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Assessing Gender Differences in First-Year Student Motivation

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Abstract

For the past decade, engineering schools have developed a variety of models for introducing first-year students to their chosen field. These range from surveys of engineering disciplines and introductions to problem solving and algorithmic thinking, to design and professional skills in project-based learning courses. Such courses have greatly enhanced the participants' early understanding of the engineering field, improving student understanding of the field and allowing students to make better choices of disciplines and, consequently, increasing their satisfaction with their engineering education[1].

Despite the growth of design projects in first-year engineering courses, little research to date examines the effect of such courses on student motivation. Broad studies of retention in engineering education show promising results for women and other under-represented students in project-based courses[2]; however, engineering educators need a richer understanding of how specific project-oriented pedagogies affect students', and in particular women's, motivations for engineering and their intended career plans. This study focuses on women because of their continued underrepresentation in engineering[3, 4] and the need to ensure effective retention efforts in the midst of a movement to enact large-scale curricular transformation in engineering.

To address this need, this study investigated student motivational level (based on the expectancy-value theory of academic achievement) as well as intentions to persist of male and female first year engineering students at a large midwestern university at three time points: as students entered their first semester (n=323; 107 female and 215 male), after completing the first semester (n=191; 70 female and 121 male), and after completing the first academic year (n=133; 52 female and 81 male.). An online survey, updated from another study[5], investigated six motivational constructs using Likert-style questions: interest in engineering, perceived usefulness of engineering, identity with engineering, sense of belonging in engineering, expectancy of success in an engineering program, and sense of worth of obtaining an engineering degree. Additionally, students were surveyed as to their intentions to persist in the engineering program and to pursue a career related to their engineering degree. A confirmatory factor analysis coupled with internal reliability measures suggested that the factors were constructed appropriately for this application of the survey.

Consistent with previous research, female students entered the university with significantly lower ratings of expectancy of success in engineering coursework than male students[5]. However, their expectancy of success increased over the first year, such that female students were statistically indistinguishable from male students by the end of the first year. In addition, women exhibited a slightly lower (marginally significant) sense of belonging in engineering than men upon entering university study. Interestingly, there were very few significant differences between the successive surveys. In addition to women showing a marginally significant increase in expectancy for success over the first year, men exhibited a marginally significant decrease in their sense that an engineering degree is worth the cost. These results contribute to an already complex set of findings on gender and motivation in engineering undergraduate studies, and an analysis of the underlying antecedents is warranted.

Introduction and Background

For the past decade, engineering schools have developed a variety of approaches to introducing first-year students to their chosen field. These range from courses that survey a variety of engineering disciplines, to courses that introduce problem solving and algorithmic thinking, to courses that emphasize design and professional skills in the context of project-based learning. Such courses have enhanced students' early understanding of the engineering field, helping them to make better choices of disciplines and, consequently, increased student satisfaction with their engineering education[1].

Despite the growth of design projects in first-year engineering courses (courses that give students a hands-on design experience early on, instead of first putting them through a series of required theory courses), little research to date has examined the effect of such courses on student motivation. Broad studies of retention do show promising results for women and other under-represented students in project-based courses[2]. Still, engineering educators need a richer understanding of how specific project-oriented pedagogies affect students', and particularly women's, motivations for choosing engineering and for subsequently persevering in the pursuit of their intended career plans. This study focuses on gender because of the continued underrepresentation of women in engineering[3, 4] and the need to ensure effective retention efforts.

Enrollment trends in engineering schools in the US show increased numbers of students entering the engineering field over the past decade[6]. Enrollment of female students has been rising, reaching 18.6 percent in 2010; however, women remain highly under-represented in the field. At the university where this research was conducted, enrollment of female students has been relatively high, reaching its peak at just over 30 percent in 2002, but has recently declined despite increasing national trends, settling at about 23 percent. Retention rates for male and female engineering students are comparable at this institution[7].

A better understanding of what motivates students can allow the program to better address students' needs in the first year. To investigate this issue, we surveyed engineering students about their motivation and plans for remaining in the engineering major and profession before, during and after the first semester of their engineering undergraduate studies. About half of the students surveyed took a required team project-based learning course, "Introduction to Engineering," which makes use of team-based experiential learning centered on the engineering design process. The other students enrolled in an introductory programming course. A comparison of student motivation levels before and after this initial semester enables us to draw inferences regarding the relative motivational effects of the two courses and, specifically, to determine whether the project-based course supports the persistence of women in engineering, as has been reported for other, similar courses[2].

