The Effect of Cooperative Education, Contextual Support, and Self-Efficacy on Male and Female Student Retention

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Abstract

This study presents the final results of a three-year longitudinal study of retention among male and female undergraduate engineering students enrolled at four major universities: Northeastern University, Rochester Institute of Technology, Virginia Polytechnic Institute and State University, and the University of Wyoming. It examines the effect of demographic characteristics, cooperative education, contextual support, and three dimensions of self-efficacy and their change over time on retention. It is based on a pathways model that links contextual support and cooperative education and other forms of student work experience to self-efficacy as a basis for retention in college and in the engineering major. As a longitudinal study, it incorporates measures at three time periods during the students' academic experience: their second, third, and fourth years.

The original data pool constituted all second-year students in the colleges of engineering from the four participating universities. Student respondents initially filled out a 20-minute survey, among which were assessments of three forms of self-efficacy. They then filled out comparable post-surveys one and two years later (as third and fourth-year students) during which those selecting co-op could have completed at least their first set of co-op placements.

The findings verified the pathways model. Academic self-efficacy and contextual support in all time periods were found to be critical to retention. Generalized contextual support was found to be particularly important to women and appears to serve as an inducement to stay in school and in engineering. Work self-efficacy, developed by students between their second and fourth years in school, was also an important factor in retention, though it is strongly tied to the students' participation in co-op programs. In particular, higher retention was associated with the number of co-ops taken by students. It was also found that the quality of the co-op placement, in particular through 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. 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 or the realization that useful knowledge can also be gained in the working environment. 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 in this study to have opened up the so-called "black box of co-op," which articulates the practices and behaviors of cooperative education that shape its contribution to the undergraduate experience.

Among the demographic variables, a relatively high GPA was found to be an inducement to persist in engineering and in school. It was also found, at the second survey point of the study, that a student's prior SAT/ACT scores had a measurable effect on retention. Finally, those students who were accustomed to work over a relatively long period of time were especially

more inclined to leave the university compared to those who had less work experience in their lifetimes.

Among the contextual support variables, support from friends and from one's college was found to explain retention at the time of the first survey as students reflected on their freshmen year experience. In an unexpected but modest finding, as we found with returning co-op students, those who persisted in the major and in school were more critical of their instructors than those who left.

The findings for co-op in this study not only lend support to those who have long asserted that quality co-ops can enhance undergraduate retention but also demonstrate co-op's enduring enhancement of students' work self-efficacy.

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 # 0827490, 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 (referred to as Time 1), a post-survey follow-up in the 2010-2011 academic year (referred to as Time 2), and a final post-survey completed in the 2011-2012 academic year (referred to as Time 3). Students initially completed a 96-item first survey (not included in this paper due to the proprietary nature of some components) as sophomores. They then completed a 102-item second survey approximately one year later and a final 104-item third survey in their fourth or senior year. The surveys were filled out either in written format or online.

A final data check was completed at the end of the fifth year of the students' undergraduate experience to more reliably report out graduation data, especially given that two of the sample universities operated on a five-year undergraduate schedule. No students were surveyed in this check; rather, their graduation statistics were gathered from the student record. The time period during which these data were assembled was approximately one year after Time 3. These data are referred to in this report as the "data check."

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 programs while the third and fourth do not require it. The total number of respondents at the point of the survey for Time 1 was 1637 students. The combined response rate was 67%. The response rate for Time 2 (calculated as the number of respondents from the first survey who successfully completed the second survey) was 54% and represents 886 students. The response rate for Time 3 (calculated as the number of respondents from the second survey who successfully completed the third survey) was 79% and represents 699 students. The Time 3 response rate as a proportion of the full dataset at Time 1 is 43%.

The overarching model for the study proposes that retention is shaped by self-efficacy. Self-efficacy, 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 the results of the analyses of longitudinal data during various times within the study period. The dependent variable, retention, is calculated as the number of students who both stayed in their university and in their major. 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 during their college careers through a number of mechanisms, in particular, through financial aid, mentors, advisors, family, friends, teachers, professional clubs, campus life, and living-learning communities.

This paper first presents the background, conceptual framework, and methodology of the study. Next, we describe the results of the principal study variables, cooperative education, contextual support, and self-efficacy, and retention over the three time periods. We then conclude by reviewing the significance of the results with implications for programs seeking to retain students, especially women, in undergraduate engineering.

Background

Retention

Student persistence has been a longstanding area of research interest not only because of internal reasons among interested universities (e.g., higher tuition revenues associated with lower dropout rates) but because of external reasons (e.g., use of retention measures in annual rankings).[1] The well-known Tinto Model of Institutional Departure[2] has pointed to the major reasons why students leave academia; namely, academic difficulties, irresolution of educational and occupational goals, and lack of integration into the intellectual and social life of the institution. Tinto and many others have subsequently offered a number of suggestions for institutional practices designed to retain students. Among them are: more targeted recruitment, reduction of experience of racial discrimination and prejudice on campus, improved chance for early academic success, better and more frequent advising, more active experiential instruction, more informed career planning, improved social acclimation and student-institution match, and an adequate level of need-based financial aid.[3 4 5 6 7]

Since the well-known mammoth Astin study in 1993,[8] which found that engineering students graduated at only a 47% rate in 1993, and in spite of many efforts to counteract this low rate of persistence, graduation rates among undergraduate engineers have not increased much more than 10%.[9] Meanwhile, demand for attractive engineering graduates continues to grow, perhaps best exemplified by President Obama's call for 10,000 more engineers per year.[10] Part of the President's proposal called for additional internship opportunities made available through the private sector. A recent study[11] using data from the National Survey of Student Engagement has seemingly concurred with the President's plans with its finding that students who persisted in the STEM (science, technology, engineering, and math) fields reported more frequent participation

in co-op and other related field experiences while dropouts spent more hours working off-campus and expressed only belated interest in general education and in reflective learning. The so-called "APPLES" study[12] generally supported these findings and added that engineering students were less satisfied with their instructors compared to students in other majors and also reported lower gains in personal growth and fewer opportunities to study abroad.

