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The Role of Work Experience and Self-Efficacy in STEM Student Retention

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The authors report the results of a three-year longitudinal study of retention among undergraduate engineering students enrolled at four major universities. The study demonstrates that self-efficacy can be a critical factor in student persistence and can be broken down into three components: work, career, and academic self-efficacy. The authors explain the relationship between two of these forms of efficacy and retention and also explore the contributing roles of gender, academic support, and work experience along with its accompanying instruction. Of note, both the quantity and quality of co-op placements in ad-

dition to efficacy and support were found to sustain collegiate persistence.

The value of undergraduate education is undermined by dropout statistics, which have consistently hovered around the 40% mark for engineering students (NCSES, 2012). Many students have difficulty integrating either academically or socially into the life of our undergraduate institutions, especially in the STEM fields, and they either leave the major or the university entirely. Although a number of solutions to this problem have been proposed, such as better and more frequent advising, greater use of active learning styles, or more enriching first-year experiences, we need to know more about the reasons behind the retention problem (Freeman et al., 2014; Pascarella & Terenzini, 2005; Tinto, 1993).

One recommendation has been to consider the role of self-efficacy as contributing to student persistence, because efficacy relates to an individual's perceived level of competence, signifying his or her confidence in completing a task once started. We know that self-efficacy can lead to performance accomplishments, but that performance, in turn, heightens subsequent self-efficacy (Bandura, 1986). Thus, it stands to reason that providing students with an opportunity to try out and succeed in deploying any newfound skills might lead to their confidence in persisting in their chosen fields (Chemers, Hu, & Garcia, 2001; Lent et al., 2002).

The Study

A team was assembled across four universities in the U.S. as part of a National Science Foundation research grant to look into the aforementioned considerations regarding retention among their engineering undergraduate students. All sophomores/second-year students from the colleges of engineering from these universities—Northeastern University, Rochester Institute of Technology, Virginia Polytechnic Institute and State University, and the University of Wyoming—were surveyed and later tracked for two more successive years using follow-up surveys. By the third year, 699 students had successfully filled out all three of the questionnaires, representing a 43% response rate from the first year of the study. Of further note is that the first two universities in the study are primarily cooperative education schools, whereas the latter two are not. Cooperative (or co-op) education enables students to intersperse their academic studies with full-time periods of work experience that are formally mapped out by the college and, thus, designed to provide targeted experience in the major.

Framework

The framework used within our study is based on a series of paths leading to the study variable of retention. As can be seen in Figure 1, retention is modeled as a function of self-efficacy, cooperative education, contextual support, and demographic characteristics. Not previously explained is the notion of contextual support, which represents the support received from parents, faculty, mentors, peers, and from the university as a whole (such as through financial aid or through the provision of living/learning communities). Note, as well, that self-efficacy is divided into three forms (work, career, and academic), signifying the confidence that students have in their own success within the workplace, within their chosen engineering career, and within the classroom, respectively. Table 1 denotes the set of components that were incorporated into each of the self-efficacy scales (Betz, Klein, & Taylor, 1996; Lent, Brown, & Larkin, 1986; Raelin, 2010).

Background on the Study Variables

Further review of the study variables, with the exception of the self-evident demographics, is provided here to furnish additional background on the study's conceptual model.

Retention

Since the well-known Astin study (1993), 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% (Clough, 2006). Meanwhile, demand for qualified engineering graduates continues to grow, as perhaps best exemplified by President Obama's call for 10,000 more engineers per year (Thibodeau, 2011). 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 (see, for instance, Cosentino de Cohen, 2009), they continue to be underrepresented in engineering. In 2011 women earned 18.4% of bachelor's degrees in engineering—having peaked at 20.6% in 2000 (Chubin, May, & Babco, 2005; Yoder, 2011). They also hold only 13% of engineering positions (NCSES, 2012).

