AC 2012-3968: THE EFFECT OF COOPERATIVE EDUCATION ON THE SELF-EFFICACY OF STUDENTS IN UNDERGRADUATE ENGINEERING

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The Effect of Cooperative Education on the Self-Efficacy of Students in Undergraduate Engineering

Abstract

This study examines the effect of cooperative education, controlling for contextual support and demographic characteristics, on three dimensions of self-efficacy change: work, career, and academic. It is based on a pathways model that links contextual support and cooperative education and other forms of student work experience, such as internships, to self-efficacy as a basis for retention in college and in the engineering major. Of the three forms of self-efficacy, work self-efficacy was found to be the one efficacy form impacted by cooperative education. Since self-efficacy is shaped by performance accomplishments, students' success in their co-op jobs appears to enhance their confidence in performing a variety of behaviors that are particular to handling the requirements of the workplace. Change in work self-efficacy from students' second to third years was also affected by change in students' confidence in their career orientation. It was found that the quality of the co-op placement, in particular such dimensions as the chance to make a difference, to be part of a team, and to apply knowledge from one's major enhanced students' subsequent work self-efficacy. The latter placement dimension enhanced both career and work self-efficacy. Co-op students were also found to rely less on support provided by their colleges, friends, parents, and academic advisors. They were also found to value the instruction of their professors less once returning to class after their first co-op experience – perhaps a reflection of the latter's potential lack of current and real-world understanding. Co-op students' GPAs were also found to decrease less between the second and third years than those of non-co-op students. The finding regarding the impact of co-op on work self-efficacy is claimed here to open up the so-called "black box of co-op" to articulate the practices and behaviors of cooperative education that shape its contribution to the undergraduate experience.

The data pool for this study was constituted of all second year students in the colleges of engineering from four participating universities. Student respondents initially filled out a 20-minute survey, among which were assessments of the three forms of self-efficacy. They then filled out a comparable post-survey one year later (as third year students) during which those selecting co-op would have completed their first co-op placement. At the completion of the study, there will be an attempt to determine whether the participation in not only one but two co-ops can reverse a trend, especially among women undergraduates, to drop out of engineering because of their lack of confidence in continuing their concentration in engineering studies.

Introduction

This study is part of a larger research project, supported by a National Science Foundation Research on Gender in Science and Engineering program grant, designed to determine the effect of self-efficacy and other factors on retention, especially of women in undergraduate engineering programs. These data represent the pre-survey of the study completed in the 2009-2010 academic year (what we will refer to as Survey 1) and a post-survey follow-up in the 2010-2011 academic year (referred to as Survey 2). Students initially completed a 96-item Survey 1 (not

included in this paper due to the proprietary nature of some components) as sophomores. They then completed a 102-item Survey 2 approximately one year later. Surveys 1 and 2 were filled out either in written format or online. Additional data will be gathered in year three of the study, corresponding to the students' fourth year in an undergraduate engineering program.

The data pool is from colleges of engineering from four universities (Northeastern University, Rochester Institute of Technology, Virginia Polytechnic Institute and State University, and the University of Wyoming). The first two institutions provide formal cooperative education while the third and fourth do not require it. The total number of respondents at the point of Survey 1 was 1637 students. The combined response rate was 67%. The response rate for Survey 2 (calculated as the number of respondents from Survey 1 who successfully completed the second survey) was 54% and represents 886 students.

Preliminary portions of the data summary and discussion given below will be appearing in a parallel publication.[1] The immediacy with which the preliminary data has seen publication speaks, we believe, to the broad interest which this study has gained. In particular, the introduction and demonstration of the work self-efficacy measure has the potential to provide a significant new instrument to academic, government, and industry researchers.

The overarching model for the study proposes that retention is shaped by self-efficacy, which, in turn, is based on the impact of students' demographic characteristics, the effect of work experience -- in particular cooperative education, and the contextual support provided by the university as well as by others, such as parents and friends. In this paper, we report on the effect of cooperative education, pursued in the second and third year of college education, on three forms of self-efficacy change, controlling for contextual support and demographic characteristics. The three efficacy forms consist of work, career, and academic self-efficacy, signifying the confidence that students have in their own success within the workplace, within their chosen engineering career, and within the classroom, respectively. Contextual support was measured as the support provided to students in their first two years of college through a number of mechanisms, in particular, financial aid, mentors, advisors, family, friends, teachers, profession, campus life, and living-learning communities.

This paper first presents the background, conceptual framework, and methodology of the study. Next, we describe the results to date regarding the effect of cooperative education, in conjunction with descriptive measures of respondent demographics, on self-efficacy change. We then conclude by reviewing the significant findings of the study thus far and describe future plans of this on-going study of pathways to retention among undergraduate students in engineering.

Background

The field of cooperative education and internships has proposed the use of the concept of self-efficacy as a promising avenue to link practice-oriented learning processes to learning outcomes.[2] Self-efficacy is defined as an individual's perceived level of competence or the degree to which she or he feels capable of completing a task. Self-efficacy is a dynamic trait that changes over time and can be influenced by experience. Self-efficacy expectations are considered the primary cognitive determinant of whether or not an individual will attempt a

given behavior. Bandura[3] identified four sources of information that shape self-efficacy: (1) performance accomplishments, (2) vicarious experience, (3) verbal persuasion, and (4) physiological and affective states.

