
AC 2011-562: THE EFFECT OF CONTEXTUAL SUPPORT IN THE FIRST YEAR ON SELF-EFFICACY IN UNDERGRADUATE ENGINEERING PROGRAMS

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The Effect of Contextual Support in the First Year on Self-Efficacy in Undergraduate Engineering Programs

Abstract

This study examines the effect of contextual support in the first year, controlling for demographic characteristics, on three dimensions of self-efficacy: work, career, and academic. Contextual support is defined as the encouragement provided to students in their first year through both institutional means, such as financial aid, mentorship, and participation in a living-learning community, and through modeling and conversation. The latter instance represents the messages that parents, faculty, role models, and peers convey to students about their efficacy at different tasks or in the career choice encouragement (or discouragement) that students obtain from influential significant others.

The data pool for this study was constituted of all sophomores in the colleges of engineering from four participating universities. Student respondents filled out a 20-minute survey, among which were assessments of the three forms of self-efficacy. The analysis of the data revealed that social support in the first year from friends, family, college support services, and faculty furnishes a powerful and independent impact on efficacy over and above demographic qualities. The only demographic characteristic that preceded social support as an explanation of self-efficacy was the impact of academic performance on academic self-efficacy. Otherwise, social support furnished the most significant explanation of work, career, and academic self-efficacy upon completing the first year in undergraduate engineering programs.

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 the retention of women in undergraduate engineering programs. These data represent the initial pre-survey of the study completed in the 2009-2010 academic year. Students completed a 96-item survey (not included in this paper due to the proprietary nature of some components). This survey was administered mostly in class and in written form at the start of their sophomore year; thus their responses were a reflection on their first year experiences. Data will be gathered at two additional points in years two and three of the study, corresponding to the students' third and fourth years in an undergraduate engineering program. A first sample was also gathered in 2008-2009 and reported out at the 2010 ASEE Annual Conference in Louisville.¹

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 was 1638 students, of which 344 were female. The combined response rate was 67%.

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 contextual support in the first year of college on three forms of self-efficacy. These three 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. A pre-test of our student populations revealed that nearly all engineering students have some form of work experience, though not necessarily provided by their colleges. Contextual support was measured as the support provided to students in their first year 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 contextual support, in conjunction with descriptive measures of respondent demographics, on self-efficacy. We then conclude by reviewing significant findings of the study thus far and describe future plans of this ongoing 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. Bandura³ 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 Lent⁴ 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 along with 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 during the freshman year 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 in the first year experience leads to improved adjustment and academic performance, which, in turn, shapes 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 self-efficacy since efficacy beliefs 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 limited research on interventions that may lead to increased self-efficacy. In theoretical pieces, Betz¹⁷ and Brown and Lent¹⁸ 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,¹⁹ 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, & Bodner²⁰ recently reported a relationship between academic and advisory support and female students' academic self-efficacy. Finally, a pilot study²¹ 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.

Contextual support is derived from social cognitive theory's perspective that social influences pervade virtually every phase of career development.²² What makes these influences contextual is their 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 about their efficacy at different tasks or in the career choice encouragement (or discouragement) that students obtain from influential significant others.^{23 24}
²⁵ Many undergraduate programs offer 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. These support mechanisms along with those cited above have been found to critically affect the retention especially of women in engineering.^{26 27}

Contextual barriers, as defined by Lent et al.,²⁸ 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 opposition from their peers or parents in their pursuit of an engineering career. 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^{29 30} 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. Further, the intervening elements of expectations and interests in the SCCT model have been thought to be more compelling in retaining students within the major once they have been exposed to its academic and social realities.

Framework

The conceptual framework for this study is depicted in Figure 1 as 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, as is indicated in the *highlighted italics* in Figure 1, we are interested in the effect of demographic characteristics and, in particular, of contextual support, on self-efficacy.

