Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #49116

Understanding Post-Graduation Intentions of Undergraduate Engineering Students

Yvette E. Pearson
Casey Harris
Dr. Charmane Caldwell, Florida A&M University - Florida State University

Dr. Charmane V. Caldwell is the Director of Student Access at the FAMU-FSU College of Engineering (COE). As Director, Charmane leads a comprehensive effort to increase the number of underrepresented undergraduate minorities and women in engineering. She h

Dr. Reginald Perry, Florida A&M University - Florida State University

Dr. Reginald J. Perry is currently a professor of electrical and computer engineering at the joint Florida A&M University-Florida State University (FAMU-FSU) College of Engineering. He received the B.S. (Co-op, Highest Honors), M.S., and Ph.D. degrees in

Melanie L Wicinski, Arkansas State University

Understanding Post-Graduation Intentions of Undergraduate Engineering Students (Research)

ABSTRACT

The Theory of Planned Behavior (TPB) has been used to determine how – or if – one's intentions are predictive of their behaviors in various contexts. In short, TPB posits that if one has positive attitude (behavioral beliefs), positive subjective norms (normative beliefs), and perceived behavioral control (control beliefs) toward a behavior, it will lead to an intention and ultimately, materialize in said behavior.

We are using TPB to examine post-graduation intentions and outcomes of undergraduate engineering students. For this paper, we focused on baseline data for a larger longitudinal study. In particular, we examined the following questions: (1) To what extent did students indicate plans to enter the STEM workforce and/or STEM graduate programs after graduation? (2) What behavioral, subjective, and/or control factors influenced their decisions? (3) Did those factors differ by income status, operationalized by Pell Grant status?

Our population was a group of undergraduate engineering students participating in a project funded by the National Science Foundation's (NSF's) Scholarships in Science, Technology, Engineering and Mathematics (S-STEM) program. S-STEM aims to increase the inclusion of graduates from low-income backgrounds in the STEM workforce and/or STEM graduate programs. We administered a Post-Graduation Plans Survey (PGPS) to all participants to understand their post-graduation intentions and the factors that influenced those intentions.

To capture post-graduation intentions, we asked if they planned to enter the STEM workforce, STEM master's or doctoral programs or other advanced degree programs within six months of graduating. Due to the small numbers of respondents in each category, we aggregated responses of intentions to pursue careers in the STEM workforce, graduate degrees (STEM master's, STEM doctoral), and combinations of responses. Results indicated most students expressed intentions to enter the STEM workforce after graduation and that Pell Grant recipients expressed stronger intentions to enter the STEM workforce, a STEM graduate program, or both compared to their peers who did not receive Pell Grants. We obtained a significant predictive model for the STEM workforce outcome, with more positive normative and control beliefs significantly influencing the likelihood students would express the intent to enter the STEM workforce after graduation. We did not obtain a significant model for predicting students' intentions toward entering a STEM graduate program or the intention to both enter the STEM workforce and a graduate program after graduation. Analyses by Pell Grant status yielded mixed results that require further study.

Results from this study may help inform strategies for supporting and cultivating pathways for engineering students, with emphasis on those from low-income backgrounds. It will serve NSF and the broader S-STEM community of current and prospective investigators as they seek evidence-based strategies for supporting student success.

INTRODUCTION

Numerous studies have examined the recruitment, retention, and graduation of students in engineering and other STEM disciplines (He et al., 2018; Lenning & Ebbers, 1999; Veenstra et al., 2009; Pearson et al, 2016; Weatherton et al., 2011; Almonteros et al., 2024); however, far fewer have explored the post-graduation intentions of undergraduate engineering students and the factors that influence those intentions (Park et al, 2022; Patrick et al, 2021; Abe & Chikoko, 2020). Knowing and understanding how both intrinsic and extrinsic factors contribute to students' attitudes, perceptions, and self-efficacy, and how these ultimately impact their post-graduation intentions and outcomes can help educators and administrators shape programs and experiences to foster student success. Further, understanding whether students from low-income backgrounds experience differences in beliefs, influences, and outcomes can help identify, mitigate, and strive to eradicate systemic barriers to their success.