Robert Lent[4] and his associates expanded on general self-efficacy theory to develop a Social Cognitive Career Theory (SCCT), a "conceptual framework aimed at understanding the processes through which people develop educational/vocational interests, make career-relevant choices, and achieve performances of varying quality in their educational and occupational pursuits" (p. 62). In addition to highlighting cognitive-person variables, such as self-efficacy, SCCT emphasizes the role of other personal, contextual, and learning variables (e.g., gender, race or ethnicity, ability, social support, external barriers) that can help shape career trajectories, including the means to remediate any disadvantages from being under-represented in particular occupations.[5]

SCCT theory has also made an impact on models attempting to explain the withdrawal of students from undergraduate education. Early theories of student persistence stressed the importance of academic performance and student-institution match, referring to the degree to which the student has been involved and integrated into the collegiate experience especially during the first year.[6 7 8 9] SCCT has more completely explained persistence rates by focusing on cognitive-person variables, such as self-efficacy, that can enable students to exercise personal agency in their career endeavors. What is especially important about these variables is that they can be assessed and their conditions altered in order to enhance students' perceived consequences of succeeding in college.[10] In particular, consistent with SCCT theory, recent studies have found that enhanced self-efficacy and social support during the collegiate experience can lead to improved adjustment and academic performance, which, in turn, shape overall satisfaction and commitment to remain in school.[11 12 13]

While this study's pathways model (Figure 1) bears some resemblance to Lent's theoretical SCCT model,[14] he and his colleagues use outcome expectations and interests as additional cognitive-person variables.[15] This study concentrates on support and self-efficacy constructs, especially since the latter are believed to be the most central and pervasive mechanism of personal agency.[16] Subsequent analyses will focus on the effects of these variables on retention.

Other than Lent's work on contextual factors, there has been some modest research on counseling interventions that may lead to increased self-efficacy. In theoretical papers, Betz[17] and Brown and Lent[18] discussed ways that counselors could increase the self-efficacy beliefs of their clients, such as by structuring successful performance experiences, finding successful role models, providing techniques for anxiety management, offering encouragement and support, encouraging data gathering that might counteract detrimental self-efficacy beliefs, and helping process efficacy-relevant data. At the secondary school level,[19] a three-day problem-based camp experience was found to increase students' self-efficacy for specific tasks as well as general self-efficacy. At the college level, Hutchison, Follman, Sumpter, & Bodner[20] more recently reported a relationship between academic and advisory support and female students' academic self-efficacy. Focusing in particular on cooperative education, a pilot study[21] was performed by the University of Wyoming's and Northeastern University's Colleges of Engineering to discriminate the effect of co-op versus other competing measures on self-efficacy. Cooperative education was found to significantly predict change in work self-efficacy. Prior academic achievement was

found to predict subsequent academic self-efficacy, and academic support was found to significantly enhance all three forms of self-efficacy. Women undergraduates were found to be more confident than their male counterparts in obtaining occupational information and learning from their work experiences.

In a theoretical study Fletcher [22] provided a first glimpse attempting to explain how cooperative education experience might enhance self-efficacy and help students make the transition from student to practitioner. Specifically, she suggested that cooperative education increases self-efficacy through performance accomplishments, one source of efficacy information. In this instance, performance accomplishments would be co-op experiences themselves in which students need to use skills, abilities, and coping strategies to perform tasks. Successful experiences can result in a feedback loop where performance accomplishments would lead to increased self-efficacy, which in turn, enhances students' performance, further strengthening their self-efficacy beliefs. The possibility that cooperative education can be a source of efficacy information through performance accomplishments is provocative, given that performance accomplishments are generally viewed as the most potent source of self-efficacy information; that is, of the four sources of efficacy information, performance accomplishments are thought to exert the most influence.[23] [24] Nevertheless, formal workplace experiences also expose students to successful peer models, mentor figures, and verbal encouragement that can provide self-efficacy information through Bandura's vicarious experiences and verbal persuasion sources.

Although the co-op field itself has not fully identified what happens during the co-op experience to produce beneficial outcomes - leading some researchers to refer to this as the "black box" of co-op[25] - there have been a number of outcome studies demonstrating its salutary effects on students' subsequent employment and career. For example, Weinstein[26] found that co-op students evinced greater certainty about career choice compared to students who did not participate in a co-op experience. Co-op students were also more likely to have first jobs related to their major and overall career plans[27] and were more likely to hold positions with higher levels of responsibility.[28] [29] They were also shown to more successfully adjust at the outset of their employment,[30] were more self-reliant in learning about their organization and work groups, and rated their knowledge of task and role more highly than non-co-ops.[31] Finally, as related to the social cognitive stream of research, co-op experience has been found to increase self-confidence, self-concept, and career identity.[32] [33]