The study was undertaken with dual purposes. It is expected that findings from this study will contribute to a better understanding of student motivation over the first semester of engineering study, and perhaps how both gender and course experiences may be related to motivational changes. The study is also intended as a program evaluation.

Theoretical Framework

The theoretical framework for this study is a combination of Expectancy-Value Theory (EVT) of Achievement and its interaction with student persistence in the field of engineering.

Expectancy-value theory, as applied to achievement[8, 9, 10], focuses on social, psychological, and cognitive reasons for choices, particularly in academic settings. Simply put, the model suggests that academic motivation is influenced by perceived competence beliefs ("Can I do this task?") and beliefs about the worth of the task ("is this task useful/interesting/etc?"). The model predicts that student motivation for engineering is influenced by both students' expectancy for success and their values. Figure 1 illustrates the general framework (A) as well as this study's interpretation of the EVT applied to student motivation for engineering (B).

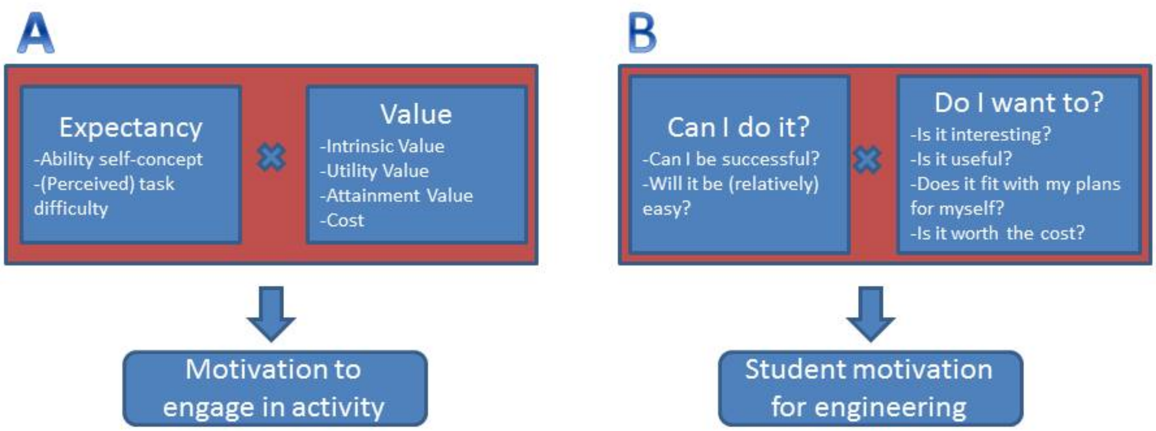

Figure 1. Expectancy-Value Theory of Achievement Motivation: general framework (A) and applied to this particular project context (B). Modified from Finelli and Daly (2012)[11].

Research by the originators of the model using factor analysis has suggested that all of the constructs regarding expectancy and value are related (significantly correlated) but distinct[12]. Research has confirmed the importance of both the expectancy-related perspectives[13, 14] and the value-related perspectives[15] in academic motivation and decision-making.

Eccles[16], via expectancy-value theory, suggests that women are less likely to enter and persist in field related to math and physical sciences (e.g. engineering) both because they lack confidence in their abilities in this domain and because they place less value on these fields than other fields. This is evidenced through statistics showing the number of women enrolling in engineering programs. For example, of the 69,895 students who earned an undergraduate engineering degree in 2008, only 12,918 (18.48%) were women[17]. Attrition rates for female and male students are typically similar[7, 18], but a multi-pronged approach to increasing female involvement in engineering may be necessary to increase initial female enrollment as well as increase female persistence and overcome the gap women experience in their expectancy for success and value-related constructs relative to the engineering disciplines.

In alignment with EVT in the context of educational and occupational choices, numerous studies have found expectancy to be different for male and female students. In multiple contexts, male students have reported higher expectancies for success[19, 20], including among undergraduate engineering students[21, 22] and practicing engineers[14].

Research Questions and Study Methods

This study investigated the following research questions with respect to first-year engineering students:

1. Do entering male and female engineering students at this institution differ in their engineering expectancy-related beliefs, value-related beliefs, or career/major plans, or in how those characteristics change over the course of their first semester/year in a university engineering program?
2. What is the relationship (if any) between course enrollment (team-based, problem-based learning course vs. more traditional programming course) and the change in expectancy-related beliefs, value-related beliefs, and career/major plans?
3. What is the relationship (if any) between expectancy-related beliefs, value-related beliefs, and performance, as measured by grade point average in the first year?