Figure 1
Conceptual Framework of the Study

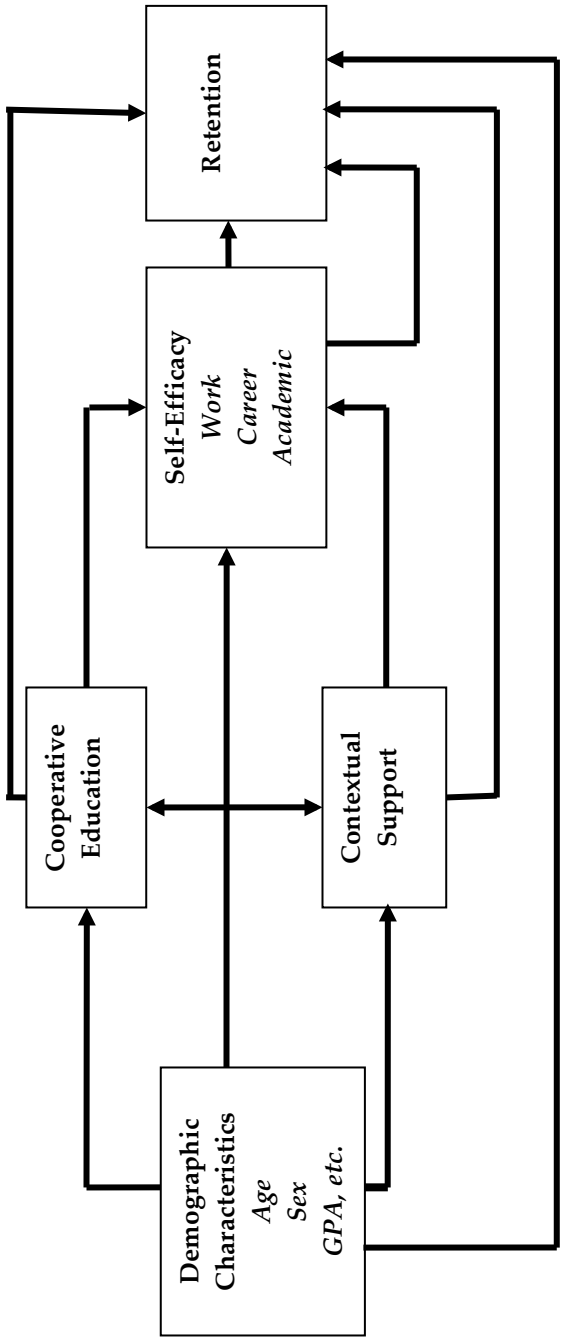

Table 1
Components of the Self-Efficacy Scales

Work Self-Efficacy	*Career Self-Efficacy*	*Academic Self-Efficacy*[1]
• problem solving	• occupational information	• the major
• sensitivity	• goal selection	• major requirements
• role expectations	• planning	• upper-level courses
• teamwork	• problem solving	• extracurriculars
• learning	• self-appraisal	• math competency
• pressure		• science competency
• politics		• degree completion

Note. [1]These items are reflective of the perceived degree of success students possess in completing their various academic pursuits in engineering.

Self-Efficacy

The concept of self-efficacy has been proposed as a promising conceptual link between practice-oriented learning processes, learning outcomes, and persistence (Chemers et al., 2001; Eames, 2004; Kahn & Nauta, 2001). Self-efficacy is defined as an individual's perceived level of competence, or the degree to which he or she feels capable of completing a task. What makes self-efficacy particularly important as an explanatory variable of success is that it can be assessed and its conditions altered during the first year of college and beyond in order to enhance students' perceived consequences of succeeding in college and staying in school (Kahn & Nauta, 2001). Among some of the prior work examining interventions leading to enhanced self-efficacy in school, Hutchison, Follman, Sumpter, and Bodner (2006) reported a relationship between academic and advisory support and female students' academic self-efficacy. A pilot study (Raelin, Reisberg, Hamann, & Whitman, 2007) was performed by the Northeastern University and University of Wyoming 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 forms of self-efficacy.