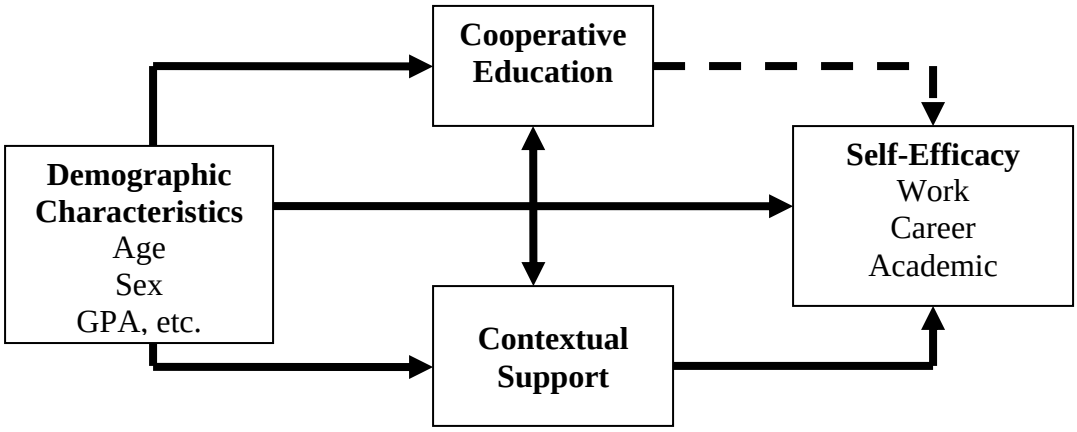
It goes without saying that cooperative education and other related formal work experience programs during the undergraduate experience provide students with opportunities to try out, learn from, and reflect on ongoing work experience.[34] As a result, they help students transition into full-time work more easily, helping them overcome the "reality shock" attributed to first job experiences for uninitiated novices.[35] [36] In addition, through its enhancement of self-efficacy, cooperative education can also prove beneficial to students in sustaining their ongoing academic performance and their persistence to graduation.[37] [38] [39] [40] [41] Blair, Millea, and Hammer[42] in a study of undergraduate engineering majors concurred that those who completed three semesters of co-op had superior academic performance and they also earned higher starting salaries (though it took them longer to complete their undergraduate program). Of the various dimensions of self-efficacy that are likely to be affected by co-op, it could be work self-efficacy that would be the construct of choice. Work self-efficacy measures a range of behaviors and

practices - e.g., exhibiting teamwork, expressing sensitivity, managing politics, handling pressure - attending to students' beliefs in their command of the social requirements necessary for success in the workplace. Since efficacy is a malleable property, there are methods by which student employees may achieve relative success in their jobs as well as learning within the workplace by increasing their confidence in performing many of these work-related behaviors.[43]

Framework

The conceptual framework for this study is depicted in Figure 1 as a set of pathways between four variable clusters. The determination of self-efficacy is based on the impact of students' demographic characteristics, the effect of work experience - in particular cooperative education - and contextual support. In this study, we are especially interested (denoted by the dashed arrow) in the effect of cooperative education on self-efficacy, controlling for demographic characteristics and contextual support.

Figure 1. Conceptual Framework of the Study



Data

The data pool represents all sophomores in the colleges of engineering from the four participating universities. Respondents filled out two 20-minute surveys, spaced out over approximately a year. While Survey 1 was completed entirely in written form, some 54% of Survey 2 respondents completed their survey online. All surveys were conducted anonymously, although IDs were used to track students for follow-up purposes and to verify some of the descriptive data against the student record. Since IDs were not associated with names in the data file, the data analysis was conducted in total anonymity. Incentives were used to generate higher response rates and entailed both direct gifts for completion (e.g., coupons to on-campus bookstores or coffee shops) and raffles (e.g., VISA gift cards, iPods). As Table 1 reveals, the total number of respondents was 1637 students for Survey 1 and 886 for Survey 2. The response rate at Survey 2 was 54%.

Besides the expected dominance of males in the sample, 79% at Survey 1 and 76% at Survey 2, the initial sample was predominantly Caucasian (79.5%) and middle and upper-middle class (83%) in socioeconomic status (SES). The average SAT score was 1269 (math plus verbal scores), based on the original SAT version with a 1600 maximum score. The average GPA was 3.21 at the end of the freshman year, and 3.07 at the end of the sophomore year for the full sample and 3.12 for those who completed Survey 2. For both surveys, the most popular major was mechanical engineering (at nearly a third of the sample) followed by civil, chemical, and electrical in that order.

By the time of Survey 2, 39 students had left their university and 110 students (or approximately 7%) had transferred out of engineering. Of those who had left engineering, the most popular substitute major was science, followed by math and social sciences. The engineering students in our sample are seen as hard-working since some 94% of them declared that they were working in some capacity. Further, 543 students (65%) participated in a co-op program during their sophomore year, and an additional 118 (13%) undertook an internship, be it in their major or not connected to their major. Finally, 42% of the sample at Survey 2 reported one year or less of total work experience in their lives, 33% worked between one and three years, and 24% had worked over three years.

Table 1
Overall Sample Statistics

School	# Students Completing Survey 1	# Students in Data Pool	Response Rate	# Students Completing Survey 2	Response Rate
Northeastern University*	363	422	86%	325	90%
Rochester Institute of Technology*	315	399	79%	174	55%
University of Wyoming	128	287	45%	94	73%
Virginia Polytechnic Institute	831	1353	61%	293	35%
TOTALS	**1637**	**2461**	**67%**	**886**	**54%**

*Signify the two universities with predominantly co-op engineering colleges.

Measurement

The measures of the principal study variables are as follows. The new work self-efficacy inventory (WS-Ei), developed by Joseph Raelin at Northeastern University, measures a range of behaviors and practices that relate to the non-technical and social skills necessary to achieve success in the workplace.[44] The inventory features seven subscales: problem-solving, sensitivity, communication, teamwork, learning, pressure, and politics. Career self-efficacy was obtained directly from the short-form of the Career Decision-Making Self-Efficacy Scale of Betz, Klein, and Taylor,[45] and academic self-efficacy was derived from the Self-Efficacy for Academic Milestones and the Self-Efficacy for Technical/Scientific Fields surveys.[46] Among the contextual support variables, the majority (friends, family, professional, financial) were derived from familiar support scales in use such as the support subscales of Lent et al.[47] Two variables were drawn from the college students' mattering literature,[48 49] purporting that the

mattering of one's friends and college were key components of social support. From the retention literature, three other important variables were included: the quality of instruction, the involvement of the student in campus life, and the opportunity to be involved in a living-learning community.[50] [51] [52] [53] Finally, the support of both an advisor and a mentor[54] was measured deploying the advisorship and mentorship scales from the rapport and apprenticeship subscales of the Advisory Working Alliance Inventory (AWAI) prepared by Schlosser and Gelso.[55] Demographic data were self-reported by the respondents directly on the survey instrument or obtained from their student records.