To address these questions, students completed a survey instrument at the beginning and end of the first semester of the first year of engineering study. The instrument, replicated from Jones and colleagues[5] with some further modifications by the original authors, included Likert-style items to measure the constructs of the expectancy-value theory of achievement motivation, as well as demographic information (gender, race) and intention to remain in the engineering degree and pursue an engineering career.

The study was conducted in a highly competitive (ranked in the top 10 nationally) College of Engineering at a large Midwestern university. All incoming first year students were invited via email solicitation to complete an online survey during the second week of the Fall 2011 semester (with four $50 Visa gift cards raffled as an incentive). In response to this solicitation, 323 students (26% of the cohort) completed the survey during September 2011 (107 females [36% of cohort]; 215 males [23% of cohort]). Students completing the September survey were invited to complete the same survey in January 2012, immediately after completing their first semester of undergraduate study, with two $75 Visa gift cards raffled off as an incentive. Of the initial respondents, 191 students (60% of the initial respondents) completed the second survey (70 females [65% of initial respondents]; 121 males [56% of initial respondents]). Of the 191 students completing the January survey, 85 had taken the introductory programming course, and 106 had taken the team-based experiential engineering design course.

The percentage of women in our samples (33.1% of the September respondents and 36.6% of the January respondents) is greater than the percentage of women (23.5%) in the entire first-year engineering class. The percentage of under-represented minority students in our sample (7.4% of the September respondents and 6.2% of the January respondents) is lower than the percentage of under-represented minorities (8.0%) in the entire first-year engineering class.

Instrument

We contacted researchers at Virginia Tech[5] to obtain their permission to administer their survey instruments to our students. The instruments shared with us had been somewhat updated since 2010, and are not exactly the same as those described in the 2010 article. We made a further minor change to the wording of the instrument so it would match our project context ("Engineering Program" was changed to "College of Engineering"). No other changes were made to items (e.g., reverse-coded questions were left reversed). The items we used are available in Appendix 1.

After the September data collection, the internal reliability of the scales was determined by computing Cronbach's alpha. Recommended criteria[23] were used to judge the values: greater than 0.9 was considered excellent, between 0.8 and 0.9 was considered good, between 0.7 and 0.8 was considered acceptable, between 0.6 and 0.7 was considered questionable, between 0.5 and 0.6 was considered poor, and below 0.5 was considered unacceptable. All values were above 0.7, and they are presented in the section that follows.

The following categories were measured:

- **Belonging.** Belonging was measured using eight items from the Psychological Sense of School Membership scale[24] . Participants responded to a series of 7-point Likert-type questions about their perceived sense of belonging in their university engineering program. The items were modified slightly to change "Engineering program" to "College of Engineering" to reflect our participants' university context. Half of the items on this scale were reverse-coded (and were flipped for analysis, such that higher number reflects higher sense of belonging). The Cronbach's alpha of 0.725 is considered acceptable, though it is the lowest reliability of the constructs measured.

- **Cost.** We measured cost (whether the effort, stress, and time to engage in the engineering program is worth the cost) with a cost scale developed by Parkes and Jones[25]. This scale, which has been validated with an undergraduate population, but not one of engineering students, has only 3 items. All items are Likert-type questions, but all use 5-point scales, in contrast to the other questions used in this study. The Cronbach's alpha of 0.793 is acceptable.

- **Expectancy.** We measured expectancy*,* students' sense of ability to perform well as an engineer/ engineering student, with a modified version of the ability/expectancy scale used as part of the Self- and Task-Perception Questionnaire[12]. The 5 items in this scale were Likert-type (7-point scales), and they yielded a Cronbach's alpha of 0.880, which is considered good.

- **Identity**. This scale, which measures students' intrinsic sense of identification as an engineer/engineering student, is identical to the one used in the original article of interest[5] and was originally based on work from Schmader, Major, and Gramzow[26]. The four Likert-style items (7-point scale) yielded a Cronbach's alpha of 0.821, which is considered good.

- **Interest.** This scale was modified from Lutrell and colleagues[27] to measure intrinsic interest in engineering problems and topics. The six items used were all Likert-style (7-point scale) and yielded a Cronbach's alpha of 0.915, which is considered excellent.

