asian American	9%
	Hawaiian or Pacific Islander	2%
	European American/Caucasian	78%
	Mexican or Mexican American	0%
	Hispanic or Latino American	2%
	Other	5%
What is your gender?	Female	21%
	Male	79%
What is your current academic level?	Rising Sophomore	2%
	Rising Junior	20%
	Rising Senior	64%
	BS Graduate	14%

Results

Key findings and results from NESLOS are presented in this section. More specifically, we present students' high and low rated outcomes as well as high and low ranked outcomes based on gender.

Overall Ratings of Learning Outcomes

Tables 2 and 3 present the fifteen high-rated and fifteen low-rated outcomes. In asking the students "how helpful their most recent co-op/internship experience was in enabling them to achieve each of the learning outcomes or skills," the percentages shown correspond to the students that rated the outcome with a 4 (helpful) and a 5 (very helpful). Starting with Table 2, we observe that the high rated technical outcomes that students gained during the co-op experience pertained to: identifying problems for which there are engineering solutions, identifying and establishing design requirements and constraints, understanding assumptions needed to solve your engineering problem, formulating a range of solutions, analyze and interpret data using evidence to draw conclusions or make recommendations, applying basic scientific and engineering principles to analyze processes and systems, as well as analyzing and interpreting data.

Table 2 also shows the more professional and personal outcomes that students highly rated as having gained during the industry experience. Some of these outcomes include: communicating effectively with others, gaining confidence, taking new opportunities for intellectual growth or professional development, recognizing the need for lifelong learning, recognizing the need to consult an expert, and improving organizational skills. Two other important outcomes that were highly rated pertained to "knowing what you *want* to after graduation" and "knowing what you *need* to do after graduation." These two outcomes illustrate how the industry experience allowed many students to either clarify or validate their career goals after graduation.

Table 2: List of fifteen highest ranked learning outcomes. Ranking is based on the percentage of respondents who rated the outcome with 4 and 5. (Ranking listings shown are from high to low.)

High Ranked Learning Outcomes	Percent
Use evidence to draw conclusions or make recommendations	94.8%
Know what you want to do after graduation (get a job, go to graduate school, etc.)	94.7%
Formulate a range of solutions to your engineering problem	91.4%
Identify and define problems for which there are engineering solutions	91.4%
Communicate effectively with others	91.2%
Gain confidence in myself	91.1%
Take new opportunities for intellectual growth or professional development	91.1%
Apply basic scientific and engineering principles to analyze the performance of processes and systems	89.5%
Recognize the need for lifelong learning	89.5%
Recognize the need to consult an expert from a discipline other than my own when working on a project	88.1%
Know what you need to do to attain the goals you have for after graduation	87.7%
Identify and establish design requirements and constraints	86.4%
Understand assumptions needed to be made to solve your engineering design problem	86.2%
Improve organizational skills	86.0%
Analyze and interpret data	86.0%

As important as it is to present the learning outcomes that were most valued by the co-op students, it is also important to present the least rated outcomes because it is from this list that we can assess what changes should be made in order to improve the experience and the learning. Table 3 shows the outcomes that were ranked low. From this list, the technical outcomes that were rated low include: following and creating a timeline when managing a project, applying engineering tools, identifying potential ethical issues and understanding ethical responsibility, understanding societal and global impact, recognizing contemporary issues, and designing an experiment. As for the professional and personal outcomes, the following were ranked low:

applying interpersonal skills in managing people, gaining leadership skills, managing the planning and organization of project tasks, and conveying ideas verbally and in formal presentations.

Table 3: List of fifteen lowest ranked learning outcomes. Ranking is based on the percentage of respondents who rated the outcome with 4 and 5. (Ranking listings shown are from low to high.)

Low Ranked Learning Outcomes	Percent
Follow a timeline when managing a project	52.3%
Create a budget when managing a project	53.3%
Apply engineering tools (e.g., software, lathes, oscilloscopes) in engineering practice	65.1%
Identify potential ethical issues and dilemmas in your design project	68.6%
Understand the impact of your engineering design/solution in a societal and global context	69.8%
Design an experiment	70.8%
Apply interpersonal skills in managing people	70.8%
Gain strong leadership skills	71.9%
Manage planning and organization of project tasks and processes	73.2%
Effectively manage conflicts that arise when working on teams	74.1%
Understand the ethical responsibility associated with the engineering profession	74.5%
I developed more awareness of social problems because of this experience	75.4%
Gain leadership skills in managing team members and project tasks	76.5%
Recognize contemporary engineering and scientific issues	76.8%
Convey ideas verbally and in formal presentations	76.8%

Additional skills and learning outcomes that students gained during the industry experience were measured in the form of an open-ended question in NESLOS. Responses to this question included the following: networking with peers, learning how to deal with authority, learning motivational skills and persistence, understanding the differences between the school settings and work settings, knowing how to ask the right questions, understanding the climate of the workplace, learning about team dynamics and professionalism.