The problem of retention among undergraduate engineering students is exacerbated when it comes to under-represented populations, for example, among women. While recent studies show that women may be closing the retention rate gap in college,[13] they continue to be underrepresented in engineering. In 2011 women earned 18.4% of bachelor's degrees in engineering[14] (having peaked at 20.6% in 2000[15]). They also hold only 13% of engineering positions.[16]

Although women in the STEM fields are as academically prepared and as academically successful as men, they nevertheless lag behind men in academic satisfaction, academic self-efficacy, and self-esteem.[17] Traditional assumptions about career options for women have been reinforced in society and have projected stereotypes that discourage talented women from continuing in engineering careers. This is evidenced by research that found a dramatic drop in women's self-efficacy throughout the course of their engineering programs. In an in-depth study of students who switched out of science, math, and engineering majors, 77.9% of women cited discouragement and loss of self-efficacy as a factor in switching.[18]

Self-Efficacy

The concept of self-efficacy has been proposed as a promising conceptual link between practice-oriented learning processes, learning outcomes, and persistence.[19] [20] [21] 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. It is a dynamic proximal 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[22] 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[23] 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.[24] More recently, Lent and his colleagues have added the construct of educational and vocational satisfaction as a contributor to structural models examining the pathways between self-efficacy and interests and persistence intentions.[25]

SCCT theory has made an impact on models attempting to explain the withdrawal of students from undergraduate education. Compared to the models cited earlier that stressed the importance of academic performance and other institutional factors, such as student-institution match, SCCT focuses more on cognitive-person variables, such as self-efficacy, to reveal the potential for students to exert personal agency in their career endeavors.[26 27] What is especially important about these variables is that they can be assessed and their conditions altered during the freshman year and beyond in order to enhance students' perceived consequences of succeeding in college and staying in school.[28 29]

While this study's pathways model (Figure 1) bears some resemblance to Lent's theoretical SCCT model,[30] he and his colleagues used outcome expectations and interests as additional cognitive-person variables.[31] This study concentrates on self-efficacy since efficacy beliefs are believed to be the most central and pervasive mechanism of personal agency.[32]

Other than Lent's work on contextual factors, there has been some modest research on interventions that may lead to increased self-efficacy. In theoretical pieces, Betz[33] and Brown and Lent[34] 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. In one study,[35] a three-day problem-based camp experience was found to increase students' self-efficacy for specific tasks as well as general self-efficacy. Hutchison, Follman, Sumpter, and Bodner[36] more recently reported a relationship between academic and advisory support and female students' academic self-efficacy. A pilot study[37] 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.

In exploring whether gender plays a role in differentiating the impact of self-efficacy on undergraduate participation and retention, Hackett and Betz[38] were the first to use self-efficacy to explain the career development of women, especially in male-dominated career domains. They suggested that societal factors have created gender differences in gaining access to primary sources of career self-efficacy in male-dominated career fields. In turn, lower self-efficacy beliefs about these careers have resulted in fewer women entering these fields. Since then, empirical studies have supported these conclusions about efficacy and gender, finding that college-aged women's self-efficacy within male-dominated fields was significantly lower than their self-efficacy in traditionally female occupations.[39 40] The one exception to this finding is when women declare an engineering major upon entering school; in this instance their career self-efficacy becomes equivalent to that of their male counterparts.[41] We may conclude, as reported by Vogt, Hocevar and Hagedorn,[42] that self-efficacy is critical to academic integration and thus needs to be sustained if women are to persist in their undergraduate engineering majors.

Cooperative Education

It has long been established 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.[43] As a result, these programs help students transition into full-time work more easily, helping them overcome the "reality shock" attributed to first job experiences for uninitiated novices.[44] [45] In addition, cooperative education can also prove beneficial to students in sustaining their ongoing academic performance and their persistence to graduation.[46] [47] [48] [49] [50] Blair, Millea, and Hammer[51] 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). Co-op students have also been found to more successfully adjust to work at the outset of their employment,[52] 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.[53] Finally, as related to the social cognitive stream of research, co-op experience has been found to increase self-efficacy, self-concept, and career identity.[54] [55]

Of the various dimensions of self-efficacy that are likely to be affected by co-op, it appears that work self-efficacy is the construct of choice.[56] 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 learn within the workplace by increasing their confidence in performing many of these work-related behaviors.[57]

Fletcher's theoretical account [58] made a first attempt 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.[59] [60] 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.

Contextual Support

Contextual support (and barriers) have been heavily researched in social cognitive career theory and derive from SCCT's perspective that social influences pervade virtually every phase of career development.[61] What makes these influences contextual is their mediation through the