The first round of analyses established the validity and reliability of these measures. Factor analyses were conducted on the components of each of these established scales using principal component analysis as the extraction method with eigenvalues set at the Kaiser greater-than-1 rule. The initial solutions for each of the analyses found all the components to load as specified on the first factor. Although not an established scale, an attempt was also made to produce a contextual support scale made up of each of the support variables. This analysis was not able to secure a single solution; rather, the financial support variable loaded on a separate factor. However, an exploratory factor analysis of all the remaining support variables indeed loaded on a single factor. Thus, a composite social support measure was created with the exception of financial support, the latter being retained as a single-item measure.

Each of the three self-efficacy scales -- work, career, and academic -- produced high reliabilities, measured by Cronbach's alpha coefficient of internal consistency:

WS-E: .94
CS-E: .93
AS-E: .91

These scores are above the recommended .70. The advisor and mentor scales also performed well: advisorship at .95 and mentorship at .97. The new social support scale, created from the merger of seven variables (friend, family, and professional support, friends and college matters, involvement, and teaching quality) achieved a sufficient reliability coefficient of .74.

One additional scale was created from the Survey 2 data, composed of ten measures used to evaluate the quality of students' co-op experiences. Research by Blackwell et al.[56] has highlighted the differential learning and employment effects that can ensue from variety in the provision of undergraduate work experience. For example, some co-ops are better at expressly providing students with an opportunity to learn or in enabling them to reflect on what they are learning. The measures used in this study were based on the work of Fogg and Putnam[57] and Highsmith, Denes, and Pierre[58] and include such indicators as whether the placement was intellectually challenging and applied the knowledge used in one's field, or whether the student worked as part of team of professionals. All ten variables loaded on the same factor and achieved a Cronbach's alpha of .87.

The three major self-efficacy scales were found to have a high degree of concurrent validity, measured initially by correlations that are high and significant but not so high as to be

equivalent. It was therefore determined that each efficacy measure represents a different facet of self-efficacy.

WS-E and CS-E = .67
AS-E and CS-E = .44
WS-E and AS-E = .32

Convergent validity was also established by significant correlations among discriminating variables. For example, academic advisorship and mentorship, provided as part of programs to support women and underrepresented students, were both significantly correlated with the three efficacy measures. Meanwhile, second and third-year GPA was found to be highly and significantly correlated with academic self-efficacy at both respective time periods. Academic self-efficacy in the second year was also significantly correlated with teaching quality and prior SAT scores.

Results

Relationship between Cooperative Education and Self-Efficacy Change

Before computing the relationship between cooperative education and self-efficacy, it is first important to determine if there has been significant change in the three main efficacy scores. Although the difference in self-efficacy between the second and third years was not huge, the scores were significant in each case, as can be see below in Table 2.

Table 2
Differences between Survey 1 and Survey 2 on Self Efficacy

	N	Survey 1 Mean	Survey 2 Mean
Work self-efficacy	886	3.88**	3.93**
Career self-efficacy	882	3.75**	3.81**
Academic self-efficacy	878	3.98**	3.90**

** Significant at p<.01 using two-tailed paired sample t-test

It is interesting to note that both work and career self-efficacy increased between the second and third years whereas the students' confidence in their academic achievement significantly decreased. In a separate analysis, it was discovered that the change in academic self-efficacy was accompanied by a corresponding significant reduction in students' GPA. A significant decrease was also recorded for the change in the contextual support composite scale, with the most significant component being change in "college mattering," a reflection perhaps of the famous undergraduate convention of the "sophomore slump."[59]

To determine whether cooperative education had an effect on self-efficacy, we first divided the sample into those students who had completed a co-op vs. those who had not. We then performed t-tests of means for these two groups on the change in self-efficacy over the period between the second and third years. We established a significance level based on the more demanding two-tailed test because we are interested in changes from the mean in both directions. We then noted whether any other changes were affected by students' co-op experience.

As can be seen in Table 3, there was a very significant change in co-op students' work self-efficacy upon completion of their co-op experience. Those who participated in co-op indicated a significant increase in their work self-efficacy, whereas those who did not participate decreased some. There were no significant outcomes in the other two self-efficacy change scores between co-ops and non-co-ops.

As could be expected, the overall support co-op students experienced during their time on co-op decreased, in particular, support available from their collegiate advisor. Interestingly, co-op students' GPAs did not decrease as much as non-co-op students' GPAs. Lastly, co-op students reported a reduction in the quality of instruction; a finding that is not unusual especially among students returning from co-op who begin to question the currency of their teachers' applied engineering experience. This finding may also reflect what Mann[60] and Auburn[61] among others view as an alienation resulting from the lack of opportunity of returning students to demonstrate their new knowledge in class due to a teaching style that controls the agenda of learning. Although the principal focus of this paper is on the impact of cooperative education on self-efficacy, we were also interested in the potential impact of internships, be they in one's major or not. Consequently, we added the 118 internship students to our original co-op measure and performed the same series of t-tests. Although the overall pattern of the findings did not change substantially, there was one interesting twist. Again, the most pervasive impact of cooperative education and internships was on change in students' work self-efficacy; however, the addition of internships also affected career self-efficacy change. When performing a t-test on interns separately from co-op students, the same effect was produced. Thus, we can conclude that students on internships are more likely to experience a positive change in their career self-efficacy compared to students choosing neither co-ops nor internships. Besides change in career self-efficacy, there appears to be a likelihood that interns are also more involved in campus life and feel more supported by their university, although these results, given the relatively low number of interns in our sample, can only be considered a trend rather than a statistical finding. It could be a mere artifact of co-ops in some cases lasting longer than internships. Nevertheless, the findings point to a potentially important difference between interns and co-op students, that being the extent of their continuing connection to the university during their internship.