- **Utility**. We measured utility (students' sense that the engineering degree/ engineering material they learn is useful) using items modified from the General Utility scale[27] to be specific to the engineering context. This 6-item scale was entirely reversed (but was flipped for analyses, so that high numbers reflected a high sense of utility). Cronbach's alpha for this scale was .833, which is considered good.

Questions also inquired about future plans both in terms of major (the likelihood that students would change their major) and career (whether students expected to have an engineering-related career). We also collected demographic information at the end of the survey: gender, race, and intended departmental major. The entire Zoomerang-hosted survey was 10 screens long and was intended to take about 10-15 minutes to complete. Finally, we collected ancillary information from the institution, including students' first year GPA and admittance test scores (ACT and SAT). Students' responses to the survey were combined with this institutional information to complete the data set.

Initial Data Preparation and Analysis

The resulting data set needed minor manipulation in order to be usable. The survey was set up so that students could indicate "N/A" and/or skip questions, which resulted in a few missing data points (14 data points in the first data set and 22 data points in the second data set). In both cases, empty cells represented less than 1% of the actual data points. Missing data points were replaced by the overall average for that question, rounded to the nearest hundredth[28].

Change scores were calculated for each participant by taking the average reported value for a particular construct in January or April and subtracting that participant's average score on the same construct in September. The resulting difference score could be negative or positive. A "zero" change score meant there was no difference in that participant's overall construct score after the first semester. A positive score represented an increase in the participant's sense of that construct over the first semester, and a negative score indicated the participant's sense of decrease in that construct over the specified time period.

The scales were investigated to determine the relationships among the six constructs. Table 1 presents correlations among the constructs, based on the larger (September) survey results. As expected, all constructs are significantly, positively inter-correlated, with Pearson coefficients ranging from 0.284 to 0.650.

Table 1. Correlations among the six constructs based on the larger (September) data set (n=323), showing the Pearson correlation value as well as the 2-tailed significance.

	Belonging	Cost	Identity	Interest	Expectancy	Utility
Belonging	1	.591** <.001	.296** <.001	.405** <.001	.488** <.001	.455** <.001
Cost		1	.284** <.001	.440** <.001	.432** <.001	.464** <.001
Identity			1	.650** <.001	.286** <.001	.418** <.001
Interest				1	.435** <.001	.465** <.001
Expectancy					1	.328** <.001
Utility						1

** = correlation is significant at the .01 level.

Results

<u>RQ 1: Examining changes over the first semester</u>: The first research question was: Do entering male and female engineering students at this institution differ in their engineering expectancy-related beliefs, value-related beliefs, or career/major plans, or in how those characteristics change over the course of their first semester/year in a university engineering program? All of the mean values from Instrument 1 (September) were in the upper third of the scale values (see Table 2), indicating that students generally had high expectations for success in their engineering courses (expectancy), a high sense of identity with engineering (identity), a high feeling of belonging in the college (belonging), a high interest in engineering (interest), found engineering to be useful for their career (utility), and believed the sacrifices they were making to be worth the cost (cost). They also report being generally confident of remaining in their chosen major (major) and of later pursuing a career related to engineering (career).

A series of ANOVAs comparing men and women on the variables of interest (using all 323 participants from the September survey) found only one significant difference between men and women students as they entered the engineering program (see Table 2): men were more likely to report a higher expectancy for success ($p<.001$). A second construct, belonging, was marginally significant ($p=.076$): men were more likely to report higher feelings of belonging in the College of Engineering. Men and women reported significantly similar values for the remainder of the variables.

Table 2. Men's and women's September scores on motivation constructs and future plans, Instrument 1. All are 7-point Likert scales except "Major" and "Career," which are both 5-pt Likert-style scales.

	Men (n=215) M (SD)	Women (n=107) M (SD)	F	Sig
Belonging	5.52 (.75)	5.35 (.82)	3.159	.076
Cost	5.54 (.95)	5.67 (.90)	1.292	.257
Expectancy	5.37 (.76)	4.99 (.82)	16.454	<.001
Identity	6.02 (.75)	6.01 (.66)	0.028	.868
Interest	6.06 (.77)	5.96 (.72)	1.129	.289
Utility	6.47 (.58)	6.41 (.57)	0.859	.355
Major	4.59 (.69)	4.58 (.71)	0.006	.940
Career	4.12 (.92)	3.99 (.95)	1.225	.269

This research question also addressed change in value over time; thus, a second set of analyses was conducted using data from both the September and January surveys, but including only those respondents who participated in both surveys (n=191). To examine change over time for the entire group, a series of paired-sample T-tests examined the pattern of change over the entire data set. To examine differences between male and female participants, "change" scores, as described previously, were computed for all participants for all motivation constructs and for "major" and "career" (value reported in January minus value reported in September, as described in the "Methods" section). The results for the entire group as a whole are presented in Table 3 and for men and women separately in Table 4.

