AC 2011-630: THE ACADEMIC EFFECTS OF COOPERATIVE EDUCATION EXPERIENCES: DOES CO-OP MAKE A DIFFERENCE IN ENGINEERING COURSEWORK?

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Introduction

Cooperative education opportunities have been a staple of engineering training for over 100 years. An idea conceived at Lehigh University and first implemented at the University of Cincinnati, in the early 21st century over 150 engineering and engineering technology programs incorporate cooperative education opportunities into their curriculum. Cooperative education is a unique form of experiential education, and is traditionally delivered through either an alternating model, whereby student alternate work experience and academic coursework on a semester-by-semester bases or a parallel model, whereby students attend class for part of the day and work during the other part of the day (7).

The potential benefits of cooperative education extend to the employer, the college or university, and to the student. Employers benefit from obtaining relatively inexpensive labor and from having the opportunity to hire motivated employees with whom they have an established investment (3, 7, 8). Educational institutions also benefit from cooperative education activities through strengthened ties between the educational and business communities which can lead to increased job placement rates and enhanced sensitivity to workforce trends and needs (8). Additionally, there is evidence indicating that providing opportunities for cooperative education positively impacts an institution’s enrollment (14, 21).

While employers and institutions certainly accrue benefits from cooperative education programs, students are at the heart of the educational endeavor and have been shown to receive both academic and career benefits from their participation in these activities. Of the two, the area that has received the most amount of research is the relationship between cooperative education experience and employment outcomes.

The 1990s brought together a number of studies examining the direct benefits of cooperative educational experiences on initial wages. Research by Gardner, Nixon, and Motschenbacher (6), and Gardner and Motschenbacher (5) showed that relative to their non-cooperative education peers, engineers who participated in co-op opportunities had higher initial salaries. Wessels & Pumphrey (23, 24) also found that there are both direct and indirect effects of cooperative education experiences on initial wages, although this advantage attenuates after several years. Students attending an institution with co-op programs benefit from higher initial salaries even if they do not participate in co-op; an indirect effect of co-op programs that is not experienced by comparable students attending an institution where co-op is not offered. These “institutional” effects of co-op are particularly salient for women and students without much work experience. More recent research on the pecuniary impact of cooperative educational experiences continues to demonstrate that initial salaries for engineers are higher when students have co-op experiences (1); although Somers (20) and Schuurman, Pangborn, and McClintic (19) raise concerns about the myriad confounding variables in studies examining the relationship between salary and college experiences. Research on specific benefits of co-op experience for women have found that women, similar to their male peers who co-op, can experience salary gains (6, 15, 19) through co-op participation.

While the majority of the research on the benefits that students receive from cooperative education has focused primarily on research related to job acquisition, job satisfaction, and job progression, there has been correspondingly limited research on the academic impact of cooperative educational experiences (7). With its roots in the progressive educational philosophy of John Dewey (4), cooperative education is designed to provide experiences that forge direct linkage between student learning and student experience. In trying to expound on the relationship between material learned in the classroom and students' understanding and usage of that information in the real world, Dewey makes a strong argument for integrating more real-world applications into a student's education.

More recent work in cognitive learning theory provides supporting evidence for Dewey's argument about the beneficial elements of educational experiences providing students with the knowledge base and skills to help them translate isolated and abstract concepts into practical applications of that knowledge. From Jean Lave's (12) work on learning and every day activity to Barbara Rogoff's (17) ethnographic studies of apprenticeship in learning, there is a rich body of evidence providing a strong theoretical foundation to the important role context plays in learning. David Kolb's (11) work on learning modes is grounded in Piaget's work on the constructive nature of knowledge and the complementary processes of assimilation and accommodation. Kolb's four learning modes include two grasping experiences (Concrete Experience and Abstract Conceptualization) and two transforming experiences (Reflective Observation and Active Experimentation). In this model, these four experiences produce a four-stage cycle of learning where concrete experiences are reflected upon, and these reflections are integrated and distilled into abstract concepts which provide the foundation for actions that can be actively tested and which, in turn, create new concrete experiences. David Kolb's work on experiential learning has shown that "experiential learning is a process of constructing knowledge that involves a creative tension among the four learning modes" (10, p. 298).