Table 3
T-Tests for Cooperative Education and Change Scores

	Reported Work Experience	N	Mean	Significance (two tailed)
Work Self-Efficacy Change	Co-Op	477	.13	.000
	Other	295	-.02	
Career Self-Efficacy Change	Co-Op	477	.09	.326
	Other	295	.05	
Academic Self-Efficacy Change	Co-Op	476	-.04	.750
	Other	294	-.05	
Advisor Support Change	Co-Op	422	-.09	.000
	Other	259	.22	
Support (Composite) Change	Co-Op	472	-.09	.001
	Other	220	.05	
Teaching Quality Change	Co-Op	468	-.05	.016
	Other	215	.14	
GPA Change	Co-Op	543	-.08	.019
	Other	293	-.12	

Relationship between Cooperative Education and Self-Efficacy Change Controlling for Contextual Support and Demographics

To determine whether cooperative education had a direct effect on self-efficacy change, independent of the contextual support variables as well as the demographics, a multiple regression was performed for each of the three self-efficacy change measures. The purpose was to determine how much of the variance in each of these dependent variables would be explainable at the intermediate phase of the project by the study variables. Statisticians tend to refer to the statistic known as r-square – the coefficient of determination – which technically represents an index of the closeness of the plotted points to the regression line. Another valuable statistic is the Beta or the standardized regression coefficient, which is expressed with a mean of zero and a standard deviation of 1. Betas of explanatory variables are directly comparable to one another, with the largest coefficient indicating which independent variable has the greatest influence on the dependent variable.

In examining each of the three regression equations, each of which had significant r-squares, the co-op variable only entered one equation with a high (p.<01) level of significance, that being work self-efficacy change. Table 4 displays this regression equation, and as can be plainly seen, participation in cooperative education is the only significant predictor other than a control for career self-efficacy change, which is also highly significant. The conclusion from the regression analysis is that cooperative education has a distinctive impact on the work self-efficacy of its participants. Work self-efficacy change was also impacted by both co-op and non-co-op

students' change in their confidence in their career orientation. Since it was also found that change in career self-efficacy was influenced by change in work self-efficacy, it appears that both forms of self-efficacy have an impact on the other.

Relationship between Co-op Quality and Subsequent Self-Efficacy

As noted in the description of our data, a set of questions were included to measure the quality of students' co-op experiences, such as their intellectual challenge or their application of subject-matter knowledge. The composite scale composed of the ten co-op quality indicators did not enter the efficacy change regression equations, but separate regressions were run for the post measure of work self-efficacy (as well as the other efficacy measures).

In the regression for work self-efficacy after students' first co-ops, three co-op quality dimensions were found to be significant predictors. The most potent predictor was whether the co-op placement made a difference to the unit or organization employing the student. The second was whether the placement allowed the student to be part of a team, and the third was whether the placement applied knowledge in the student's major. It also turns out that this latter co-op quality measure appeared significantly in the two other regression equations, i.e. placements that afford students opportunities to apply knowledge enhance the students' career and academic self-efficacy as well as their work self-efficacy. Career self-efficacy was also found to be bolstered by placements that provided students with opportunities for feedback on their performance.

There are two clusters of findings not related to self-efficacy that are of interest to report, even though the select sub-samples are too low to infer statistical significance. The first is a report of our data on mentorships, limited to those students who sought out a mentor affiliated with a women-in-engineering or multicultural engineering program. For these students, a solid association, using correlational analysis, was found between the perceived support received from one's mentor and six of the ten co-op quality dimensions. Mentors appear to make a difference in assisting students in getting the most out of their co-op experiences.

Secondly, continuing our attention on internships and their distinctiveness, the study differentiated those internships that were connected to the students' majors and those that were not. The same "quality of placement" measures were also administered to both sets of interns. Although only 16 of the 118 internships were reported as <u>not</u> connected to the major, it was discovered that the mean score for all ten of the quality measures for these internships were lower than for those internships connected to the major. As would be expected, the difference between these two types of internship varied most dramatically on the measure of the placement's applicability to knowledge in one's major (by over 1 point on a scale from 1-5), but two measures also exceeded a difference of .5, specifically, having a placement with an attentive supervisor and one that involved the intern as part of a team.

Table 4
Regression for Work Self-Efficacy (WS-E) Change

Model Summary

R	R^2	Adjusted R^2	Std. Error of the Estimate
0.555[a]	0.307	0.287	0.431

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	41.963	15	2.798	15.038	0.000
Residual	94.501	508	0.186		
Total	136.464	523			

Entered Variables[b]

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-.246	.701		-.352	.725
Career self-efficacy change	.498	.039	.540	12.928	.000
Co-op participation	.123	.044	.112	2.789	.005
Contextual support change	-.047	. 041	-.049	-1.133	.258
Advisory support change	-.021	.022	-.038	-.922	.357
Amount of prior work	.009	.013	.028	.703	.483
SAT scores	.089	.000	.020	.518	.605
Financial support change	-.008	.017	-.018	-.479	.632
Academic self-efficacy change	.011	.032	.014	.329	.742
Living in Learning Dorm	.010	.039	.010	.258	.797
Change in GPA	.011	.088	.005	.121	.904

[a] Dependent variable is Work Self-Efficacy (WS-E) Change

[b] The demographic variables of age, socioeconomic status, and gender were also entered as controls in this equation, along with the extent of any current work experiences, but were found to be not at all significant.