This study was part of a larger project designed to understand the impacts of the Educating Engineering Students Innovatively (EESI) program on STEM post-graduation outcomes for students from low-income backgrounds (Caldwell & Perry, 2023). EESI is, in part, supported by the National Science Foundation's (NSF) Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program, which aims to increase STEM students from low-income background in their successful preparation for and entry into STEM careers or graduate programs. We used We are using Ajzen's Theory of Planned Behavior (TPB) (Ajzen, 1991) to examine post-graduation intentions of undergraduate engineering students by examining how – or if – their intentions evolve over three matriculation points – program entry, major entry, and final semester – and the factors that influence those intentions. For the current study, we focused on baseline data at the first matriculation stage for a larger longitudinal study. In particular, we examined we examine the following questions:

1. To what extent did students indicate plans to enter the STEM workforce and/or STEM graduate programs after graduation?
2. What behavioral, subjective, and/or control factors influenced their decisions?
3. Did factors differ by income status, operationalized by Pell Grant status?

Studies applying TPB in STEM higher education are sparse, especially with respect to post-undergraduate intentions and behaviors. Further, while some studies used social identities like gender as controls, none examined potential differences based on socioeconomic status. This study addressed gaps in the literature to advance knowledge on factors that support the prediction of engineering students' post-graduation intentions, examining whether differences exist based on income status. It lays the foundation for a longitudinal analysis of how – or if – those factors change over time and the extent to which they can reliably predict students' post-graduation pursuits.

LITERATURE REVIEW

Overview of Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was developed through the Theory of Reasoned Action (TRA), which postulates that behavior is predicted from intention, meaning that a person's likelihood of participating in specific behaviors is motivated through their intentions, however, TRA only is applied with specific behaviors (Madden, Ellen, & Ajzen, 1992; Fishbein & Ajzen, 1975 as cited in Azjen, 1991).

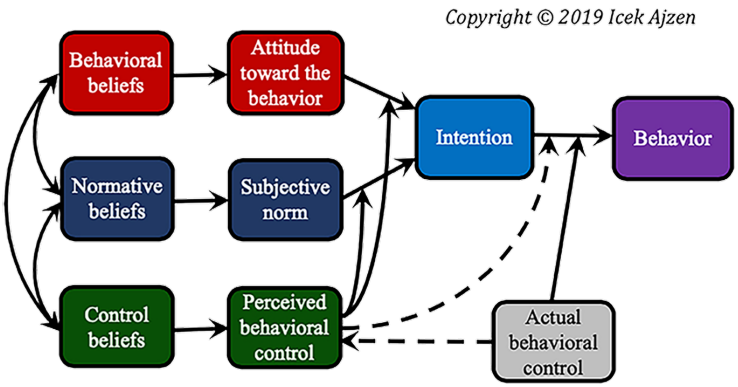

Figure 1. Theory of Planned Behavior Model (Azjen, 2019)

TPB has extended TRA to include perceived behavioral control as this can include behavior as well as intention (Ajzen, 1991; Armitage & Conner, 1999). Azjen (1991) argued that TPB explains actions through individuals' attitudes about behaviors, the subjective norms associated with behaviors, and the perceived control that participants feel towards the behaviors as these factors are predictive of participants' actions. Additionally, Ajzen (1991) believed that behavioral intentions along with perception of behavioral control, can explain differences in behaviors.

Theory of Planned Behavior in STEM Education

Through examining the experiences of 11th and 12th grade high schoolers, Ong et al. (2022) examined, through the theoretical lens of TPB and the Self-Determination Theory (SDT), participants' sense of control and intentions of taking chemistry-related courses as well as participants attitudes and autonomy, relatedness, affect, and participants feelings of competency. Ong et al. (2022) found that attitudes toward chemistry were impactful for affect whereas autonomy and competency were significantly related to behavioral control. Additionally, they stated that affect was significantly related to students' intentions to enroll in chemistry-related courses. Ong et al. (2022) argue that the theoretical framework of TPB as well as SDT can be used to understand students' intentions to enroll in courses and that universities should prioritize their efforts to engage potential students.