As Sakofs notes:

> Broadly defined, experiential education is a philosophical orientation toward teaching and learning that values and encourages linkages between concrete educative activities and abstract lessons to maximize learning. Through these experiences, it is hoped and believed that learners attain a qualitatively superior level of knowing than can be achieved through abstract lessons alone; this goal is accomplished by confronting the learner with elements of reality which augment their understanding of the materials under investigation, because reality demands that the learners more fully engage themselves in the learning process in ways that abstract teaching tools, such as books, cannot accomplish. (18, p. 148)

Interestingly, for all the potential academic benefits that should accrue from participating in cooperative education programs, the research on these academic benefits remains sparse. In an early survey of the literature, Wilson (26) found that there were a number of studies showing a "small but statistically reliable difference in grades between groups of co-op and non-co-op students [that] were found to favor the co-op students. Typically, these gains were somewhat less than one letter grade" (p. 275). Wilson also noted a number of methodological differences with these studies, including a failure to control for entering student characteristics.

More recently, Blair and Millea (2) found a co-op benefit in cumulative grade point averages for business and engineering majors but not for students in other majors who participated in co-op, but, again, they did not control for academic ability at entry. Van Gyn, Cutt, Loken, and Ricks (22), utilizing a matched-pairs design, examined the longitudinal benefits of cooperative education and found that students who completed a co-op program had significantly higher scores on the Objective Form of the College Outcomes Measures Program exam developed by the American College Testing (ACT) Program. Examining the subscores on the test showed that the benefit was greatest for co-op students on the *problem solving* and *functioning in social situations* items. Wendy Williams and colleagues (25) have also shown that students with only five months of cooperative education experience benefit from a better understanding of the work world than their non-co-op counterparts, while also showing greater tacit knowledge in general than their non-cooperative education peers. Murphy, MacGillivary, Reid, and Young (16) in a study examining differences in cognitive style among co-op and non-co-op students, found that students who participated in co-op were more intuitive than their non-co-op peers, but that the length of time in co-op did not have an effect on cognitive style.

Finally, because the majority of students participating in co-op programs alternate work experiences and academic coursework on a semester-by-semester basis, concerns have been raised about the effect of these coursework gaps on student academic performance. In a study examining the effect of sixteen-month, long-term co-op placements on students' academic performance Iqbal (9) found indications that co-op students do better in subsequent classes than do their non-co-op counterparts, but that these differences were not significant. Research on students taking a "gap year" between high school and college has, however, shown that there are benefits for student academic performance and motivation, with "gap year participation positively predict[ing] adaptive behavior and negatively predict[ing] maladaptive behavior at university or college" (13, p. 570). Additionally, Martin concluded that "students who had participated in a gap year reflected a more adaptive profile of motivation (p. 572).

Given the general paucity of controlled studies on the effect of co-op experiences on academic performance, this study seeks to add to the research by examining whether co-op experience has any impact on grades in core engineering courses across a variety of engineering disciplines. The overall hypothesis guiding this analysis is that students who engage in co-op programs will benefit from active, contextual learning experiences obtained on the job and when compared to their non-co-op counterparts, this learning will be reflected in higher grades in required engineering courses. Additionally, it is hypothesized that these gains will be cumulative—that is, students with multiple co-op experiences will perform better in coursework than those with single experiences or no experiences at all. Finally, the study seeks to explore potential gender effects among co-op students—do women differentially benefit from co-op experiences and if so, in what types of courses?

Methods

The analysis involved data from 9,870 undergraduate students enrolled in six engineering majors at a Carnegie Research University (very high research activity) with an extensive history of student involvement in cooperative education. In order to be included in the sample, a student had to have completed at least 30 hours of coursework at the institution and at least one course in the engineering core curriculum between the spring 2004 and summer 2009 semesters. Table 1 shows the demographic breakdown of the sample.