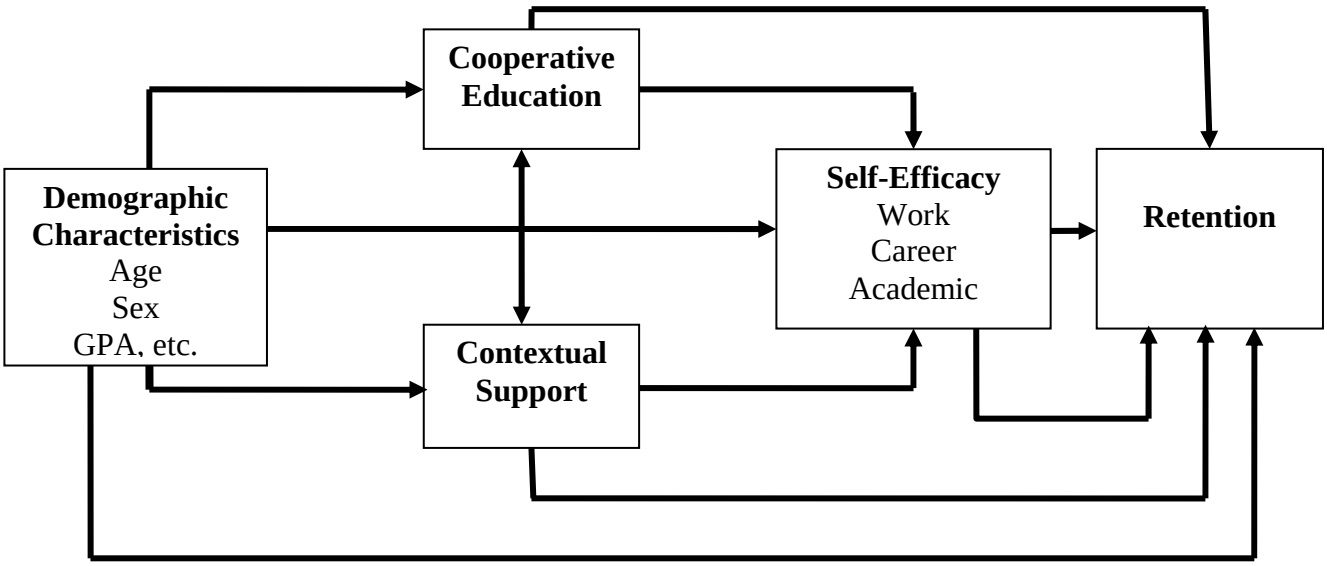
situation at hand, for example, through financial aid to those in need, through modeling and conversation, through the messages that parents, faculty, role models, and peers convey to students about their efficacy at different tasks, and through the career choice encouragement (or discouragement) that students obtain from influential significant others. [62] [63] [64] Consequently, contextual support has been found to enhance not only academic self-efficacy but academic achievement as well.[65] Many undergraduate programs have responded to the impact of support by offering traditionally under-represented students a variety of support systems, such as access to mentors and role models, to help them with the transition to college life. The Lichtenstein study[66] referred to earlier, for example, pointed out that female engineering undergraduates took more advantage of mentors compared to male undergraduates. These support mechanisms along with those cited above have been found to critically affect the retention especially of women in engineering.[67] [68]

Contextual barriers, as defined by Lent et al.,[69] consist of proximate (occurring during the time of undergraduate study) obstacles to career and academic self-efficacy and to retention. For example, students may face pressure for or against their pursuit of an engineering career from their peers or parents. They may also be dissatisfied with the instruction in the field or may encounter financial constraints. This study focuses on supports rather than barriers because Lent's work [70] [71] has found that supports and not barriers were more influential in students' pursuit of an engineering major and in their persistence in engineering beyond their second semester.

Framework

The conceptual framework for this study is depicted in Figure 1 as a set of pathways between five variable clusters. The determination of retention in undergraduate engineering education is based on the impact of students' demographic characteristics, the effect of work experience – in particular cooperative education, contextual support, and self-efficacy – categorized by three forms: work, career, and academic.

Figure 1
Conceptual Framework of the Study



Data

The data pool represents all sophomores, as of the start of the study, in the colleges of engineering from the four participating universities: Northeastern University, Rochester Institute of Technology, Virginia Polytechnic Institute and State University, and the University of Wyoming. Respondents filled out three 20-minute surveys, spaced out over approximately a year. While the Time 1 survey was completed entirely in written form, some 54% of Time 2 respondents and 62% of Time 3 respondents completed their surveys online. All surveys were conducted confidentially, and unique 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 at Time 1 was 1637 students (a response rate of 67%). The response rates for Times 2 and 3 were 54% and 79% respectively.

Besides the expected dominance of males in the sample, 79% at Time 1, 76% at Time 2, and 75% at Time 3, 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 Time 1, 3.12 at Time 2, and 3.10 at Time 3. For all surveys, the most popular major was mechanical engineering (at nearly a third of the sample) followed by civil and chemical. Electrical engineering was the fourth most popular major at Times 1 and 2, but was replaced by industrial and systems engineering at Time 3.

By the time of Survey 3, 100 students (approximately 6.1%) had left their university and 122 students (approximately 7.45%) had transferred out of engineering. The dropout percentages were very similar between men and women, except that slightly more women (+.4%) had left engineering and slightly more men (+.3%) had left the university. Of those who had left engineering, the most popular substitute major was science, followed by math, business, and social sciences in that order. The engineering students in our sample are viewed as hard-working since some 95% of them declared that they were working in some capacity. During their lifetimes, 30% of the sample at Time 3 reported one year or less of total work experience, 51% worked between one and three years, and 19% had worked over three years. In terms of organized school-based work experiences, 665 students (41%) participated in at least one co-op program during the three years of the study and an additional 174 (11%) undertook an internship, be it in their major or not connected to their major.

When asked about their plans following graduation, approximately 70% of respondents indicated that they would seek to work in a job in the engineering field. The bulk of the remaining respondents said that they would plan to attend graduate school in the field or do so part-time while working. By the time of the third survey, 437 students, or nearly 27% of the original 1637 in the full sample, had graduated. The others were either finishing up their course credits or had not graduated at the time their status was recorded. Those at the co-op universities (Northeastern University and Rochester Institute of Technology) were likely facing one additional year of matriculation.

The final data check reported earlier as assembled at the end of the fifth year of the students' undergraduate experience found that some 26% of the sample were still in school. Approximately 60% of them had graduated "on time," that is, in May of their fourth year for the four-year schools, or in May of their fifth year, for the five-year schools. Among those who graduated, 95% had earned their BS, while 3% earned a combined BS-MS with the remaining 2% the combined BS-MENG. The data check confirmed the Time 3 survey results that approximately 6% of the students had left the university; however, the percentage of students who left the major was reported as nearly 10% rather than the earlier reported 7.45%. The final GPA at the final data point was also just slightly higher than that reported at Time 3, with a mean of 3.16 versus the earlier reported Time 3 mean of 3.10.