Next Steps

In the third survey to be conducted in this study (during the Fall 2011 – Spring 2012 academic year), the research team hopes to determine whether the predictors of self-efficacy as well as self-efficacy itself will be viewed as potential contributors to retention both within the students' engineering major and within their university. At the current intermediate stage, there are not enough cases to make this determination and it is premature to draw conclusions about retention. By the conclusion of the study, we hope to have sufficient data to discern whether cooperative education, given its effect on work self-efficacy, can reverse the trend, especially among women, to drop out of engineering because of their lack of confidence in continuing their concentration in undergraduate engineering studies.

Conclusion and Implications

This study has developed one of the key components of the pathways model that ties cooperative education to students' self-efficacy controlling for contextual support and students' demographic characteristics. At the third phase of the study, there will be a determination of whether co-op's impact (especially having a second co-op) can contribute to a reversal of the trend, especially among women, to drop out of their engineering concentration.

The study has also introduced a form of self-efficacy that has received little attention in the literature, that being work self-efficacy. Work self-efficacy measures a range of behaviors and practices - e.g., exhibiting teamwork, expressing sensitivity, managing politics, handling pressure - attending to students' beliefs in their command of the social requirements necessary for success in the workplace. Since efficacy is shaped by performance accomplishments, it was theorized in this study that student success in their co-op jobs would enhance their confidence in performing a variety of behaviors that are particular to handling the requirements of the workplace.

The results have supported the link between cooperative education (both separate from and including internships) and change in work self-efficacy from the second to the third year. Change in work self-efficacy was also affected by change in student's confidence in their career orientation. In examining the quality of the co-op experience that affects work self-efficacy, it was found that when the placement afforded students a chance to make a difference, to be part of a team, and to apply knowledge from their major, subsequent work self-efficacy was significantly enhanced. This finding is consistent with the practical view[62] that not all work experience programs are of equal value. An ongoing effort needs to be made by those responsible for placements that the quality of the experience be an affirmative training ground that not only teaches productive work skills but also productive work habits that may transfer into full employment when the time comes.

Co-op students were also found to rely less on support provided by their colleges, friends, and parents or as provided by their academic advisors. Although this finding may be initially discomforting, it may also reflect a maturity required of co-op students or interns now having to fend for themselves more independently in the working world. It may also lend insight into findings[63] that have shown a reduced "reality shock" among co-op students once they have to fully enter the workforce.

Co-op students were also found to value the instruction of their professors less once returning to class after their first co-op experience – a reflection of a possible mismatch between the expectations of the returning student and the classroom instructor. Some instructors may simply not wish to or may not know how to take sufficient advantage of their students' newfound knowledge and maturity to enhance the classroom experience. In fact, it is conceivable that students fresh from the field may be able to provide an updating of some engineering applications. This would require, however, an explicit attempt by the respective instructor to involve returning students in voicing their new knowledge and contributing to the lessons that have obvious workplace implications. Besides the foregoing rationale for the reduction in co-op students' teaching quality assessment, an alternative explanation is that some co-op-based engineering programs have given special emphasis to dynamic instruction during the freshman year (vs. the subsequent years) as a means to enhance first-year retention.

Finally, throughout much of the history of cooperative education in undergraduate study, there has been affirmation of the value and contribution of cooperative education to students' personal, career, and academic development. However, the actual contributory processes of co-op have been benignly assigned to what has been referred to as the "black box of co-op" because it was thought to be too complex a proposition to determine the complexity of co-op's operational impact. Now, with the addition of the measure known as "work self-efficacy," this study has claimed to open up the black box to show that co-op's eminent contribution to undergraduate studies is based on its enhancement of a form of self-efficacy that addresses the confidence acquired during co-op in handling the demands and requirements of the workplace.

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References

[1] Raelin, J. A., Bailey, M. B, Hamann, J., Pendleton, L. K., Raelin, J. D., Reisberg, R. and Whitman, D. (2012). "The Effect of Cooperative Education on Change in Self-Efficacy Among Undergraduate Students: Introducing Work Self-Efficacy." *Journal of Cooperative Education and Internships*, forthcoming.

[2] Eames, C. (2004). "Researching in Cooperative Education: How a Practitioner Met the Challenge." In P. Linn (Ed.), Handbook for Research in Cooperative Education and Internships (pp. 71-94). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

[3] Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

[4] Lent, R. W., Brown, S. D., Talleyrand, R., McPartland, E. B., Davis, T., Chopra, S. B., Alexander, M. S., Suthakaran, V., and Chai, C. (2002). "Career Choice Barriers, Supports, and Coping Strategies: College Students' Experiences." *Journal of Vocational Behavior*, 60, 61-72.

[5] Blustein, D. L., McWhirter, E. H., & Perry, J. C. (2005). "An Emancipatory Communitarian Approach to Vocational Development Theory, Research, and Practice." *The Counseling Psychologist*, 33, 2, 141-179.

[6] Tinto, V. (1975). "Dropout from Higher Education: A Theoretical Synthesis of Recent Research." *Review of Educational Research*, 45, 1, 89-125.

[7] Bean, J. PP. (1980). "Dropouts and Turnover: The Synthesis and Test of a Causal Model of Student Attrition." *Research in Higher Education*, 12, 155-187.