Additional research indicates how the TPB can impact high school students' potential to major in STEM-related fields. In a dissertation, utilizing TPB as the theoretical perspective, Walton (2023) found that higher scores on both the mathematics portion of the American College Test (ACT) and students' STEM benchmark scores were positively and significantly related to students' decision to choose a STEM academic major. Another study also indicated that variables related to the TPB can explain high school students' intentions in pursuing a STEM degree (Moore and Burrus, 2019). Through exploring high school students' intentions to major

in STEM, Moore and Burrus (2019) examined ACT mathematics scores, high school mathematics GPA, and demographics, finding that TPB was a strong predictor of students' intended STEM major and career choice more than other variables. Students' attitudes and intentions were especially predictive variables and while the analysis had similar results across gender, Moore and Burrus (2019) found that interest and attitude were more predictive for female-identifying students. Moore and Burrus (2019) urged interventionists to utilize the TPB and to specifically focus on impacting attitudes concerning STEM, as attitudes were the strongest predictors of STEM major and career choice. Some empirical foundation for utilizing the TPB to understand students' behaviors surrounding their decision to major in and pursue a STEM field exists.

Additionally, TPB may be impactful for STEM students in their career decision making. Roy, Akhtar, and Das (2017) examined the intention of science and technology students at the Indian Institute of Technology to pursue entrepreneurship careers. Roy et al. (2017) specifically explored decision making through an adapted version of the TPB that focused on participants' perceived professional options, knowledge of entrepreneurship, and personality straits specific to entrepreneurship. They concluded that the intention to pursue an entrepreneurial career was significantly influenced by positive attitudes toward entrepreneurial careers, supported by knowledge of entrepreneurship as well as a possible career option in entrepreneurship. In addition, Roy et al (2017) determined that subjective norms surrounding entrepreneurship were weakly, but positively, influencing the formation of students' intentions.

METHODS

Study Context and Participants

Each semester, we administered a Post-Graduation Plans Survey (PGPS) to students in the EESI program. The EESI program supports undergraduate students majoring in various engineering disciplines. Some EESI participants are S-STEM scholarship recipients; others are not. These groups were not delineated in this study.

We developed the PGPS by adapting the TPB methodology. We began by administering a survey to capture factors impacting students' post-graduation intentions, spanning their behavioral, normative, and control beliefs; however, response rates were low (partially due to the pandemic) and that aspect of data collection was not completed. To mitigate this limitation, we pivoted and conducted a literature review to identify factors, which we incorporated into survey items. When asking about factors that might support or hinder their post-graduation plans, we integrated the limited student responses we received from students, where possible.

The PGPS survey logic was designed to capture data at three matriculation points – the students' first semester in EESI, the point at which they are transitioning from pre-engineering into their majors, and during their final semester. We used unique identifiers to track students through each stage. This study examined baseline data collected from students at the first matriculation stage.

On the PGPS, students were asked what they plan to do within six months of completing their undergraduate degrees (i.e., enter the STEM workforce, a STEM graduate program, a

combination of these, or something else). Among other items on the survey, there was a question asking students to self-report their status as a current or past Pell Grant recipient.

From Fall 2021 through Spring 2024, a total of 62 undergraduate engineering students took the PGPS as first semester EESI students. After cleaning the dataset (i.e., records with blanks), there were 60 usable records for analyzing post-graduation intentions and between 45 and 50 usable responses for each TPB-related analysis. Roughly 95% of respondents were Black/African American; 7% were Hispanic or Latino/a, half of whom were both Black/African American and Hispanic/Latino/a; 2% were Native American/Alaska Native; and 2% were White. Regarding gender, 61% were men, 37% were women, and 2% were nonbinary. Less than 1% identified as disabled. By self-report, 43% of respondents indicated they had received a Pell Grant at some point during their enrollment; 48% had not and 8% were unsure.