Table 1
Overall Sample Statistics

School	# Students Completing Time 1	# Students in Data Pool	Response Rate	# Students Completing Time 2	Response Rate	# Students Completing Time 3	Response Rate
Northeastern University*	363	422	86%	325	90%	299	92%
Rochester Institute of Technology*	315	399	79%	174	55%	121	70%
University of Wyoming	128	287	45%	94	73%	77	82%
Virginia Polytech	831	1353	61%	293	35%	202	69%
TOTALS	**1637**	**2461**	**67%**	**886**	**54%**	**699**	**79%**

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

Measurement

Principal Study Measures

The measures of the principal study variables are as follows. The principal retention measure is the number of students who remained in their engineering college over the three-year time period of the study. Those who left the major or university were coded as drop-outs. Given the criticalness of this measure, each student's status as reported in the survey was checked against the student record. Only students who began the survey at Time 1 were counted, eliminating the chance for variation based upon the entry of new or transfer students. Although measures were taken separately of departures by major and university, the combined score provided a larger N necessary to evaluate the precursors to dropout status.

Self-efficacy was measured in three formats due to findings in the literature that support segmenting efficacy in determining persistence in engineering (see, e.g.., the work of Cech, Rubineau, Silbey, and Seron[72]). 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.[73] The inventory features seven subscales: problem-solving, sensitivity, role expectations, 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,[74] and academic self-efficacy was derived from the Self-Efficacy for Academic Milestones and the Self-Efficacy for Technical/Scientific Fields surveys.[75]

The numerical cooperative education variable was calculated by determining the number of co-ops that students experienced from 0 to 2 up to time periods 2 and 3, and from 0 to 6 using the data check at year 5 (with one student actually registering a 7th placement). The numerical internship variable was similarly derived. As for the contextual support variables, the majority (friends, family, professional, financial) were developed from familiar support scales in use such as the support subscales of Lent et al.[76] Two variables were drawn from the college students'

mattering literature,[77] [78] 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.[79] [80] [81] [82] Finally, the support of both an advisor and a mentor[83] was measured by deploying the advisorship and mentorship scales from the rapport and apprenticeship subscales of the Advisory Working Alliance Inventory (AWAI) prepared by Schlosser and Gelso.[84] Demographic data, such as SAT/ACT scores, major, and GPA, were self-reported by the respondents directly on the survey instrument, but were verified and in some cases (e.g., where the data were missing) directly obtained from their student records.

Scale Validity and Reliability

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 Time 2 data, composed of ten measures used to evaluate the quality of students' co-op experiences. Research by Blackwell et al.[85] 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[86] and Highsmith, Denes, and Pierre[87] 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 a 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, GPAs at all three time periods were found to be highly and significantly correlated with academic self-efficacy at these respective time periods. Academic self-efficacy in all time periods was also significantly correlated with the teaching quality measures at their respective time period and SAT/ACT scores overall.

Change Scores

To compute the differences between time periods, three change scores were calculated for each of the scaled independent measures: between Time Periods 1 and 2, between 2 and 3, and between 1 and 3. An initial analysis, using paired sample t-tests, was also conducted to determine if there were significant differences between these respective time periods for the measures involved. Table 2 below depicts just the efficacy change scores. As can be seen, most of the changes are significant in a positive direction. However, academic self-efficacy actually went down between Time 1 and Time 3 and significantly between Time 1 and Time 2. This suggests that student's overall confidence in their academic performance declined after the relative early success of the freshman year and before the rigorous requirements of the major kicked in. There was reason for the slump in academic self-efficacy as the students' GPAs, at Time 2 especially, fell in comparison to their GPAs at Time 1. Regarding the other change scores (like GPA, not displayed in the table), only two differences were lower at subsequent time periods: college mattering and college involvement. Students overall found their universities to care less about them and seemingly responded by decreasing their involvement in campus life. This finding may be a reflection of the oft-reported undergraduate phenomenon known as the "sophomore slump."[88]

Table 2
Changes in Efficacy Scores Between the Time Periods

	N	Time 1 vs. Time 2	N	Time 2 vs. Time 3	N	Time 1 vs. Time 3
Work self-efficacy	885	3.88 vs. 3.93**	704	3.93 vs. 3.94	704	3.88 vs. 3.94*
Career self-efficacy	879	3.76 vs. 3.81**	693	3.80 vs. 3.89**	704	3.77 vs. 3.89**
Academic self-efficacy	871	3.98 vs. 3.91**-	689	3.93 vs. 3.99*	695	4.01 vs. 3.98-

** Significant at p<.01 using two-tailed paired sample t-test
* Significant at p<.05 using two-tailed paired sample t-test
- Indicates negative t

Statistical Analysis

The primary purpose of the statistical analysis is to determine the pattern of explanatory variables, representing the study's pathways model, which may account for the retention of students in undergraduate engineering. Prior to the final analysis at Time 3, the analysis of the data focused on the impact of the study's independent variables on the three separate dimensions of self-efficacy (work, career, and academic). For this purpose, regression equations were constructed to determine how much of the variance in each of these dependent variables could be explained by the demographic and support variables.

At Time 3, the principal study variable of retention was calculated and thus was able to enter the analysis. Since this dependent variable is a categorical measure, the method chosen was discriminant function analysis (DFA). Like multiple regression analysis, the purpose of DFA is to isolate the independent variables which predict a dependent variable, but in the latter case, it is to find the attributes which contribute most to the separation between two or more groups (such as stayers vs. leavers) rather than to isolate the factors to explain the fraction of variance in a continuous dependent variable. What is reported in this paper is the Wilks' Lambda and the canonical correlation statistics and their respective test for significance (Box's M F-score and chi-square respectively). Wilks' Lambda denotes the significance of the discriminant function, and the canonical correlation reflects the multiple correlations between the predictors and the discriminant function – comparable to the R-square or proportion of variance explained in the more familiar regression model. The order of the predictors is based on each function's discriminant loadings.