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 (Raelin, 2007). As a result, these programs assist students in transitioning to full-time work more easily, helping them to overcome the "reality shock" attributed to first job experiences for uninitiated novices (Elfering, Semmer, Tschan, Kalin, & Bucher, 2007; Wanous, Poland, Premack, & Davis, 1992). In addition, cooperative education can also prove beneficial to students in sustaining their ongoing academic performance and their persistence to graduation (Davie & Russell, 1974; Gardner, Nixon, & Motschenbacker, 1992; Lindenmeyer, 1967; Smith, 1965; Somers, 1986). 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 (Raelin et al., 2011). Work self-efficacy measures a range of behaviors and practices—for example, exhibiting teamwork, expressing sensitivity, managing politics, handling pressure—relating to students' beliefs in their command of the social requirements necessary for success in the workplace.

Contextual Support

Support is considered to be contextual when mediated 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 career choice encouragement (or discouragement) that students obtain from influential significant others (Arbona, 2000; Marra, Rodgers, Shenn, & Bogue, 2009; Zeldin & Pajares, 2000). Contextual support has been found to enhance both academic achievement and self-efficacy as well as to contribute to academic persistence (Hackett, Betz, Casas, & Rocha-Singh, 1992; Nicpon et al., 2006/2007).

The Sample

Besides the expected dominance of males in the sample (79% at time period 1, the sophomore or second year; 76% at time period 2, the third year; and 75% at time period 3, the fourth year), the initial sample was predominantly Caucasian (79.5%) and middle and upper-middle class (83%) in socioeconomic status. The students' average SAT score was 1269 (math plus verbal scores), based on the original SAT version with a 1600 maximum score. Their average GPA was 3.21 at time period 1, 3.12 at time period 2, and 3.10 at time period 3. By the time of the third survey, 100 students (approximately 6.1%) had left their university, and 122 students (approximately 7.45%) had transferred out of engineering. These relatively favorable dropout rates, compared to national averages, were very similar between men and women, except that slightly more women (by .4%) had left the major, and slightly more men (by .3%) had left their 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 students in our sample are viewed as hard-working, because some 95% of them declared that they were employed in some capacity. Thirty percent of the sample at Year 3 reported one year or less of total work experience during their lifetimes, 51% had worked between one and three years, and 19% had worked for 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, either in their major or not connected to their major.

When asked about their plans following graduation, approximately 70% indicated that they would seek employment in the engineering field. The bulk of the remaining respondents reported plans 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 (where most students follow a 5-year schedule) were likely facing one additional year of matriculation.

Measurement and Analysis

The measures of the principal study variables were assembled 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 dropouts. Self-efficacy was measured in three self-efficacy formats due to findings in the literature that support segmenting efficacy in determining persistence in engineering (see, for instance, the work of Cech, Rubineau, Silbey, & Seron, 2011). Consequently, all three formats, work, career, and academic, were measured using established scales. 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 a data check at year 5. A numerical internship variable was similarly derived. A new scale was developed to measure the quality of the co-op placements. 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. (2001). Where scales were employed, each was subjected to Cronbach's test for internal consistency and a fresh exploratory factor analysis to scrutinize its reliability and validity. Finally, to compute the differences between time periods, three changes scores were calculated for each of the scaled independent measures: between time periods 1 and 2, between time period 2 and 3, and between time periods 1 and 3.

The primary purpose of the statistical analysis of the data 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 period 3, the analysis of the data focused on the impact of the study's independent variables on the three separate dimensions of self-efficacy. For that 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 period 3, the principal study variable of retention was calculated and, thus, was entered into the analysis. Since

this dependent variable is a categorical measure, the method chosen was discriminant function analysis (DFA).

Results

For Co-Op

Our pathways framework hypothesized that a 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 had completed their first co-op and those who had not. We then performed *t* tests of means for change in self-efficacy in these two groups between time period 1 and time period 2. We established a significance level based on the more demanding two-tailed test because we were 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 2, there was a very significant change in co-op students' work self-efficacy upon completion of their co-op experience. Those who had participated in a co-op indicated a significant increase in their work self-efficacy, whereas those who had not participated experienced a decrease. There were no significant outcomes in the other two self-efficacy change scores between co-op and non-co-op students. As could be expected, the overall support co-op students experienced during their time on co-op—in particular, the support available from their collegiate advisor—decreased. 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. This finding 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 (2001) and Auburn (2007), among others, view as a sense of alienation resulting from the lack of opportunity for returning students to demonstrate their new knowledge in class due to a teacher-centered teaching style. Research on effective teaching has consistently advised that instructional practices deploy the prior and ongoing knowledge of students in creating an interactive and engaging classroom most conducive to learning (see, for example, Feden, 2012).