Table 3. Paired sample t-tests for cohort as a whole, comparing Sept. and Jan. surveys.

	Change score (n=191) M (SE)	T	Sig
Belonging	+0.131 (0.063)	-2.087	.038
Cost	-0.062 (0.085)	0.732	.465
Expectancy	+0.156 (0.062)	-2.524	.012
Identity	-0.065 (0.077)	0.847	.398
Interest	+0.009 (0.062)	-0.149	.881
Utility	0.000 (0.038)	0.000	1.00

Table 4. Difference scores for men and women, comparing Sept. and Jan. surveys.

	Men (n=121)			Women (n=70)		
	M (SE)	T	Sig	M (SE)	T	Sig
Belonging	+0.101 (.081)	-1.246	.215	+0.185 (.100)	-1.852	.068
Cost	-0.186 (.110)	1.685	.095	+0.155 (.129)	-1.201	.234
Expectancy	+0.100 (.078)	-1.397	.165	+0.238 (.101)	-2.361	.021
Identity	-0.105 (.093)	1.121	.265	+0.004 (.136)	-0.027	.979
Interest	+0.021 (.074)	-0.291	.772	-0.012 (.113)	0.107	.915
Utility	-0.018 (.048)	0.367	.714	+0.031 (.062)	-0.498	.620

Table 3 shows that the average changes in the motivational constructs between September and January for the entire cohort are small; however, there are two significant gains. Specifically, students exhibited a small increase in their expectancy for success (p=.012) and in their sense of belonging in engineering (p=.038). There is little or no change in students' interest in engineering and their perception of the utility of engineering. The results should be viewed with some uncertainty, as the effect size is small. The largest average difference, the increase in expectancy, is just over $1/10^{th}$ of one point on a 7-point Likert Scale.

As is shown in Table 4, over the course of the first semester of enrollment in their undergraduate engineering study, men show a similar trend to the entire group with small but measurable increases in belonging and expectancy. A more notable difference for men is the larger drop in their sense that engineering is worth the cost. Over the same time period, the average difference scores for women show a significant increase in their expectancy for success (p=.021), which is larger than the increase for men on the same measure. Women also exhibit a marginally significant increase in their sense of belonging (p=.068).

A comparative analysis using the ANOVA reveals only one marginally significant interaction between time and gender: over the course of the first semester, men decrease in their sense that the engineering degree was worth its cost, whereas women increase on this value (p=0.054).

RQ 2: Effect of course enrollment (team-based, problem-based "Intro to Engineering" vs. traditional coursework): The second research question was: What is the relationship between course enrollment (team-based, problem-based learning course vs. more traditional programming course) and the change in expectancy-related beliefs, value-related beliefs, and career/major plans? This analysis compares the fall semester scores of students who took the team-based, problem-based Engineering design course with students who did not.

It is important to note that, although about one half of the entering first year students enroll in the design course in the Fall semester and the other half enroll in the Winter semester, enrollment is not random. Sections of the design course have different topics, and some topics are offered only in the Fall or only in the Winter (so, for example, a student who is highly interested in wind energy might choose to delay enrollment in the design course until Winter semester so as to take that particular section). Students with particularly weak physics and math backgrounds are counseled to take the design course in the Fall (because they are encouraged to delay the programming course, which is typically taken in the other semester, later in their coursework). This nonrandom assignment of students to course makes interpretation of this set of results problematic.

A series of two-way ANOVAs was used to investigate the effects of two independent variables (gender and enrollment in the design course) on the change scores of the motivational constructs and the intention variables. None of the main effects or interactions were significant at the p=.05 level. The only marginally significant findings from this analysis were for expectancy and cost. Students who enrolled in the design course in the fall semester experienced a greater increase in their sense of expectancy for success in engineering as compared to students in the programming course (p=.067). Also, students who took the design course reported an increase in their perception that engineering was worth the cost over the first semester (p=.079), while students who enrolled in the programming course experienced a decrease in this variable.