Further analysis of the moderating effect of contextual support on the relationship between gender and retention and of the moderating effect of work self-efficacy on the relationship between cooperative education and retention is conducted using cross-tabulation.

Results

For Co-op

Our pathways framework hypothesized that co-op experience would be a critical ingredient in enhancing self-efficacy, which would, in turn, produce a higher rate of retention among co-op students. To initially determine this possible effect, we first divided the sample into students who completed their first co-op and those who had not. We then performed t-tests of means for these two groups on change in self-efficacy between Time 1 and Time 2. 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

experienced a decrease. 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, the support available from their collegiate advisor. Interestingly, co-op students' GPAs did not decrease as much as non-co-op students' GPAs. Co-op students also 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[89] and Auburn[90] 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 co-op has taken center stage in this study, 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 as those described above. 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 the 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 between Times 1 and 2

	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	

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 significantly 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 self-efficacy 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.

Turning aside from the focus on self-efficacy, 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. In addition, 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 was also administered to both sets of interns. Although only 16 of the 118 internships were reported as not 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.

The data check at the end of the fifth year of the students' undergraduate experience provided nearly final co-op data. As can be seen in Table 4, half of the sample had at least one co-op. Given that one of the participating universities sponsored 3-month co-ops based on a quarter system, some students had as many as six or seven co-ops, though the most frequent co-op number was 3.

Table 4
Number of Co-ops at the end of Year Five

Co-ops	N	Relative Percentage
0	733	50%
1	65	4%
2	113	8%
3	325	22%
4	80	5%
5	131	9%
6	11	1%
7	1	0%

As shall be reported below in our discussion of the principal study variable of retention, the data check confirmed the importance of the cumulativeness of co-op participation. Those students who stayed in school and in their major had an average of 1.73 co-ops, whereas those who dropped out only had an average of .48 co-ops. The data check also found a solid relationship between number of co-ops and academic performance. Those students who did not participate in co-op or had just one co-op had a weighted GPA of just over 3.0; whereas those with two or more co-ops had a weighted GPA of 3.33, nearly a half-grade higher.

For Contextual Support

Contextual support was defined in this study as influences on student success via mediation through the situation at hand, such as through financial aid to those in need as well as through modeling and conversation, such as in the messages that parents, faculty, role models, and peers convey to students. As early as the pre-survey of this study, women students were found to significantly take more advantage of support in all forms.[91] Consider Table 5, where it becomes clear that women benefit far more from mentorship (though this can be expected given that the programs in question were designed exclusively for this purpose). They also exceeded the scores of their male counterparts in four other support dimensions: they report receiving more support from professional clubs and associations; they say they are more involved in campus life; and they also report that they not only receive more support from their friends but that their friends really matter to them.

Table 5
Contextual Support by Gender

	Mentor-ship	**Prof. Support**	**Friend Support**	**Friends Matter**	**Involve-ment**
Males	3.98	3.54	4.25	4.19	3.60
Females	**4.24**	**3.75**	**4.49**	**4.43**	**3.78**
F-ratio	2.23	6.07	12.51	14.60	4.57
Sig.	0.137	0.014	0.000	0.000	0.033

*****Bold figures indicate higher value and F-ratio calculated using Scheffe's Test

The study also considered the impact of students choosing residence in selective living/learning communities, such as special floors or houses in engineering, honors, or leadership. Nearly half of the sample took advantage of these special residential arrangements, but women were significantly more likely to have chosen this residential option. Specifically, 64% of women chose a living/learning community in their freshman year, compared to 43% of men. Furthermore, those who chose to live in living/learning communities reported greater effects among several of the study's support variables. In particular, they were more likely to receive financial and professional support, were more involved in campus life, and declared that both their friends and the university as a whole mattered more to them.

For the Efficacy Variables

A range of multiple regression analyses were conducted for the separate self-efficacy constructs during the different phases of the study. During the early stages, given that none of the students in our sample had been engaged in formal university-sponsored work experience programs, such as cooperative education, the results especially for work self-efficacy were expected to be modest, and this was in fact the case. The first critical outcome was reported at Time 1 for *academic* self-efficacy. Confirming prior work on gender and academic self-efficacy within male-dominated fields such as engineering, women in this study at Time 1 were found to have significantly lower academic self-efficacy, but not lower career or work self-efficacy. Table 6 reveals the full results of this regression analysis. A robust 43.7% of the variance is explained. Not surprisingly, GPA accounts for the largest portion (with a Beta weight of .449). After GPA,

the most powerful predictor of academic self-efficacy is the composite of social support, assembling all the support variables in our study minus financial support, which coincidentally also appears as a significant predictor. A related predictor is advisorship, comprising a scale of support received from one's academic advisor. From the demographic variables, two descriptive measures entered the equation: the student's SAT/ACT score and the major of chemical engineering.

The overwhelming contribution of GPA to academic self-efficacy was confirmed at Times 2 and 3 of the study. By the fifth year of the students' undergraduate experience, the data check revealed a significant correlation between final GPA and academic self-efficacy at Time 3 to be .67, far and away the highest correlation by +.37 compared to its next highest correlate, that being number of final co-ops (for which the correlation coefficient was .30).

Table 6
Regression for Academic Self-Efficacy (AS-E) at Time 1

Model Summary

R	R^2	Adjusted R^2	Std. Error of the Estimate
0.665[a]	0.442	0.437	0.59

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	346.539	11	31.504	91.259	0.000
Residual	437.380	1267	0.345		
Total	783.919	1268			

Significant Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-1.118	0.5535		-2.092	.037
GPA	.690	.035	.449	19.479	.000
Soc. Support	.491	.033	.354	15.037	.000
Gender	-.270	.041	-.141	-6.593	.000
SAT Score	.045	.000	.072	3.133	.002
Major	.010	.004	.058	2.678	.007
Fin. Support	.029	.013	.050	2.221	.027
Advisorship	.042	.020	.049	2.152	.032

[a] Dependent Variable is Academic Self-Efficacy (AS-E)

The results for career self-efficacy sustained the overriding impact of contextual support as the primary predictor at Time 1. Moreover, the aligned and specialized variable, mentorship, was a particularly strong independent variable, though it produces lowered degrees of freedom since it applies to (and was answered only by) students who receive special support from programs for women and those otherwise underrepresented in engineering.