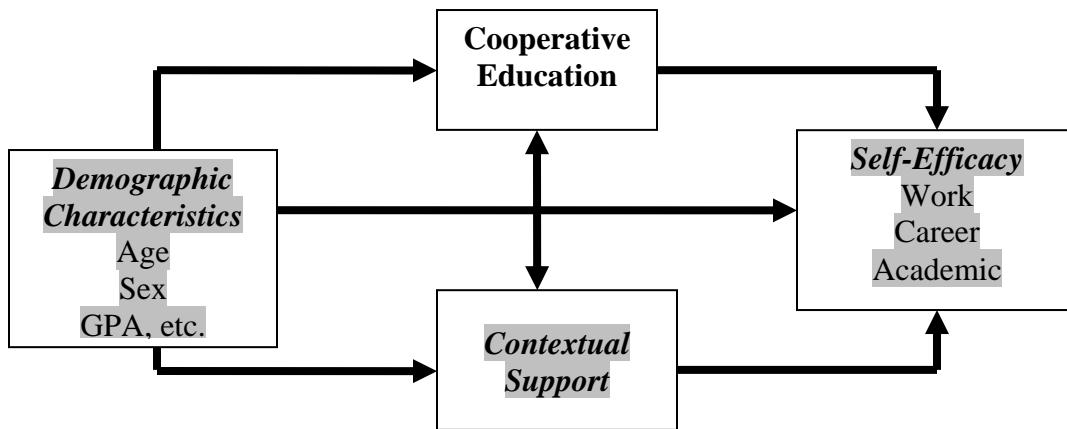


Figure 1. Conceptual Framework of the Study

Data

The data pool represents all sophomores in the colleges of engineering from the four participating universities. All students filled out a 20-minute survey, mostly in class and in written form. As Table 1 reveals, the total number of respondents was 1638 students, of which 344 were female -- a proportion of 21%. The overall response rate was 67%.

Besides the expected dominance of males in the sample at 79%, it is predominantly Caucasian (79.5%) and upper-middle and middle class (83%) in socioeconomic status (SES). The average SAT score is 1269 (math plus verbal scores), based on the original SAT version with a 1600 maximum score. The average GPA is 3.21 as reported at the end of the freshman year. The most popular major is mechanical engineering (at nearly a third of the sample) followed by civil, chemical, and electrical in that order.

Table 1
Overall Sample Statistics

School	# Students Completing Survey 1	# Students in Data Pool	Response Rate	# Women Completing Survey 1	% Women
Northeastern University*	363	422	86%	71	20%
Rochester Institute of Technology*	315	399	79%	61	19%
University of Wyoming	128	287	45%	27	21%
Virginia Polytechnic Institute	832	1353	61%	185	22%
TOTALS	1638	2461	67%	344	21%

*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 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.³¹ 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,³² and academic self-efficacy was derived from the Self-Efficacy for Academic Milestones and the Self-Efficacy for Technical/Scientific Fields surveys.³³ Among the contextual social support variables, the majority (friends, family, professional, financial) were derived from familiar support scales in use such as the contextual support subscales of Lent et al.³⁴ Two variables were drawn from the college students' mattering literature,^{35 36} suggesting 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 choose a living-learning community.^{37 38 39 40} Finally, the support of both an advisor and a mentor⁴¹ 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.⁴² Demographic data were obtained from the respondents directly on the survey instrument or 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.

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, freshman GPA was found to be highly and significantly correlated with academic self-efficacy. The latter was also significantly correlated with teaching quality and prior SAT scores.

Results

Relationship Between Social Support and Self-Efficacy

Initially a correlation analysis was performed to determine whether there is a bivariate relationship between social support, as measured by the new composite variable minus financial support, and the three forms of self-efficacy. The results show highly significant ($p < .01$) relationships for all three forms of self-efficacy as follows:

Social Support and WS-E = .31
Social Support and CS-E = .46
Social Support and AS-E = .42

Financial support was also significantly correlated with self-efficacy, but the coefficients were much lower. In addition, as would be expected, the correlations between social support and advisorship and mentorship were also significant and strong.

Relationship Between Social Support and Self-Efficacy Controlling for Demographic Conditions

To determine whether the bivariate relationship between social support and self-efficacy persists even when controlling for the demographic variables, three separate multiple regression equations were calculated, including the demographic variables, advisorship, mentorship, and social support. The purpose was to determine how much of the variance in each of the dependent variables can be explained at this early stage of the study by the demographic and support 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.

Results for Work Self-Efficacy: At this early stage in this study, given that none of the students in our sample, as sophomores, had been engaged in formal university-sponsored work experience programs, such as cooperative education, the regression results for work self-efficacy were modest with only an r-square (equivalent to the variance explained) at 14%. However, three support variables -- social support, advisorship, and financial support -- entered the equation at significant levels along with age. The Beta, or standardized regression coefficient, for social support was a high .32, significant at a $T < .01$ level. The other predictors had substantially lower Betas with significances at $T < .01$ for age, $T < .02$ for advisorship, and $T < .04$ for financial support. It appears that contextual support has an important effect on work self-efficacy; furthermore, the older students, as might be expected having likely had more exposure to work, have higher work self-efficacy.