RQ 3: Relationship between expectancy and value beliefs and performance: To investigate the relationship between expectancy and value beliefs and performance, we used multiple stepwise regression, partly because of the high intercorrelations of our variables. We used the average construct scores from the September and January surveys (separately) as well as the institutional information of first year GPA in this analysis. We conducted this analysis for the entire population as well as for men and women separately.

For the entire population, the September constructs proved to be only mildly correlated to the GPA at the end of the year. Expectancy played the largest role (B=.137, p=.004) explaining only 6% of the variance in GPA. Identification held a negative relationship to GPA (B=-.204, p=.002), explaining only 3% of the variance. The third variable in the model was interest (B=.143, p.029) and explained only 2% of the variance. When disaggregated by gender, there was no evidence of any correlation between these variables and performance for women, and men showed only one significant relationship: expectancy (B=.205, p=.002) explaining only 8% of the variance

Two input variables from the January surveys emerged as significant predictors of GPA at the end of the first year: expectancy (B=.381, p<.001) explaining approximately 32% of the variance, and belonging (B=-.118, p=.003) covering an additional 3% of the variance. No other constructs explained a significant amount of variance in this model for the entire population. When the same analysis is run for male students only, both expectancy (B=.454, p<.001), explaining approximately 41% of the variance, and belonging (B=-.134, p=.008), explaining an additional 4%, were shown as significant predictors. The latter correlation there is odd, as the negative relationship indicates that men who reported belonging less within the College of Engineering had higher GPAs in the first year. For female students, there is only one significant predictor of GPA, expectancy (B=.244, p<.001), which explained only 24% of the variance in GPA.

Discussion

The goal of this project was to consider the constructs of the expectancy-value theory of motivation for academic achievement in the context of first year engineering students experiencing a team project-based learning environment. This initial study demonstrates that both motivation constructs (belonging, cost, expectancy, identity, interest, and utility) and attainment plans (major and career) are highly interrelated, and that for this cohort these scores remain relatively constant over the first semester of study. There were some significant differences between male and female students; female students were initially less confident than their male counterparts regarding the likelihood of being successful in their engineering courses; however, they were more likely to experience a larger September-to-January increase in their expectancy for success. In addition, women experienced an increased perception that the engineering degree was worth its cost, while men experienced a decrease in this measure. No other differences by gender, or based on course enrollment, reached the p≤.05 level of significance. The marginal result suggesting that enrollment in the team project-based course results in students having an increased appreciation that pursuing engineering is worth the cost (compared to the reverse for those enrolled in the programming course) and an increased sense of expectancy for success may be a valuable indicator for first year curricular decision-making.

The finding that expectancy for success is related to first-year GPA is not surprising. This finding is consistent with those of Jones and colleagues[5] who found expectancy-related constructs to be highly correlated with performance measures in first year students. However, it is interesting to note that the relationship between expectancy for success and GPA develops with time, suggesting that students expectancy for success in engineering, based in prior experience, is not a true indicator of their actual performance in the context of GPA and that a feedback exists between student performance and expectancy for success (e.g. performing well in terms of grades increases student expectancy for success in the domain). It is also interesting to note the gender difference in this analysis, showing that expectancy for success is a stronger predictor of GPA for men than for women, explaining 41% versus 24% of the variance in GPA. This may indicate that there are other significant factors that influence women's academic performance in engineering outside of those constructs tested in this study.

This exploratory study has many characteristics that require readers to interpret it with care. For example, many tests were run (multiple one-way ANOVAs and paired t-tests), all at the p=.05 level. It is likely that some of the findings reported here as significant were different solely due to chance, and steps should be taken in a later study to control this type of error.

Additionally, the sample itself needs to be considered a limitation. Of 1300 students invited to participate, 191 are represented in the majority of the analyses reported here. This response rate, while fairly high for an online survey with only a lottery incentive, still leaves majority perspectives untapped. It is unclear whether the 191 respondents are unique in some way, perhaps leading to their willingness to respond.

Finally, the considerations of class enrollment (students enrolled in the problem-based learning class vs. students enrolled in the introductory programming course) need to be evaluated carefully. Students are not randomly assigned to classes in the first year, and some of the ways that they are advised into classes might result in systematic differences between these two cohorts. For example, students who appear to advisers less prepared for college (based on standardized test scores, high school attended, science/math background, etc.) are typically counseled into delaying the programming course until the Winter semester, leading to their overrepresentation in the Fall problem-based learning cohort. This non-random assignment of students to groups makes it impossible to attribute differences in the two cohorts to their class experiences.