Work self-efficacy was not a prominent variable in the early stages of the study because other than casual work experience, none of the students in the sample had yet to have their first co-op experience. Hence, students' confidence in managing themselves in the workplace was largely unaffected in the first year of undergraduate study. However, as was reported earlier, work self-efficacy between Time 1 and Time 2, during which period students at our co-op universities would have had their first co-op, was significantly enhanced, as was career self-efficacy. In fact, in a regression on work self-efficacy change – not presented here – between Time 1 and Time 2, only two prominent predictors were found: career self-efficacy change and participation in cooperative education.

For Retention

To determine the impact of the pathways model on retention, separate discriminant function analyses were conducted using the change scores as well as the regular scores during each of the three time periods. Using both the change as well as the component scores was suggested by Edwards[92] as a way to assess the integrity of the former. The discriminant analyses were also conducted using the components of the retention dependent variable, namely leaving the major and leaving the university, as well as for gender.

Tables 7 and 8 reveal the results of four of these analyses. Table 7 lists the significant discriminating variables on retention for changes between Time 1 and Time 3, and Table 8 lists the discriminating variables for Times 1, 2, and 3. The retention variable is recorded at Time 3, although the heavy majority of departing students (70%) left the major or university at Time 1. Fifteen percent left at Time 2 and the remaining 15% at Time 3.

Examining first the change results, the discriminant model is highly significant with a Wilks' Lambda of .901 and a canonical correlation of .31. The most critical variable predicting retention was the number of co-ops taken by the respondents. Those who stayed in school or in the major participated in more co-ops than those who left. The number of co-ops was ostensibly more important than their quality. Similar, though less robust, results were found for internships. There was also a significant difference for change in academic self-efficacy. Although as already noted, overall academic self-efficacy decreased (along with GPAs) after the freshman year, this form of efficacy particularly plunged for drop-outs compared to those who persisted either in the major or in school.

Another important predictor was the amount of past work experience, but, perhaps surprisingly, those who worked the most were more likely to drop out. There are many possible reasons for this result, but the two most likely hypotheses – given that the relationship was most critical for those who chose to leave the university rather than the major – are that students with a history of consistent work experience need to work to sustain the income to attend school or that they may

find academic studies to be less relevant than the rigors of the working world. Another prospective hypothesis is that age may play a role and the findings display a moderate effect; in particular, dropouts over the age of 20 have approximately six months more work experience than dropouts under the age of 20. It should be noted that the "work" associated with this measure could be any reported prior and current employment and may not reflect ongoing work experience programs offered through one's institution, such as co-ops or internships.

Though not quite at an acceptable significant level, Table 7 reports the means for change in work self-efficacy, which were far lower for drop-outs than for those who persisted. There was also a near-significant effect for change in teaching quality. Provocatively, those who stayed, especially by Time 3 of the study, were far less impressed with their instruction than those who left the major or the university. One possible rationale for this result might be that those who stayed were more serious students than those who left and thus were more critical of their instructors. Another rationale might be that those who stayed and participated in co-op or internship programs have developed a more critical view of a curriculum and instruction that may not be sufficiently "real-world."

For the Three Time Periods

Looking next at the discriminant analysis results for the separate time periods, all models are significant. It is clear that four variables dominate the explanation of retention, three of which were cited in the change model: number of co-ops, academic self-efficacy, past work experience, and GPA. There is a likelihood that the variable, past work experience, would have appeared in the Time 1 model but it was not included in the first survey. The support composite variable, including the multiple facets of support, also appears in each equation, though not at the same robust level of significance. Clearly, those who stay, experience more contextual support across the board compared to those who leave. In the Time 1 equation, the two "mattering" variables – friends and college – appear; thus it seems important that in the early undergraduate experience, students need to develop a rapport with friends at college and with the college as a whole in order to develop a commitment to stay in school. Having the support of friends continues to play a role in retention at Time 2. At Time 2, the demographic variable, prior SAT/ACT score, makes its appearance, providing some support to the contention by such authorities as the College Board and ACT that achievement test scores are an indicator of subsequent academic retention as well as performance.[93 94] Finally, at Time 3, work self-efficacy manifests itself again, this time significantly, in predicting the retention of students. Since most students work in some capacity, those who develop confidence in managing themselves in the workplace tend to stay in school at a higher rate than those who do not.

Conditional Analyses

Separate DFAs were conducted on retention for the components of the retention variable and for gender. In spite of the reduced number of cells for students who left, the pattern of prediction for the dependent variables, left the university, and, left the major, was comparable to the overall retention variable. As for the analysis when separate runs were performed for men and women,

the men had a nearly identical pattern as the full population. However, the DFA changed somewhat for women. Although only 45 women were found to have dropped out of either the major or university, the discriminant function for the change scores was found to be highly significant with a canonical correlation of .50. As in the case of the men, the number of co-ops and change in academic self-efficacy from Time 1 to Time 3 were still found to be the significant predictors. However, unlike the men, past work experience, change in work self-efficacy, and change in teaching quality did not enter the equation. Rather, the next most important predictor of retention for women was socioeconomic status. Although this result needs to be viewed with some caution because of the low number of cells among female dropouts, those women who stayed were on average more likely to be slightly above middle class, whereas those who left were more likely to be slightly below middle class in socioeconomic status. Finally, the data check confirmed the overall pattern of the discriminant analysis results. The variables, number of co-ops, change in academic self-efficacy, and GPA continue to dominate the findings on retention. In the change discriminant run, for example, the statistics, e.g., the Wilks' Lambda and the Canonical Correlations and the discriminating variables are comparable except that final GPA and the support composite entered the equation.