Results for Career Self-Efficacy: The r-square or variance explained for career self-efficacy was a much higher 24%. In this case, five variables entered the equation at significant levels: social support with a Beta of .44, major with a Beta of .07, advisorship with a Beta of .07, SES (socioeconomic status) with a Beta of .06, and financial support with a Beta of .06. The first three Betas were significant at $T < .01$ and the fourth and fifth at $T < .03$. In the case of career self-efficacy, the support variables again make their entrance, but so do major and SES. Aerospace majors are the most confident in succeeding in their careers. Lastly, we observed that the higher the socioeconomic status, the greater the career self-efficacy.

Results for Academic Self-Efficacy: Perhaps given the sample's sophomore-only status, the academic self-efficacy equation was the most robust with an r-square of 44% and a number of explanatory variables significantly entering the regression equation. These results are displayed in Table 2.

Table 2
Regression for Academic Self-Efficacy (AS-E)

Model Summary

R	R²	Adjusted R²	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	t	Sig.
	B	Std. Error	Beta		
(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)

As would be expected, current academic performance and SAT scores significantly predict academic self-efficacy along with social support, financial support, and advisorship. Not surprising, given the literature on gender and self-efficacy, males have higher academic self-efficacy compared to females, although a separate analysis revealed that they do not have a higher mean GPA compared to women. When it comes to major, students in chemical engineering have the highest academic self-efficacy.

To determine if any demographic factors strongly influenced the contextual support variables, regressions were run for social support, financial support, advisorship, and mentorship. In no

instance did the demographic variables explain any more than 6% of the variance, suggesting the independence of this class of support variables. Only one Beta of greater than .20 was found, socioeconomic status, and as would be anticipated, it had an inverse relationship to financial support.

Finally, separate regression analyses were run to determine the nature of the social support that had such a powerful influence on all three forms of self-efficacy. It turns out that nearly all the components of social support factor into explaining each of these dependent variables. The exceptions were: college matters and college involvement did not significantly enter the work self-efficacy equation, college matters and friends matter did not significantly enter the career self-efficacy equation, and friends matter did not significantly enter the academic self-efficacy equation.

Discussion

The analysis of the data revealed that social support in the first year from friends, family, college support services, and faculty furnishes a powerful and independent impact on all three forms of efficacy over and above demographic qualities. In the next surveys to be conducted by this study, the research team hopes to determine whether formal work experiences offered to students in their sophomore and subsequent years might contribute to equalizing the balance in academic self-efficacy among women undergraduates compared to men. Such work experiences might also contribute to enhancing both male and female work self-efficacy, which is likely to lead to subsequent positive experiences within the discipline and within the workplace. Finally, in the last phase of this study, the predictors of efficacy as well as efficacy itself will be viewed as potential contributors to retention both within the students' engineering major and within college in general.

The initial results from this study invite several questions regarding the need for formal services associated with support to engineering freshmen. The findings indicate a strong relationship between support and students' self-efficacy, which has already been shown to lead to persistence in engineering. So, for example, where many colleges already provide both advising and mentorships to women and to under-represented students, might there be value in providing such services to all freshmen? Might there also be value in extending outreach to parents of prospective engineering students to convey the importance of their support to their children regarding the value of an engineering education? We suspect that our initial and future findings will serve as an impetus for starting conversations among educators and administrators regarding the initiation or continuation of such services.

Conclusion

This study sustains the introductory logic of the pathways model, which will attempt to explain the retention of undergraduates in engineering majors through self-efficacy-related theory. In particular, it has shown that contextual support in the first year of college experience is a critical and powerful intermediate predictor of three forms of self-efficacy – work, career, and academic – both in its own right and in conjunction with students' demographic characteristics. Contextual support as a prominent predictor of self-efficacy in our pathways model is derived

from social cognitive theory's perspective that social influences pervade virtually every phase of career development. What makes these influences *contextual* is their mediation through the situation at hand, such as through financial aid to those in need or through modeling and support, such as in the messages that parents, faculty, role models, and peers convey to students about their ability to succeed in their studies and careers. Many undergraduate programs offer students, especially those who are traditionally under-represented in particular academic pursuits, a variety of support systems, such as access to mentors and role models, to help them with the transition to college life.

Social support in particular, constituting a range of factors such as advisor, parental, academic, peer, and professional support, combine to uplift the confidence of students in succeeding within the workplace, within their chosen engineering career, and in the classroom. As 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.

Among the demographic variables, age was a significant predictor in the work self-efficacy equation; major and SES (socioeconomic status) featured in the career self-efficacy equation; and GPA, gender, SAT scores, and major entered the academic self-efficacy equation. 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,^{43 44} though this study will determine if women catch up over the course of their college career. Regarding major, aerospace and chemical engineering majors maintain relatively high career and academic self-efficacy, respectively. Finally, this study has also confirmed the measurement integrity of the three measures of self-efficacy and shown their independence from each other as separate properties.

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