Table 1. Demographics

	Engineering Program					
	Aerospace (*n* = 954)	Civil (*n* = 1319)	Chemical & Biomolecular (*n* = 805)	Electrical & Computer (*n* = 2374)	Industrial & Systems (*n* = 1993)	Mechanical (*n* = 2425)
Gender						
F	13.2	24.5	35.7	10.0	34.2	12.2
M	86.8	75.5	64.3	90.0	65.8	87.8
Ethnicity						
Minority	10.7	16.2	15.7	17.7	15.2	12.0
White/ Asian	89.3	83.8	84.3	82.3	84.8	88.0
Co-op Participation						
% Participating in Co-op	23.8	17.3	26.6	27.5	23.9	29.9

The analysis involved comparing the academic performance, as measured by final course grades, of co-op and non-co-op students in required core engineering courses at the institution. In order to capture the largest possible samples of students for comparison, the analysis focused on required (rather than elective) engineering courses in each major. Additionally, each course was categorized as “hard skill” or “soft skill” based on the ABET program outcomes the course addressed (see Table 2). This classification is imperfect—many courses fulfilled multiple outcomes, as well as both hard and soft skill categories. However, the categories allow the ability to determine if co-op experiences differentially affect academic performance in different types of engineering coursework. It is also recognized that course grades are only a gross indicator of student learning; however, their use permits a statistically powerful analysis of a very large number of cases, collected over several years and across numerous engineering disciplines. Differences in academic ability among students were controlled by using the cumulative institutional GPA after 30 hours as a covariate (i.e., the cumulative GPA after each student earned 30 hours at the institution). The analysis was based on grades received for the first attempt at a given course (A = 4, B = 3, C = 2, D = 1, F = 0), with Withdrawals treated as missing data.

Table 2. ABET Program Outcomes Criteria

ABET Criteria	
Hard Skills	
3a:	an ability to apply knowledge of mathematics, science, and engineering
3b:	an ability to design and conduct experiments, as well as to analyze and interpret data
3c:	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
3e:	an ability to identify, formulate, and solve engineering problems
3j	A knowledge of contemporary issues
3k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
Soft Skills	
3d:	an ability to function on multidisciplinary teams
3f:	an understanding of professional and ethical responsibility
3g:	an ability to communicate effectively
3h:	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
3i	a recognition of the need for, and an ability to engage in life-long learning

Results

An Analysis of Variance was conducted on 80 required engineering courses across six engineering disciplines, with 30-hour institutional GPA used as a covariate. The findings show that of the 80 courses analyzed, a “co-op effect” was demonstrated in 22 courses (27.5 percent of the total). That is, for these courses controlling for previous academic performance, students who had completed at least one term of co-op had a significantly higher average course grade than did those students who did not have any co-op experience. Table 3 shows the number of courses in each school by ABET program outcome that experienced a co-op effect.

Table 3. “Co-op Effect” by Engineering Program

	Courses			Co-op Effect	
Engineering Program	Total	Hard Skills Only	Soft Skills Included	Hard Skills Only	Soft Skills Included
Aerospace	18	12	6	2	3
Civil	9	5	4	0	0
Chemical & Biomolecular	15	12	3	3	1
Electrical & Computer	12	5	7	0	4
Industrial & Systems	11	6	5	2	3
Mechanical	15	8	7	2	2

To analyze the academic effect of co-op on the hard skill versus soft skill courses, a chi-square test was run based on whether or not the course included soft-skill ABET outcomes. The results show that students were significantly more likely to experience a “co-op effect” in courses that addressed both hard and soft skills (40.6%) than in courses addressing only hard skills (18.8%), χ^2 (1, *N* = 80) = 4.61, $p < 0.05$. Table 4 presents the results of the ANOVAs in the 22 courses with a statistically significant ($p < .05$; two-tailed test) co-op effect.