Measures

Post-Graduation Intentions. The primary aim of the S-STEM program is to produce graduates from low-income backgrounds who entered the U.S. STEM workforce or a STEM graduate program. Therefore, a primary focus of our research was to understand EESI students' post-graduation plans. We asked students:

> *Which of the following BEST describes your plans within six (6) months after completing your undergraduate degree? Check all that apply.*
>
> - *I plan to enter the STEM workforce.*
> - *I plan to enter a STEM master's program.*
> - *I plan to enter a STEM doctoral (Ph.D.) program.*
> - *I plan to enter a graduate professional degree program (e.g., medicine, law).*
> - *I plan to enter a graduate program not listed here.*
> - *I plan to do something not listed here (please specify).*
> - *I'm not sure.*
> - *I prefer not to respond.*

This yielded binary results for each outcome (1=yes, 0=no). For this study, we only addressed the first three outcomes and, to ensure a sufficient sample size, we aggregated the intention to enter a STEM master's program and intention to enter a STEM doctoral program into a single variable – intention to enter a STEM graduate program.

Behavioral Beliefs/Attitudes toward the Behaviors. For students who indicated intentions to enter the STEM workforce or STEM graduate programs after graduation, we asked questions to gauge their attitudes toward those outcomes. Specifically, we asked the extent to which each post-graduation outcome (STEM workforce or STEM graduate program) would enable them to help people in communities like theirs, help society as a whole, earn an attractive salary, and be a creative problem solver. Response options were on a four-point Likert scale ranging from strongly agree (1) to strongly disagree (4).

Normative Beliefs/Subjective Norms. To understand students' perceptions of beliefs or expectations of other potentially influential people in their lives, questions focused on the extent to which they believed their family members, close friends, EESI mentors, the Director of Student Access, and academic advisors each believed they should enter the STEM workforce or STEM graduate programs after graduation. Response options were on a Likert scale ranging from strongly agree (1) to strongly disagree (4) with an additional option for not sure, which was excluded from the analysis. Respondents were also able to select "not applicable;" however, none of them did.

Control Beliefs/Perceived Behavioral Control. This measure was designed to help understand students' perceptions of the existence of factors that could potentially support or hinder their attainment of the desired outcomes. Consistent with TPB, the questions posed did not ask about those factors explicitly; rather, they were asked in a way that allowed students to consider them and how they might influence their behavioral intentions. Specifically, we asked the extent to which they agreed or disagreed with statements about their confidence in their ability to enter the STEM workforce and STEM graduate programs and their confidence in their ability to succeed in each of those post-graduation behaviors. Response options were on a four-point Likert scale ranging from strongly agree (1) to strongly disagree (4).

Socioeconomic Status. We used students'self-repor ted Pell Grant status as an indicator of whether students were from low-income backgrounds. We asked whether they had ever received a Pell Grant. Response options were "yes," "no," "I'm not sure," or "I prefer not to respond." Only "yes" and "no" responses were included in the analysis of the third research question.

Data Analysis

We used response frequencies to examine post-graduation plans, comparing intentions of Pell Grant recipients to those of non-Pell Grant recipients. To determine the influence of behavioral, subjective, and control beliefs on post-graduation intentions, we used logistic regression. Before conducting those analyses, we used Cronbach's alpha to determine internal consistency. Details of the analyses are included in the sections that follow.

RESULTS

Post-Graduation Plans

Roughly 83% (50/60) of first semester EESI students indicated intentions to enter the STEM workforce within six months after graduation (Figure 2). Just over half of the respondents (~52%, 31/60) indicated they intended to enter a STEM master's or doctoral program; ~43% (26/60) of first semester students indicated they planned to do both – enter the STEM workforce and a STEM graduate program.

As shown in Figure 3, the data reflects that self-reported Pell Grant recipients were roughly 1.2 times more likely to express the intention to enter the STEM workforce after graduation than their peers who did not receive Pell Grants (89%, 23/26 versus 76%, 22/29). Similarly, Pell

Grant recipients are more likely to express intentions to enter a STEM graduate program (62%, 16/26 versus 45%, 13/29) and much more likely to express intentions to do both (54%, 14/26 versus 35%, 10/29) than their non-Pell Grant recipient peers.