[8] Pascarella, E. T., Terenzini, P. T., and Wolfle, L. M. (1986). "Orientations to College and Freshman Year Persistence/Withdrawal Decisions." *Journal of Higher Education*, 57, 2, 155-175.

[9] Cabrera, A. F., Castaneda, M. B., Nora, A., and Hengstler, D. (1992). "The Convergence between Two Theories of College Persistence." *Journal of Higher Education*, 63, 143-164.

[10] Kahn, J. H., and Nauta, M. M. (2001). "Social-Cognitive Predictors of First-Year College Persistence." *Research in Higher Education*, 42, 6, 633-652.

[11] Chemers, M. M., Hu, L. and Garcia, B. F. (2001). "Academic Self-Efficacy and First-Year College Student Performance and Adjustment." *Journal of Educational Psychology*, 93, 1, 55-64.

[12] Friedlander, L. J., Reid, G. J., Shupak, N., and Cribbie, R. (2007). "Social Support, Self-Esteem, and Stress as Predictors of Adjustment to University among First-Year Undergraduates," *Journal of College Student Development*, 48, 3, 259-274.

[13] Meyers, K. L., Silliman, S. E., Gedde, N. L., and Ohland, M. W. (2010). "A Comparison of Engineering Students' Reflections on their First-Year Experiences." *Journal of Engineering Education*, 99, 2, 169-178.

[14] Lent, R. W., Brown, S. D., Schmidt, J., Brenner, B., Lyons, H., and Treistman, D. (2003). "Relation of Contextual Supports and Barriers to Choice Behavior in Engineering Majors: Test of Alternative Social Cognitive Models." *Journal of Counseling Psychology*, 50, 4, 458-465.

[15] Lent, R. W., Brown, S. D., and Hackett, G. (1994). "Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance." *Journal of Vocational Behavior*, 44, 79-122.

[16] Bandura, A. (1989). "Human Agency in Social Cognitive Theory." *American Psychologist*, 44, 1175-1184.

[17] Betz, N. (1992). "Counseling Uses of Career Self-Efficacy Theory." *Career Development Quarterly*, 41, 1, 22-25.

[18] Brown, S. D. and Lent, R. W. (1996). "A Social Cognitive Framework for Career Choice Counseling." *Career Development Quarterly*, 44, 4, 354-366.

[19] Speight, J. D., and Rosenthal, K. S. (1995). "Medcamp's Effect on Junior High School Students' Medical Career Self-Efficacy." *Career Development Quarterly*, 4, 3, 285-295.

[20] Hutchison, M., Follman, D., Sumpter, M., and Bodner, G. (2006). "Factors Influencing the Self-Efficacy Beliefs of First-Year Engineering Students." *Journal of Engineering Education*, 95, 1, 39-47.

[21] Raelin, J., Reisberg, R., Whitman, D. and Hamann, J., (2007). "Cooperative Education as a Means to Enhance Self-Efficacy among Sophomores (with Particular Attention to Women) in Undergraduate Engineering", Paper presented at the 37th ASEE/IEEE Frontiers in Education Conference, Milwaukee, WI, October 10-13, 2007.

[22] Fletcher, J. (1990). "Self Esteem and Cooperative Education: A Theoretical Framework." *Journal of Cooperative Education*, 26, 3, 41-55.

[23] Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

[24] Lent, R W., Brown, S.D., & Hackett, G. (1994). "Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance." *Journal of Vocational Behavior*, 44, 79-122.

[25] Ricks, F., Cutt, J., Branton, G. Loken, M., and Van Gyn, G. (1993). "Reflections on the Cooperative Education Literature." *Journal of Cooperative Education*, 29, 1, 6-23.

[26] Weinstein, D. (1980). *Cooperative Education Strategies and Student Career Development*. Boston: Northeastern University, Cooperative Education Research Center, CEA. Monograph #1.

[27] Brown, S.J. (1984). *The Influence of Cooperative Education on First Job After College.* ERIC Document Reproduction Services (ED 254 663). Boston: Northeastern University.

[28] Gore, G. (1972). "New Evidence of Co-op System Relevancy." *Journal of Cooperative Education*, 8, 2, 7-14.

[29] Brown, S. (1976). *Cooperative Education and Career Education: A Comparative Study of Alumni*. Boston: Northeastern University, Cooperative Education Research Center.

[30] Brown, S. (1985). *The Relationship of Cooperative Education to Organizational Socialization and Sense of Power in First Job after College*. Doctoral dissertation, Chestnut Hill, MA: Boston College.

[31] Gardner, P. and Koslowski, S.W.J. (1998). "Learning the Ropes: Coop Students Do It Faster." *Journal of Cooperative Education*, 28, 3, 30-41.

[32] Ducat, D. (1978). *Cooperative Education, Self-Concept, and Occupational Concept for Community College Students*. Doctoral dissertation, New York: Columbia University.

[33] Weston, W. D. (1986). "Career Identity and its Relationship to Participation in a Cooperative Education Program." *Journal of Cooperative Education*, 23, 1, 25-36.

[34] Raelin, J.A. (2000). *Work-Based Learning: Bridging Knowledge and Action in the Workplace.* San Francisco: Jossey-Bass.

[35] Wanous, J. P., Poland, Y.F., Prermack, S. L., and Davis, K.S. (1992). "The Effects of Met Expectations on Newcomer Attitudes and Behaviors: A Review and Meta-Analysis." *Journal of Applied Psychology*, 77, 288-297.