Table 4. Adjusted Mean Grades in Courses Demonstrating a "Co-op Effect"

	ABET Criteria	*N*		Adjusted Mean Grade			
Engineering Program	Include Soft Skills	No Co-op	Co-op	No Co-op	Co-op	*F*	sig (2-tailed)
Aerospace:							
Experimental Fluid Dynamics	Y	545	161	3.14	3.33	8.692	***
Introduction to Aerospace Vehicle Performance	Y	672	181	2.98	3.17	8.505	***
System Dynamics & Control		646	170	2.56	2.77	7.178	**
Aerospace Design Project I	Y	384	114	3.32	3.50	6.298	**
Jet & Rock Propulsion		600	180	2.66	2.87	7.360	**
Chemical & Biomolecular:							
Transport Processes I		527	173	2.86	3.03	6.320	**
Transport Processes II		444	168	2.73	2.90	5.460	*
Separation Processes	Y	435	163	2.96	3.16	6.852	**
Kinetics & Reactor Design		433	171	2.67	2.82	4.362	*
Electrical & Computer:							
Digital Design Lab	Y	1064	349	3.16	3.30	11.752	***
Instrumentation & Circuits Lab	Y	1544	469	3.00	3.14	16.146	***
Microelectronics Circuits Lab	Y	1398	489	3.13	3.21	4.887	*
Project Engineering & Professional Practice	Y	611	224	3.21	3.33	4.729	*
Industrial & Systems:							
Simulation Analysis & Design		1236	373	2.98	3.07	5.812	*
Engineering Optimization	Y	883	305	3.00	3.11	5.005	*
Senior Design	Y	959	335	3.10	3.23	4.512	*
Supply Chain Modeling: Logistics		1026	270	3.16	3.28	5.005	*
Supply Chain Modeling: Manufacturing & Warehousing	Y	1029	295	3.16	3.31	9.113	***

Note: $*p \leq .05$; $**p \leq .01$; $***p \leq .001$

Table 4. Adjusted Mean Grades in Courses Demonstrating a “Co-op Effect” (continued)

Engineering Program	ABET Criteria Include Soft Skills	*N* No Co-op	*N* Co-op	Adjusted Mean Grade No Co-op	Adjusted Mean Grade Co-op	*F*	sig (2-tailed)
Mechanical:							
Mechanics of Deformable Bodies		924	396	2.88	3.04	9.771	***
System Dynamics & Control		1455	543	2.72	2.81	4.877	*
Experimental Methods Lab	Y	837	401	3.42	3.54	10.211	***
Machine Design	Y	1297	499	2.83	2.97	11.220	***

Note: *p ≤ .05; **p ≤ .01; ***p ≤ .001

While the above analysis demonstrates a significant co-op effect in over one-quarter of the required engineering core, this design does not permit an exploration of the cumulative effects of multiple co-op terms on academic performance. In order to address this area of inquiry, a separate analysis of 3000-level core engineering courses was undertaken in which course grades for those with no co-op experiences, one co-op term, and multiple (two or more) terms were compared. Third-year courses were chosen because only at this level were there sufficient numbers of students with these varying levels of co-op experience.[1]

ANOVA was used to examine 36 3000-level courses across the six engineering disciplines, again using 30-hour cumulative institutional GPA as a covariate. The final course grade was examined at three levels—those with no co-op experience, those with one work term, and those with two or more terms. For those courses with an omnibus *F*-statistic indicating differences among the three groups, post-hoc tests (LSD) were conducted to determine if cumulative (i.e., 2 > 0 or “dosage” (2 > 1 > 0) effects were evident.

The results show that in 12 of the courses analyzed (33.3 percent) there was a cumulative effect. In each case students completing at least two co-op experiences significantly outperformed their peers completing zero co-op experiences. While all of the significant main effects showed a significant linear relationship (with scores generally improving in a straight line), post-hoc tests did not detect a significant dosage effect. That is, while students with two or more co-op terms significantly outperformed those with no co-op experiences, they did not outperform those with only one work term. Nor did students with only one co-op experience outperform those with no co-op experiences. Adjusted means and post-hoc comparisons are shown in Table 5. Similar to the previous analysis, a chi-square test was performed on the results based on the differential impact of co-op on courses that contained soft skills and those that included only hard skills.

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[1] Due to the way in which most students move through the curriculum, in most 2000-level courses, few students have had more than one co-op term, and in most 4000-level courses, few students have had fewer than two co-op terms.

Again the results showed that co-op had a significantly greater impact for students in courses incorporating a combination of hard and soft skills χ^2 (1, *N* = 36) = 5.06, p = .024.