The data analysis focused on the quality of co-op placements as well as the sheer quantity of co-ops during the undergraduate experience. In a regression for work self-efficacy after students' first co-ops, three co-op quality dimensions were found to be significant predictors. The most

Table 2
***T* Tests for Cooperative Education and Change Scores Between Time Periods 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	

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.

For Self-Efficacy

A range of multiple regression analyses were conducted for the separate self-efficacy constructs during the three 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. This was, in fact, the case. The first critical outcome was reported at time period 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 period 1 were found to have significantly lower academic self-efficacy, but not lower career or work self-efficacy. Table 3 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 of explained variance (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.

Exploring the two dependent variables of work and academic self-efficacy in the regression analyses more deeply, we noticed an intriguing pattern in their respective explanations. Each of these two forms was associated with the experience from which it was derived. That is, work self-efficacy was contingent upon co-op participation, and academic self-efficacy was associated with academic performance. Over three fourths of the students in our sample who had at least one co-op reported a higher or equivalent work self-efficacy at time period 3, whereas the same proportion of those students without a co-op reported a lower or equivalent work self-efficacy by that time period. For academic self-efficacy, the overall average GPA for all juniors went down to some degree, along with their academic self-efficacy. However, the decrease in these respective scores was far more dramatic for those who dropped out compared to those who persevered in their major and in their university. For example, the reduction in academic self-efficacy between time periods 1 and 3 for dropouts was nearly one-half point on a 5-point scale, whereas the difference was negligible for those who persevered.

The data lend a secondary explanation for the tendency for those with poor grades and lowered academic self-efficacy to drop out. Students who dropped out by the end of their sophomore year also reported a decrease in two so-called "mattering" variables, namely, whether or not their college or friends matter to them (Rayle & Chung, 2007; Schlossberg, 1989). In other words, retention may not only ensue from relative academic success, but also from relative social acclimation.

Table 3
Regression for Academic Self-Efficacy (AS-E) at Time Period 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

Note. [a] Dependent variable is Academic Self-Efficacy (AS-E).

For Contextual Support

A string of analyses throughout the three-year term of our longitudinal study consistently endorsed the value of contextual support in elevating the confidence of undergraduate students. Support through institutional means, such as through financial aid, mentorships, and participation in living/learning communities, and through modeling and conversation, was found, especially in the first year to help students cope with the stress of college life. This, in turn, shaped students' self-efficacy, not only in regard to their academic pursuits, but also in their work and career aspirations (Friedlander, Reid, Shupak, & Cribbie, 2007). The availability of support was also found to be particularly worthwhile to women in their first year. Specifically, their scores exceeded the scores of their male counterparts in five support dimensions—namely, they participated more actively in professional clubs and associations, they were more involved in campus life, they took more advantage of residence within living/learning communities, and they reported that they not only received more support from their friends, but that their friends really mattered to them. Finally, by the time of the third year of our study, students, and again, especially women, were more likely to stay in school and persist in their major when they took advantage of the institutional support provided by their institutions.

For Retention

To determine the impact of our 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 change as well as component scores was suggested by Edwards (1994) as a way to assess the integrity of the former. Table 4 reveals the significant discriminating variables on retention for changes between time period 1 and time period 3. The retention variable is recorded at time period 3, although the heavy majority of departing students (70%) left the major or university at time period 1 (15% left at time period 2 and the remaining 15% at time period 3).

As can be seen in Table 4, the discriminant model is highly significant, with a Wilks's 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. 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

Table 4
Discriminant Analysis Displaying Significant Change Variables Between Time Period 1 and Time Period 3 on Retention

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

Notes. Dependent Variable: Retention; $N = 586$; Wilks' Lambda: .901; Canonical Correlation: .31; Chi-Square Significance: .001

self-efficacy decreased (along with GPAs) after their first year, this form of efficacy particularly plunged for dropouts compared to those who persisted either in the major or in school.