Significance and Next Steps

These findings may be important in the context of administrators, counselors, and faculty who work to increase student retention in the field. Engineering programs now suffer from generally lower levels of enrollment than ideal (not filling capacity or job openings), with gender and racial gaps in enrollment intention performance and retention.

From a program evaluation perspective, the finding of few significant differences by gender is important and worth noting. Contrary to many findings at other Universities and at other time points, this study found few significant differences between male and female incoming students in their motivation for engineering or in their intentions to remain in the major and career, as well as in the trajectory of those beliefs over the first semester of study. This may imply that the program is adequately addressing the values that these students inherently bring to their studies. Our findings confirm earlier work indicating that expectancy for success is a strong predictor of performance[5], and suggests that mechanisms for building on this construct for women may be important in efforts aimed to foster improved retention of women to graduation and into the field as practitioners. This is particularly important in light of indications (although not highly significant) that women's sense of expectancy increases more than men during their first semester in this engineering program.

This project will continue with the analysis of data obtained in April 2012 and March 2013 surveys (of the same cohort, at the end of their first year and now in their second year), as well as acquisition of qualitative information via focus groups. This will provide the opportunity to develop a better understanding of the results of the survey study that are unique to this application. For instance, we wish to explore what experiences students are encountering both inside and outside the first year engineering course context (e.g. student organizations, teamwork) that might contribute to the maintenance of high motivation, and what role do enrollment in core math and science courses play in student perceptions of cost. We also wish to explore other factors that may contribute to performance for women.

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Appendix 1. Constructs and Items

The following items were part of the Zoomerang-hosted survey. Additional demographic items were asked at the end, but are not reported here.

Interest (strongly disagree / strongly agree):
1. I find many topics in engineering to be interesting.
2. Solving engineering problems is fascinating to me.
3. Engineering fascinates me.
4. I am interested in solving engineering problems.
5. Learning new topics in engineering is interesting to me.
6. I find engineering intellectually stimulating.

Utility (strongly disagree / strongly agree):
1. Knowing about engineering does not benefit me at all.
2. I see no point in being able to do engineering.
3. Having a solid background in engineering is worthless to me.
4. I have little to gain by learning how to do engineering.
5. After I graduate, an understanding of engineering will be useless to me.
6. I do not need engineering in my everyday life.

Identity (strongly disagree / strongly agree):
1. Being good at engineering is an important part of who I am.
2. Doing well in engineering tasks is very important to me.
3. Success in engineering school is very valuable to me.
4. It matters to me how well I do in engineering school.

Belonging (never / always):
1. I feel like a real part of the College of Engineering.
2. Sometimes I feel as if I don't belong in the College of Engineering.
3. People in the College of Engineering are friendly to me.
4. I am treated with as much respect as other students in the College of Engineering.
5. I feel very different from most other students in the College of Engineering.
6. The instructors in the College of Engineering respect me.
7. I wish I were in a major other than Engineering.
8. I feel proud of belonging in the College of Engineering.

Expectancy:
1. Compared to other students, how well do you expect to do in your engineering-required courses this year? (much worse than average / much better than average)
2. How well do you think you will do in your engineering-related courses this year? (terrible / excellent)
3. How good are you at math, science, and engineering? (terrible / excellent)
4. If you were to order all the students in your engineering-related courses from the worst to the best in engineering-related ability, where would you put yourself? (among the worst / among the best)

5. How have you been doing in your engineering-related courses this year? (terrible / excellent)

Cost (strongly disagree / strongly agree):
1. The amount of effort it takes to do well in the College of Engineering is worthwhile to me.
2. The amount of stress involved in being a student in the College of Engineering is worthwhile to me.
3. The amount of time I devote to my engineering education is worthwhile to me.

Career:
How likely is it that your eventual career will directly relate to engineering? (I am as sure as I can be right now that my career will NOT directly relate to engineering / I am as sure as I can be right now that my career will directly relate to engineering)

Major:
How likely is it that you will change your major to a non-engineering major? (I have not considered changing my major to a non-engineering major at this time / I have already changed my major (or plan to do so very soon) to one that is non-engineering)