[Insert Table 5 here]

Finally, an analysis was performed to examine whether men (*n* = 7918) and women (*n* = 1952) demonstrate differential benefits from their co-op experiences. Of the 80 courses analyzed, seven courses showed a significant interaction between gender and co-op experience. The results were mixed. In six of the courses, women who had completed at least one co-op experience earned a higher average grade in the course than did their non-co-op female peers while this pattern did not apply to men. In one course men saw a benefit from co-op experience while women who had completed at least one co-op term actually had a lower average course grade than their female peers who had not completed any co-op terms. Interestingly, a gender by co-op interaction was found in only two of the 22 courses that had originally shown an omnibus co-op effect—*Microelectronics Circuits Lab* and *Mechanics of Deformable Bodies*. Similar analyses could not be run for ethnicity because of a disparity in sample sizes. Table 6 presents the items which showed a statistically significant gender by co-op experience interaction.

Table 6. Statistically Significant Gender by Co-op Interactions

Engineering Program	ABET Criteria Included Soft Skills	Gender	No Co-op		Co-op		*F* (G x C)	Sig (2-tailed)
			N	Adj. Mean	*N*	Adj. Mean		
Aerospace:								
Aerospace Structures		F	37	2.78	21	2.22	9.216	***
		M	304	2.53	84	2.78		
Chemical & Biomolecular:								
Bioprocesses Lab	Y	F	27	3.31	8	3.66	5.307	*
		M	33	3.34	10	2.74		
Electrical & Computing:								
Microelectronics Circuits Lab	Y	F	141	3.16	44	3.46	3.769	*
		M	1257	3.12	445	3.18		
Mechanical:								
Dynamics of Rigid Bodies		F	148	2.47	48	2.70	4.022	*
		M	1088	2.52	356	2.46		
Deformable Bodies		F	108	2.76	47	3.22	5.104	*
		M	816	2.90	349	3.01		
Thermodynamics		F	197	2.79	65	3.09	4.809	*
		M	1395	2.83	457	2.84		
Manufacturing Processes & Engineering	Y	F	158	2.79	66	3.10	3.768	*
		M	1056	2.79	420	2.84		

Note: *p ≤ .05; **p ≤ .01; ***p ≤ .001

Discussion

This study arose to address the paucity of controlled research on the effects of co-op experience on the academic performance of engineering students. Using data from nearly 10,000 students over a five-year period, it has been possible to examine the relationship of co-op participation to end-of-course grades in the required engineering courses of six engineering majors.

Across five of the six engineering programs, a co-op effect was found in slightly more than 25 percent of 80 required engineering courses, whereby students who had completed at least one co-op term had significantly higher grades in the courses than did their peers who had not completed any co-op terms. Additional analysis of the types of courses in which co-op students outperformed their peers shows that courses that include “soft skills” are more likely to demonstrate a co-op effect than courses that stress hard skills only. It may well be that the experiential learning obtained through co-op is a superior method of inculcating communication skills (both oral and written) as well as teamwork skills. However, more detailed analysis of these skills in a controlled setting is required to reach a more definitive conclusion here.

Another area this research attempted to address is the benefit of repeated exposure to the working world through multiple co-op terms. Many students may participate in one-time internships, but a smaller number of students participate in the multiple-term co-op program. How much work experience is “enough” to confer an academic benefit? Analysis of 3000-level engineering courses found that academic performance in these courses do not improve significantly from zero work terms to one to two—that is, there is no “dosage effect” conveyed by co-op. However, for one-third of the courses examined, there is a significant cumulative effect. In other words, students with two or more work-terms significantly outperformed their non-co-op peers. Additionally, in virtually all the courses examined, the relationship between work terms and course grades was linear. Thus, even if not statistically significant, there is an upward slope in course GPA when plotted against the number of work terms. One limitation of this analysis is that the investigators did not explicitly compare students who enrolled in the institution’s internship program and those enrolled in the more expansive co-op program. It may be that students in these different programs have different goals and motivations. While it seems to be the case that students benefit from multiple work-terms (at least in terms of academic performance), a more controlled quasi-experiment that explicitly compares one-time interns to students with multiple-term work experience is suggested.