High and Low Ranked Outcomes Based on Gender

In this section, we present high and low ranked outcomes for female and male students. Tables 4 and 5 respectively show the top fifteen ranked outcomes and lowest fifteen ranked outcomes for male and female students. Similar to the prior tables, the rankings are based on the percentage of respondents that selected 4 and 5 as the rating. The shading in these tables illustrates the outcomes that are common to both groups. Starting with the fifteen top-ranked outcomes (Table 4), we observe that 10 of the 15 outcomes (corresponding to 67% of the outcomes) are common to both groups. Differences arise in male students ranking to following highly: communicating effectively with others, recognizing the need for lifelong learning, recognizing the need to consult an expert, understanding assumptions needed to solve problems, and applying technical codes and standards. Whereas, female students rated the following highly: improve organizational skills, set and pursue my own learning goals, improve work ethic, recognize the need for diverse perspectives in solving engineering/scientific problems, reaching beyond myself (challenging myself to new limits). From these ten outcomes (the ones not shaded in Table 4), the ones that show statistically significant differences (**p<0.05, chi-square test and t-test analysis) in the ratings of male and female students are:

- set and pursue my own learning goals (Male: 74%, Female: 100%, 26% difference, **)
- improve organizational skills (Male: 80%, Female: 100%, 20% difference, **)
- reach beyond myself (Male: 78%, Female: 92%, 14% difference, **)
- improve work ethic (Male: 80%, Female: 92%, 12% difference, **)
- recognize the need for diverse perspectives
  (Male: 80%, Female: 92%, 12% difference, **)

Table 5 lists the lowest ranked outcomes for male and female students. Eighty percent of these fifteen outcomes are common to both groups. Differences arise in male students ranking the following outcomes low: understanding the impact of your engineering solution in a societal and global context, gaining strong leadership skills, and generating multiple design concept alternatives. The female students ranked the following low: using feedback from an experiment to improve solutions, conveying technical ideas in formal writing and other documentation, as well as using and referencing engineering and scientific documents. From these six outcomes (the ones not shaded in Table 5), the ones that show statistically significant differences (**p<0.05, chi-square test and t-test analysis) in the ratings of male and female students are:

- gain strong leadership skills (Male: 65%, Female: 92%, 27% difference, **)
- understand the impact of your engineering solution in a societal and global context skills
  (Male: 59%, Female: 83%, 24% difference, **)
- use feedback from an experiment to improve solutions to an engineering problem
  (Male: 76%, Female: 58%, 18% difference, **)
- convey technical ideas in formal writing and other documentation
  (Male: 80%, Female: 67%, 13% difference, **)

Table 4: List of fifteen highest rated learning outcomes for male and female students. Percentages shown correspond to respondents who rated the outcome with 4 and 5. **Outcomes that are common to both groups are shaded.

High Rated Learning Outcomes – Male Students		High Rated Learning Outcomes – Female Students	
Use evidence to draw conclusions or make recommendations	93.5%	Know what you want to do after graduation (get a job, go to graduate school, etc.)	100%
Know what you want to do after graduation (get a job, go to graduate school, etc.)	91.3%	Apply basic scientific and engineering principles to analyze the performance of processes and systems	100%
Formulate a range of solutions to your engineering design problem	89.1%	Know what you need to do to attain the goals you have for after graduation	100%
Identify and define problems for which there are engineering solutions	89.1%	Improve organizational skills	100%
Communicate effectively with others	89.1%	Set and pursue my own learning goals	100%
Recognize the need for life-long learning	89.1%	Use evidence to draw conclusions or make recommendations	91.7%
Recognize the need to consult an expert from a discipline other than my own when working on a project	87.0%	Formulate a range of solutions to your engineering design problem	91.7%
Gain confidence in myself	87.0%	Identify and define problems for which there are engineering solutions	91.7%
Take new opportunities for intellectual growth or professional development	87.0%	Gain confidence in myself	91.7%
Identify and establish design requirements and constraints	84.8%	Take new opportunities for intellectual growth or professional development	91.7%
Understand assumptions needed to be made to solve problems	84. 8%	Identify and establish design requirements and constraints	91.7%
Apply basic scientific and engineering principles to analyze the performance of processes and systems	82.6%	Value the diversity of a team (students, faculty, customers, etc.) leading to diverse talents and ways of thinking	91.7%
Know what you need to do to attain the goals you have for after graduation	82.6%	Improve work ethic	91.7%
Value the diversity of a team (students, faculty, customers, etc.) leading to diverse talents and ways of thinking	82.6%	Recognize the need for diverse perspectives in solving engineering/scientific problems	91.7%
Apply technical codes and standards	82.6%	Reach beyond myself (challenge myself to new limits)	91.7%

Table 5: List of fifteen lowest rated learning outcomes for male and female students. Percentages shown correspond to respondents who rated the outcome with a 4 and a 5. **Outcomes that are common to both groups are shaded.