Table 7

Discriminant Analysis Displaying Significant Change Variables Between Time 1 and Time 3

Dependent Variable: Retention N = 586*

Wilks' Lambda: .901 Canonical Correlation: .31 Chi-Square Significance: .001

Discriminating Variables	Mean for Retention	Mean for Drop-Out	F-Score	Significance
Number of Co-ops	1.22	.43	20.23	.001
Change in Academic Self-Efficacy	-.03	-.48	10.47	.001
Past Work Experience	4.20	4.79	-6.41	.012
Change in Work Self-Efficacy	.05	-.16	3.18	.075
Change in Teaching Quality	.06	.39	-3.01	.083

*The reason for the lower N compared to Table 2 is due to the nature of multivariate analysis in which the number of missing values is based on the full set of variables entered. Minor discrepancies in scores may also occur due to these differences in handling missing values.

Table 8

Discriminant Analysis Displaying Significant Independent Variables over Three Time Periods

Time Period 1

Dependent Variable: Retention N = 778
Wilks' Lambda: .915 Canonical Correlation: .29 Chi-Square Significance: .001

Discriminating Variables	Mean for Retention	Mean for Drop-Out	F-Score	Significance
Number of Co-ops	1.28	.61	30.18	.001
GPA	3.32	3.02	19.84	.001
Academic Self-Efficacy	4.03	3.62	14.53	.001
College Matters	3.81	3.33	12.58	.001
Friends Matter	4.34	3.98	11.09	.001
Support Composite	4.33	4.10	7.80	.005

Time Period 2

Dependent Variable: Retention N = 752
Wilks' Lambda: .875 Canonical Correlation: .35 Chi-Square Significance: .001

Discriminating Variables	Mean for Retention	Mean for Drop-Out	F-Score	Significance
Academic Self-Efficacy	3.97	3.16	42.23	.001
Number of Co-ops	1.18	.40	32.20	.001
Past Work Experience	3.91	4.98	-21.80	.001
GPA	3.23	2.90	21.20	.001
Support Composite	4.39	4.09	12.15	.001
Friends Matter	4.37	4.04	8.30	.004
SAT Score	1281	1243	4.44	.035

Time Period 3

Dependent Variable: Retention N = 629
Wilks' Lambda: .915 Canonical Correlation: .29 Chi-Square Significance: .001

Discriminating Variables	Mean for Retention	Mean for Drop-Out	F-Score	Significance
Academic Self-Efficacy	4.02	3.29	30.00	.001
Number of Co-ops	1.20	.45	18.47	.001
Past Work Experience	4.18	4.79	-7.37	.007
GPA	3.28	3.07	5.77	.017
Work Self-Efficacy	3.93	3.77	5.39	.021
Support Composite	4.33	4.08	4.88	.028

Moderation of Results by Gender and by Work Self-Efficacy

As reported earlier, in a pre-survey it was found that female undergraduate engineering students in their freshman and sophomore years took significantly more advantage of the support provided to them through friends, professional clubs, and the university, such as through living/learning communities. Therefore, once the longitudinal surveys were completed, an attempt was made to determine if the main finding of an insignificant effect of gender on retention was masked by the effect of contextual support. As can be seen in the contingency table displayed in Table 9, reporting only the results for students who persisted in the major and university, there is no particular effect for men on levels of support (which is coded into three categories of low, medium, and high support). However, women who stay in the major or in school are far more likely to report higher levels of contextual support – support being measured in this illustration by an overall composite score at Time 1 (though the pattern reported in this table for support and gender was reflected in all time periods).

Table 9

The Relationship of Gender and Retention Moderated by Contextual Support*

	Low Support		Medium Support		High Support	
	Count	Percentage	Count	Percentage	Count	Percentage
Men	334	30%	407	37%	365	33%
Women	61	21%	97	33%	138	47%

* Pearson chi-square test for stayers significant at .001

A comparable contingency analysis was performed for the moderation of change in work self-efficacy on the relationship between number of co-ops and retention, clearly one of the most powerful relationships uncovered by the DFA. Our study of the data at Time 2, as reported earlier, had found that an initial co-op experience had a pervasive impact on the development of work self-efficacy. The results of the current analysis are shown in Table 10. As in Table 9, only data for those who stayed in the major or in the university are included. Change in work self-efficacy has been recoded into three categories: went down, stayed about the same, and went up. As can be seen in the table, a significant inverse pattern emerged. Some 76% of those who had at least one co-op saw their work-self efficacy going up or staying the same whereas the same percentage of those who did not have co-op saw their work self-efficacy going down or staying the same.

The relationship between co-op and change in work self-efficacy was confirmed in the data check. The correlation for these two variables was found to be a highly significant Pearson coefficient of .32. A breakdown analysis can reveal a more fine-grained view of the effect of the cumulativeness of co-op participation. As can be seen in Table 11, there is almost a perfect pattern (with the exception of the flipped case between having three and four co-ops) demonstrating that each additional co-op is associated with a more positive change in work-self-efficacy.