[36] Elfering, A., Semmer, N.K., Tschan, F. Kalin, W., and Bucher, A. (2007). "First Years in Job: A Three-Wave Analysis of Work Experiences." *Journal of Vocational Behavior*, 70, 97-115.

[37] Smith, H.S. (1965). "The Influence of Participation in the Cooperative Program on Academic Performance." *Journal of Cooperative Education*, 2, 1, 13-23.

[38] Lindenmeyer, R. (1967). "A Comparison Study of the Academic Progress of the Cooperative and the Four-Year Student." *Journal of Cooperative Education*, 3, 2, 8-18.

[39] Davie, R. & Russell, J. (1974). "Academic Performance and Work Experience: An Australian Cooperative Experience." *Journal of Cooperative Education*, 10, 2, 1-12.

[40] Somers, G. (1986). "How Cooperative Education Affects Recruitment and Retention." *Journal of Cooperative Education*, 25, 1, 72-78.

[41] Gardner, P. D., Nixon, D.C. and Motschenbacker, G. (1992). "Starting Salary Outcomes of Cooperative Education Graduates." *Journal of Cooperative Education*, 27, 3, 16-26.

[42] Blair, B. F., Millea, M., and Hammer, J. (2004). "The Impact of Cooperative Education on Academic Performance and Compensation of Engineering Majors," Journal *of Engineering Education*, 93, 4, 333-338.

[43] Raelin, J.A. (2007). "Toward an Epistemology of Practice," *Academy of Management Learning & Education*, 6, 4, 495–519.

[44] Raelin, J. A. (2010). *The Work Self-Efficacy Inventory*, Menlo Park, CA: Mind Garden, Inc., Available at: http://www.mindgarden.com/products/wsei.htm.

[45] Betz, N. E., Klein, K., and Taylor, K. M. (1996). "Evaluation of a Short Form of the Career Decision-Making Self-Efficacy Scale." *Journal of Career Assessment*, 4, 47-57.

[46] Lent, R. W., Brown, S. D. and Larkin, K. C. (1986). "Self-Efficacy in the Prediction of Academic Performance and Perceived Career Options." *Journal of Counseling Psychology*, 33, 265-269.

[47] Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., and Suthakaran, V. (2001). "The Role of Contextual Supports and Barriers in the Choice of Math/ Science Educational Options: A Test of Social Cognitive Hypotheses." *Journal of Counseling Psychology*, 48, 4, 474-483.

[48] Schlossberg, N. K. (1989). "Marginality and Mattering: Key Issues in Building Community." *New Directions for Student Services*, 48, 5-15.

[49] Rayle, A. D., and Chung, K-Y. (2007). "Revisiting First-Year College Students' Mattering: Social Support, Academic Stress, and the Mattering Experience." *Journal of College Student Retention: Research, Theory and Practice*, 9, 1, 21-27.

[50] Tinto, V. (1999). "Taking Retention Seriously: Rethinking the First Year of College." *NACADA Journal*, 19, 2, 5-9.

[51] Habley, W. R., and McClanahan, R. (2004). *What Works in Student Retention*? Iowa City: ACT, Information for Life's Transitions.

[52] Nicpon, M. F., Huser, L., Blanks, E. H., Sollenberger, S., Befort, C., and Robinson Kurplus, S. E. (2006). "The Relationship of Loneliness and Social Support with College Freshmen's Academic Performance and Persistence." *Journal of College Student Retention: Research, Theory and Practice*, 8, 3, 345-358.

[53] Ziskin, M., Hossler, D., and Kim, S. (2009). "The Study of Institutional Practices Related to Student Persistence." *Journal of College Student Retention: Research, Theory and Practice*, 11, 1, 101-121.

[54] Thom, M. (2001). *Balancing the Equation: Where are Women and Girls in Science, Engineering and Technology?* New York: National Council for Research on Women.

[55] Schlosser, L. Z., and Gelso, C. J. (2001). "Measuring the Working Alliance in Advisor-Advisee Relationships in Graduate School." *Journal of Counseling Psychology*, 48, 157-167.

[56] Blackwell, A., Bowes, L., Harvey, L., Hesketh, A. J., & Knight, P. T. (2001). "Transforming Work Experience in Higher Education." *British Education Research Journal*, 27, 3, 269-285.

[57] Fogg, N, and Putnam, M. (2004). "Considering the Needs of Different Stakeholders: The Impact of Co-op Job Quality on Post-Graduation Earnings." In P. Linn (Ed.), *Cooperative Education and Internships* (pp. 229-249). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

[58] Highsmith, R. J., Denes, R., and Pierre, M. M. (1998). “Mentoring Matters.” *NACME Research Letter*, 8, 1.

[59] Wilder, J. S. (1993). “The Sophomore Slump: A Complex Developmental Period That Contributes to Attrition.” *College Student Affairs Journal*, 12, 2, 18-27.

[60] Mann, S. J. (2001). “Alternative Perspectives on the Student Experience: Alienation and Engagement.” *Studies in Higher Education*, 26, 1, 7-19.

[61] Auburn, T. (2007). “Identity and Placement Learning: Student Accounts of the Transition Back to University Following a Placement Year.” *Studies in Higher Education*, 32, 1, 117-133.

[62] Ryan, G. Toohey, S., and Hughes, C. (1996). “The Purpose, Value and Structure of the Practicum in Higher Education: A Literature Review.” *Higher Education*, 31, 355-377.

[63] Gardner, P. D., and Koslowski, S.W.J. (1998). “Learning the Ropes: Co-op Students Do It Faster.” *Journal of Cooperative Education*, 28, 3, 30-41.