Low Rated Learning Outcomes – Male Students		Low Rated Learning Outcomes – Female Students	
Follow a timeline when managing a project	43.5%	Create a budget when managing a project	25.0%
Create a budget when managing a project	45.7%	Follow a timeline when managing a project	25.0%
Apply engineering tools (e.g., software, lathes, oscilloscopes) in engineering practice	50.0%	Conduct (or simulate) an experiment	41.7%
Apply interpersonal skills in managing people	56.5%	Apply engineering tools (e.g., software, lathes, oscilloscopes) in engineering practice	41.7%
Understand the impact of your engineering solution in a societal and global context	58.7%	Design an experiment	50.0%
Design an experiment	60.9%	Use feedback from an experiment to improve solutions to an engineering problem	58.3%
Identify potential ethical issues and dilemmas in your design project	60.9%	Identify potential ethical issues and dilemmas in your design project	58.3%
Understand the ethical responsibility associated with the engineering profession and also your design project	65.2%	Understand the ethical responsibility associated with the engineering profession and also your design project	66.7%
Gain strong leadership skills	65.2%	Convey technical ideas in formal writing and other documentation	66.7%
Gain leadership skills in managing team members and project tasks	67.4%	Effectively manage conflicts that arise when working on teams	66.7%
Generate multiple design concept alternatives	69.6%	Gain leadership skills in managing team members and project tasks	66.7%
Effectively manage conflicts that arise when working on teams	69.6%	Apply interpersonal skills in managing people	66.7%
Manage planning and organization of project tasks and processes	69.6%	Use and reference engineering and scientific textbooks, journal papers, and other documents	75.0%
Conduct (or simulate) an experiment	71.7%	Recognize contemporary engineering and scientific issues	75.0%
Recognize contemporary engineering and scientific issues	71.7%	Manage planning and organization of project tasks and processes	75.0%

Future Career Path

Part of NESLOS was the assessment of participants' plans after graduation. The following table summarizes the results from the NESLOS question "What are your plans after graduation?" and presents overall responses as well as responses for female and male participants separately. Students were also asked to rate how well they agree with the following statements: "I am considering to pursue a Master's degree" and "I am considering to pursue a Ph.D." About 59% of the participants "agreed" and "strongly agreed" that they are considering a M.S. degree and 24% that they are considering a Ph.D. degree. When students were asked to rate how well they agreed with the following statement - "I am in interested in continuing to work in this subject area" – 60% of the participants "agreed" and "strongly agreed" with the statement.

Table 6: Summary of responses for participants' plans after graduation.

What are your plans after graduation?	Overall %	Gender %	
		Male	Female
Industry - In an engineering/scientific occupation	67%	65%	71%
Industry - Outside an engineering/scientific occupation	2%	2%	0%
Graduate School - In an engineering/scientific discipline	23%	21%	29%
Graduate School - Outside an engineering/scientific discipline	4%	5%	0%
Other	5%	7%	0%
TOTAL	100%	100%	100%

Overall Experience Ratings

Overall, students highly valued their industry experience. When asked to rate how well they agreed with the following statements - "overall, I am satisfied with my project/experience" – 93% of the participants "agreed" and "strongly agreed" with the statement. Similarly, when asked to rate how well they agreed with "overall, the experience is a valuable learning experience," 96% of the participants "agreed" and "strongly agreed" with the statement.

Discussion and Conclusions

In this paper, we presented preliminary findings from a quantitative study designed to assess engineering students' learning outcomes as a result of participating in co-op experiences. Sixty students from a research university participated in the study and were administered NESLOS at the end of their co-op experience. A majority of these student participants were rising seniors (64%), 42% were mechanical engineering students, and 55% of the participants had prior industry experience as well. Overall, the experience was highly valued by the students as a very important learning experience.

Students' high and low ranked learning outcomes were presented. The high rated technical outcomes (identifying problems, identifying and establishing design requirements and constraints, understanding assumptions needed to solve problems, formulating a range of solutions, analyze and interpret data, applying basic scientific and engineering principles) revealed that students learned problem solving skills in real-world settings and applying the engineering process to solve problems. The high ranked professional and personal outcomes (communicating effectively, gaining confidence, taking new opportunities for intellectual growth or professional development, recognizing the need for lifelong learning, recognizing the need to consult an expert, and improving organizational skills) revealed that the experience allowed the students to grow professionally. Additionally, the results showed that the co-op experience allowed many students to either clarify or validate their career goals after graduation, whether that be industry or graduate school in engineering or not.