Table 10

The Relationship of Co-op and Retention Moderated by Change in Work Self-Efficacy*

	Went Down		Stayed About the Same		Went Up	
	Count	Percentage	Count	Percentage	Count	Percentage
At least one co-op	98	24%	136	33%	180	43%
No co-op	95	43%	71	33%	53	24%

* Pearson chi-square test for stayers significant at .001

Table 11

Breakdown of Change in Work Self-Efficacy By Number of Co-ops

Mean	N	Co-ops
0.471	7	6
0.226	57	5
0.213	265	3
0.118	48	4
0.084	56	2
-0.045	26	1
-0.287	167	0

P<.001 for F-value, verified by Scheffe's Test

Conclusion and Implications

This study has verified the contours of the pathways model linking particular demographic characteristics, cooperative education, contextual support, and self-efficacy to the retention of students in undergraduate engineering education. Since the study was longitudinal, it was able to assess the change in the support and efficacy measures over time. Academic self-efficacy and contextual support in all time periods were found to be critical to retention. Contextual support was found to be particularly important to women and appears to serve as an inducement to stay in school and in the major. Work self-efficacy, developed by students between their second and fourth years in school, is also an important factor in retention, though it is strongly tied to the participation by students in co-op programs. Career self-efficacy did not play a unique role in the change analysis.

The relationship between co-op participation by students and change in work self-efficacy and their combined effects on retention are worth highlighting. First, this study 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 indeed supported the link between cooperative education (both separate from and including internships) and change in work self-efficacy. In particular, the quantity or cumulativeness of co-op experience was found to be incrementally important in augmenting work self-efficacy. 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[95] 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[96] 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, in a finding relatively new to the co-op literature, retention in both the major and in school appears to be enhanced by the number of co-op assignments (the more the better). This study was initially only able to assess the effects of two co-op assignments, but the data check incorporated the standard three co-op assignments at Northeastern University, and the multiple 5, 6, and even 7 co-op assignments at Rochester Institute of Technology (though taken for a shorter period of time).

Concerning the contextual support variables, a composite score was found to be highly predictive of academic self-efficacy during all time periods but especially for women students. Contextual

support was also predictive of all forms of self-efficacy after the first year in school. The impact of contextual support derives from social cognitive theory's perspective that social influences pervade virtually every phase of career development. As further suggested by the literature, social support furnishes a means in the first year of college to cope with the stress of a new environment allowing for greater adjustment to college life, which likely shapes the self-efficacy of students not only in their academic pursuits but in their work and career aspirations as well.

Acknowledging the link between support and efficacy, colleges of engineering have begun to take active steps in providing support to women during their early college years. Some of the support mechanisms, such as the availability of professional and friend support, come at modest incremental costs to colleges. Furthermore, this study has suggested that women are taking advantage of these support mechanisms. For example, their reliance on special mentorship opportunities can enhance their career self-efficacy. Women can also take advantage of residences in specialized living/learning communities which, in turn, can increase their connection to the university.

Beyond the finding of the significant relationship between the composite of support and retention, two component measures are worth highlighting. The two "mattering" variables of feeling support from friends and from one's college at Time 1 were found to sustain retention. In an unexpected though modest finding, those students who persisted in the major and in school were more critical of their instructors than those who left.

Among the demographic variables, there is no substitute for sustaining a relatively high GPA as an inducement to persist in the major and in school. It was also found at Time 2 of the study that a student's prior SAT/ACT scores had a measurable effect on retention. Initially, age was a significant predictor of work self-efficacy; major and SES (socioeconomic status) featured in career self-efficacy, and GPA, gender, SAT/ACT scores and major were prominent in academic self-efficacy. These relationships are each predictable, with the possible exception of race, gender, and major. Race is notable because of its complete absence as an explanatory variable, at least when it comes to self-efficacy among engineering students. That males have higher *initial* academic self-efficacy has been long established in the literature.[97 98] Regarding major, aerospace and chemical engineering majors maintain relatively high career and academic self-efficacy, respectively. Finally, those students who were accustomed to work over a relatively longer period of time were more inclined to leave the university compared to those who had less work experience in their lifetimes. It should be noted, however, that this work exposure likely includes many experiences outside the auspices of co-op and internship opportunities associated with the major.

Changes in states and attitudes in this study were calculated between the first and second, second and third, and first and third time periods. Most of the changes were in a positive direction except for academic self-efficacy, which decreased in concert with GPA. Engineering students experience a degree of discouragement and lowered confidence as their academic performance declines. There was also a reported decline in college mattering and college involvement. As reported earlier, some students overall found their universities to care less about them by their sophomore year (perhaps in contrast to "first-year" retention programs) and seemingly responded

by decreasing their involvement in campus life, suggesting that the "sophomore slump" is still a condition that should be addressed.

These results point to some prospective methods to improve the retention of undergraduate engineering students. Although many students in engineering have access to co-op programs or internships, many still do not participate because of personal preferences or because their university hasn't made the sustained financial and human resource commitment to provide for a program of formal targeted placements along with counseling support. Nevertheless, the benefit in terms of retention seems to be worth the investment. Although co-op can be an important resource to enhance work self-efficacy, universities also need to find ways to enhance and develop students' academic self-efficacy. Along these lines, there may be no substitute for continuing to provide a range of support services to students, both of an academic, professional, and social nature. In conjunction with the series of studies conducted in prior years with the original database, support especially for women and for under-represented students can be enhanced through such means as providing academic counselors and mentors to students, giving them the opportunity to have a residence in a living/learning community, affording them exposure to role models in the field, or upgrading instruction to be more experiential than rote.[99] Although these support services are thought to be especially important during the first year of college, they should be sustained throughout the collegiate experience. For those students who have had or are currently engaged in extensive work experience, whether or not institutionally provided, it is especially important that the nature of instruction show a high degree of relevance and connection to the contemporary operating conditions within the working world.

The study's emphasis on and findings for self-efficacy have implications for ongoing research relying on social cognitive constructs. It appears from this study that self-efficacy's power is associated with the academic experience from which it derives.[100] In this study, given the high association (correlations between .46 and .67) between GPA at each time period and at the end of the fifth year with academic self-efficacy, it is likely that both conditions sustain each other over time. Meanwhile, this study has also revealed that the reciprocal relationship between work self-efficacy and co-op participation has also played a critical role in retention. Co-op provides the opportunity to develop work self-efficacy, which in turn provides for a deeper co-op experience, and both thus serve to keep students committed to their academic experience.

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