Finally, the study examined whether or not women and men obtained differential benefits from their co-op experiences. Here, the results are mixed. Of the 80 courses examined, when performance by students who completed at least one co-op term and those completing zero co-op terms was compared, only seven courses showed a significant gender by co-op interaction. Among these seven courses, in six of them women who had completed at least one co-op term had significantly higher average end-of-course grades than did women who had not completed any co-op term, while this relationship was not generalized to men. Interestingly, for women this co-op effect was seen in some courses that were more foundational in nature (e.g., thermodynamics and deformable bodies), providing basic engineering concepts that would form the foundation for more specialized courses in the later years. When examined without the gender factor, these courses did not demonstrate an omnibus difference between co-op and non-co-op students. It may be interesting to further explore the possible gender effects in foundational coursework such as statics and dynamics.

Previous research examining the academic impact of co-op experience has been hampered by methodological issues such as the failure to control for entering ability (2, 26), failure to control for the number of co-op terms experienced (2, 10, 26), and examination of cumulative grade point averages rather than individual course performance (2). With access to data on close to10,000 students over a five-year span, this study was able to control for both entering ability and number of co-op terms, and has permitted an examination of individual course performance rather than on cumulative grade point average. The use of end-of-course grades is, however, acknowledged to be a rough measure of skill acquisition, and more refined data can be obtained through more granular measures such as examination of specific course artifacts (such as specific examination questions or individual labs), focus groups, interviews or surveys that ask students to directly reflect on the role the that co-op experience played in their understanding of course material and course performance. These methods need to be employed to further elucidate the impact of experiential learning opportunities such as cooperative education. However, a narrowly focused beam of light is most effective when an investigator first knows the general direction to look. The research presented here is but a first step in limning a vaguely defined space.

References

1. Blair, B.F., & Millea, M. (2004a). Student academic performance and compensation: The impact of cooperative education. *College Student Journal, 38*(4), 643-650.
2. Blair, B. F., & Millea, M. (2004b). Quantifying the benefits of cooperative education. *Journal of Cooperative Education, 38*(1), 67-72.
3. Braunstein, L. A., & Stull, W. A. (2001). Employer benefits of, and attitudes toward postsecondary cooperative education. *Journal of Cooperative Education, 36*(1), 7-17.
4. Dewey, J. (1933/1997). *Experience and Education*. New York, NY: Free Press.
5. Gardner, P.D., & Motschenbacher, G. (1997). Early work outcomes of co-op and non-co-op engineers: A comparison of expectations, job level, and salary. *Journal of Cooperative Education, XXXIII* (1), 6-24.
6. Gardner, P.D., Nixon, D., & Motschenbacher, G. (1992). Starting salary outcomes of cooperative education graduates. *Journal of Cooperative Education, XXVII*(3), 16-26.
7. Grubb, W. N. & Villeneuve, J. C. (1995). *Co-operative education in Cincinnati: Implications for school-to-work programs in the U.S.* Technical Assistance Report.
8. Hurd, J., & Hendy, M. (1997). What we know about co-op employers' perceptions of cooperative education: A synthesis of research in the USA and in Canada. *Journal of Cooperative Education, 32*(2), 55-62.
9. Iqbal, J. (2007). Effect of long term placements on academic performance of co-op students. *Journal of Cooperative Education, 41*(1), 97-104.
10. Kolb, A. Y., & Kolb, D. A. (2009). The learning way: Meta-cognitive aspects of experiential learning. *Simulation Gaming: An Interdisciplinary Journal, 40*(3), 297-327.
11. Kolb, D.A. (1983). *Experiential learning: Experience as the source of learning and development*. New York, NY: Prentice Hall.
12. Lave, J. (1988). *Cognition in practice*. Boston, MA: Cambridge.
13. Martin, A. J. (2010). Should students have a gap year? Motivation and performance factors relevant to time out after completing school. *Journal of Educational Psychology, 102*(3), 561-576.
14. Martin, G. R. (1997). A case study of student recruitment and educational implications for colleges considering mandatory co-op. *Journal of Cooperative Education, 32*(3), 96-101.
15. Morgan, J. & Brannon, T. (1999). The relationship of undergraduate work terms and other variables to starting base salary of agricultural graduates. *Journal of Cooperative Education, 34*(3), 25-29.
16. Murphy, H. J., MacGillivary, A. C., Reid, J. G., & Young, J. D. (1999). Cognitive style differences between cooperative and non-cooperative education undergraduates: Some preliminary findings. *Journal of Cooperative Education, 34*(1), 54-61.
17. Rogoff, B., (1991). *Apprenticeship in thinking: Cognitive development in social context*. Cary, NC: Oxford University Press.
18. Sakofs, M. (1995). Piaget—a psychological rationale for experiential education. In Warren, K. & Sakofs, M. (Eds.). *The theory of experiential education: A collection of articles addressing the historical, social, and psychological foundation of experiential education (3rd ed.).* Dubuque, IA: Kendall Hunt.
19. Shuurman, M. K., Pangborn, R. N., & McClintic, R.D. (2008). Assessing the impact of engineering undergraduate work experience: Factoring in pre-work academic performance. *Journal of Engineering Education, 2008*(2), 207-212.
20. Somers, G. (1995). The post-graduate pecuniary benefits of co-op participation: A review of the literature. *Journal of Cooperative Education, XXXI*(1), 25-41.
21. Van Gyn, G., Branton, G., Cutt, J., Loken, M., & Ricks, F. (1996). An investigation of entry level characteristics between coop and non coop students. *Journal of Cooperative Education, 32*(1), 15-28.
22. Van Gyn, G., Cutt, J., Loken, M., & Ricks, F. (1997). Investigating the educational benefits of cooperative education: A longitudinal study. *Journal of Cooperative Education, 32*(2), 70-85.
23. Wessels, W., & Pumphrey, G. (1995). The effects of cooperative education on job search time, quality of job placement, and advancement. *Journal of Cooperative Education, XXXI* (1), 42-52.
24. Wessels, W. J., & Pumphrey, G. (1996). The impact of cooperative education on wages. *Journal of Cooperative Education, XXXII*(2), 36-51.
25. Williams, W.M., Sternberg, R. J., Rashotte, C. A., & Wagner, R. K. (1993). Assessing the value of cooperative education. *Journal of Cooperative Education, 28*(2), 32-55.
26. Wilson, J. W. (1987). What students gain from cooperative education. In Ryder, K. G., Wilson, J. W., and Associates (eds.) *Cooperative education in a new era: Understanding and strengthening the links between college and the workplace.* San Francisco: Jossey-Bass.