Another important predictor of students' retention was the amount of their past work experience. However, perhaps surprisingly, those who worked the most were more likely to drop out. Although the data suggested that these work-experienced students tended to be somewhat older, it is likely that these same students needed to work to attend college. Though not quite at an acceptable significance level, the mean for change in work self-efficacy was far lower for dropouts than for those who persisted. There was also a near-significant effect for change in teaching quality. Provocatively, those who stayed, especially by time period 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 had developed the more critical view that their curriculum and instruction might not be sufficiently "real-world."

The pattern of discriminant analysis results for the separate time periods was comparable to the change scores, and five variables predominate as reasons for retention, three of which were cited in the change model: number of co-ops, academic self-efficacy, past work experience, GPA, and contextual support.

A final data check was completed at the end of the fifth year of the students' undergraduate experience to more reliably report out specific graduation data, such as final GPA. No students were surveyed in this check; rather, their graduation statistics were gathered from the students' records. The time period during which these data were assembled was approximately one year after time period 3. The results were confirmed by the data check, but two of our explanatory variables came into stark relief: GPA and co-op participation. First, the correlation between final GPA and academic self-efficacy at time period 3 was found to be .67, far and away the highest correlation (by +.37, compared to its next highest correlate). As for co-op participation, co-op students had a dropout rate of 4.7%, compared to 11.2% among non-co-op students. Another way to express this relationship is that those students who stayed in school and in their major had an average of 1.73 co-ops, whereas those who dropped out had an average of only .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 a 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.

Discussion and Implications of the Findings

Taken together, the findings from our study over three years point to a number of methods, curricular and non-curricular, to improve the retention of college students. Although the students in our sample were enrolled in engineering colleges, the findings may well apply to undergraduates in a variety of different majors, especially in those that have work implications. First, we point to the advantage of having access to co-op programs or internships. In a finding relatively new to the co-op field, retention in both the major and in school appears to be enhanced by the number of co-op assignments (that is, the more the better). Many undergraduates do not participate because of personal preferences or because their university has not made the sustained financial and human resource commitment to provide for a program of formal targeted placements along with counseling support. Nevertheless, the benefits in terms of retention seem to be worth the investment. However, not all work experience programs are of equal value. An ongoing effort needs to be made by those responsible for placements to ensure that the quality of the experience be an affirmative training ground that teaches not only productive work skills but also work habits that may transfer into full employment when the time comes (Fogg & Putnam, 2004).

Although co-op can be an important resource to enhance work self-efficacy, universities also need to find ways to develop students' academic self-efficacy. Along these lines, there may be no substitute for providing a wide range of academic, professional, and social support services to students. Such support, especially for women and for under-represented students, can be sustained through such means as providing academic counselors and mentors to students, giving them the opportunity to reside in a living/learning community, affording them exposure to role models in the field, and upgrading instruction to be more experiential than rote. Although these support services are thought to be particularly important during the first year of college, they should be sustained throughout the collegiate experience, especially as academic rigor ramps up once students formally transition into their majors.

In summary, our findings are encouraging in drawing upon social and work-related approaches in arresting the outflow of students, especially in the STEM fields. While our recommendations in terms of providing support services are more confirmatory than novel, our suggestions for

integrating work-based learning into the undergraduate curriculum as a means of retention are likely less familiar. In particular, we recommend for those students who have had or are currently engaged in extensive work experience, whether or not institutionally provided, that any concurrent or subsequent instruction show a high degree of relevance and connection to contemporary operating conditions within the working world. Further, with the identification of the components of a new construct known as work self-efficacy, which was found to be nearly as important to retention as its cousin, academic self-efficacy, we can urge university staff as well as supervisors/preceptors in the field to focus on the students' application of the specific meta-competencies associated with this form—namely, problem solving, sensitivity, role identification, teamwork, work learning, stress management, and handling politics.

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