Even more important than the highly ranked outcomes are the outcomes that were ranked low. It is from these low ranked outcomes that we can learn from and assess what changes should be made in order to improve co-op experiences. The low-ranked technical outcomes (following and creating a timeline when managing a project, applying engineering tools, identifying potential ethical issues and understanding ethical responsibility, understanding societal and global impact, recognizing contemporary issues, and designing an experiment) revealed that these are some of the outcomes and skills that we need to better incorporate in industry experiences and certainly in the undergraduate curriculum. As for the low ranked professional and personal outcomes (applying interpersonal skills in managing people, gaining leadership skills, managing the planning and organization of project tasks, and conveying ideas verbally and in formal presentations), once again we observe what skills need to be addressed by employers and by faculty. It is important to note that looking at this list, one can speculate that in an industry setting where many of these co-op students are seen as interns, supervisors do not assign management and leadership responsibilities to these students, thus these are skills that were not learned by the students. Furthermore, as interns, these students would also not be given the independence or initiative to design or conduct an experiment, but rather be given data for analysis, thus explaining some of the higher ranked outcomes discussed above.

Additional skills, measured in the form of open-ended questions, that students gained during the industry experience were: networking, dealing with authority, learning motivational skills and persistence, understanding the differences between school and work settings, learning how to ask the right questions, understanding the climate of the workplace, learning about team dynamics and professionalism.

High and low ranked outcomes for female and male students were also presented and compared. For both groups, the results showed that 10 of the 15 (67%) high-ranked outcomes and 12 of the 15 (80%) low-ranked outcomes were common to the male and female students. Thus, there were many similarities in how the outcomes were ranked by male and female students; yet, differences arose in how outcomes were rated. Five of the high-ranked outcomes (set and pursue my own learning goals, improve organizational skills, improve organizational skills, improve work ethic, and recognize the need for diverse perspectives) revealed significant differences between male and female students. These five were rated higher by the female students.

As for students' future career goals, 67% of the participants planned to stay in industry in an engineering-related position after graduation and 23% planned to go to graduate school in an engineering-related field. Students experiencing an industry setting realized the value of education and the need for advanced degrees. About 59% of the participants were considering a M.S. degree and 24% were considering a Ph.D. degree.

Although there are limitations to this study, many of which can be solved by incorporating qualitative methods, such as interviews and focus groups, these are important preliminary findings, which can aid engineering departments, cooperative education professionals, career service offices at institutions, and industry representatives to improve co-op experiences and assessment efforts.

Acknowledgements
The authors would like to thank (a) ASEE's Cooperative Education Division (CED) for funding support, (b) CASEE for supporting Dr. Pierrakos as a National Academy of Engineering CASEE (Center for the Advancement of Scholarship on Engineering Education) Postdoctoral Fellow, (c) Pam Hermann, Senior Assistant Director of Career Services at Virginia Tech, for all her support during this effort, and (d) graduate student Shankar Arul, who assisted us with the analysis.

References

1. Blair, B.F., Miller, M., and Hammer, J., "The Impact of Cooperative Education on Academic Performance and Compensation of Engineering Majors," *Journal of Engineering Education*, Vol. 93, No. 4, 2004, pp. 333–338.
2. Gardner, P.D., Nixon, D., and Motschenbacker, G., "Starting Salary Outcomes of Cooperative Education Graduates," *Journal of Cooperative Education*, Vol. 27, No. 3, 1992, pp. 16–26.
3. Crow, C. "Cooperative Education in the New Millennium." Cooperative Education Experience, pp. 1-5. Columbia, MD: Cooperative Education Association, 1997.
4. Prados, J. W., G. D. Peterson, L. R. Lattuca, Jan. 2005, "Quality Assurance of Engineering Education through Accreditation: The Impact of Engineering Criteria 2000 and Its Global Influence," *Journal of Engineering Education*, 94 (1), pp. 165-184.
5. Shuman, L. J., M. Besterfield-Sacre, J. McGourty, Jan. 2005, "The ABET "Professional Skills"-Can They Be Taught? Can They Be Assessed?" *Journal of Engineering Education*, 94 (1), pp. 41-55.
6. 2003-2004 Criteria for Accrediting Engineering Programs, Accreditation Board for Engineering and Technology, Baltimore, MD, 2002.
7. Bjorklund Stefani and Norman L. Fortenberry, August 2005, "Final Report: Measuring Student and Faculty Engagement in Engineering Education," Center for the Advancement of Scholarship on Engineering Education (CASEE), National Academy of Engineering.
8. Pierrakos O., J. Lo, M. Borrego, 2007, "Assessing Learning Outcomes of Senior Mechanical Engineers in a Capstone Design Experience," ASEE Annual Conference and Exposition, Honolulu, Hawaii.