Table 5. Adjusted means and post-hoc comparisons of engineering programs

Engineering Program	Include Soft Skills	*N* Co-op Terms			Adjusted Mean Grade Co-op Terms			Main Effect		Pairwise Significance		
		0	1	2+	0	1	2+	*F*	sig	0 v 1	1 v 2+	0 v 2+
Aerospace:												
Experimental Fluid Dynamics	Y	545	34	127	3.14	3.24	3.36	4.739	.009	.449	.375	**
Introduction to Aerospace Vehicle Performance	Y	672	72	109	2.98	3.18	3.15	4.282	.014	.029	.794	*
System Dynamics & Control		646	60	110	2.56	2.62	2.86	5.021	.007	.655	.092	**
Chemical & Biomolecular:												
Transport Processes I		527	72	101	2.86	2.98	3.06	3.410	.034	.210	.477	*
Transport Processes II		444	45	123	2.73	2.80	2.94	3.217	.041	.579	.324	**
Separation Processes	Y	435	42	121	2.96	3.09	3.19	3.629	.027	.335	.521	**
Electrical & Computing:												
Instrumentation & Circuits Lab	Y	1544	173	296	3.00	3.18	3.12	8.572	.000	.001	.318	**
Industrial & Systems:												
Simulation Analysis & Design		1236	126	247	2.98	3.04	3.09	3.163	.043	.323	.473	*
Manufacturing & Warehousing	Y	1029	110	185	3.16	3.26	3.34	4.911	.008	.171	.399	**
Mechanical:												
Deformable Bodies		924	120	276	2.88	3.02	3.05	4.913	.007	.082	.803	**
Experimental Methods Lab	Y	837	44	357	3.42	3.57	3.54	5.135	.006	.101	.104	*

Note: *p ≤ .05; **p ≤ .01; ***p ≤ .001