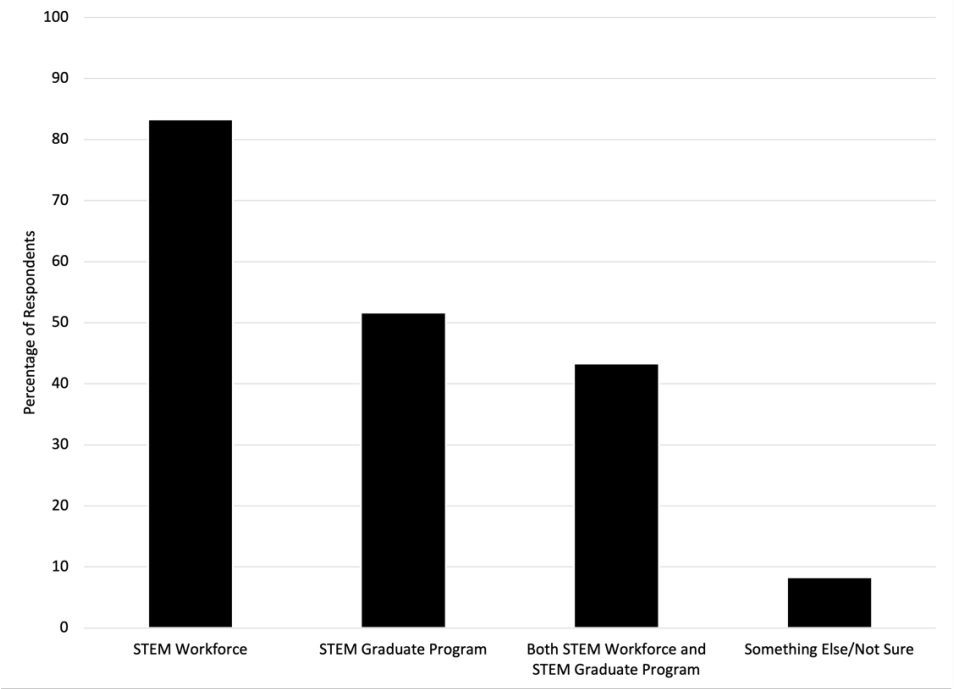

Figure 2. Post-Graduation Plans (N=60)

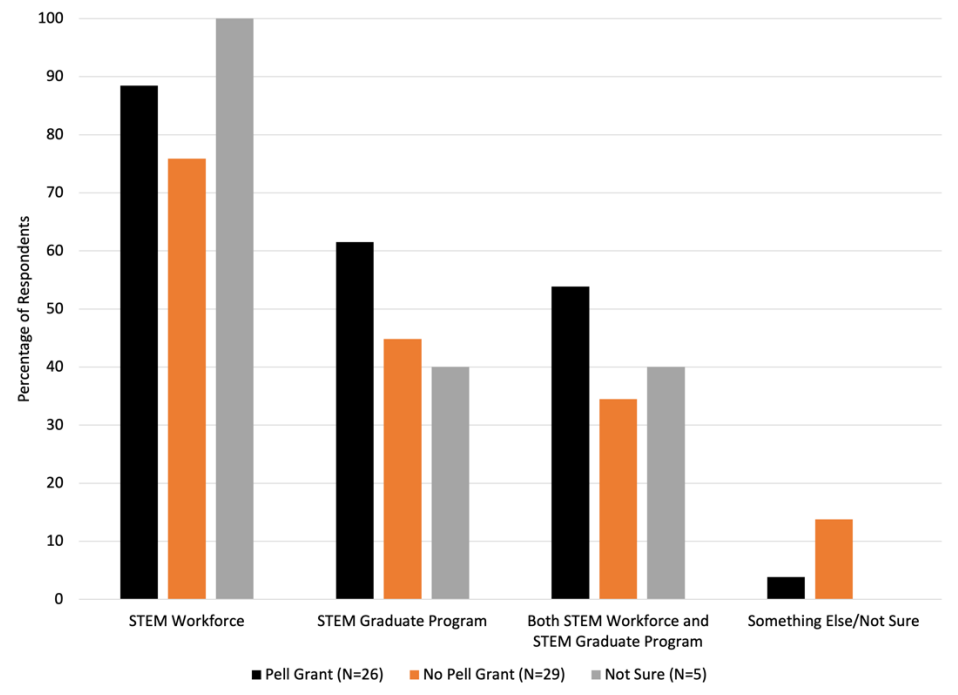

Figure 3. Post-Graduation Plans by Pell Grant Status

Influence of Behavioral, Subjective, and Control Beliefs on Post-Graduation Intentions

Reliability. We conducted separate analyses to determine the extent to which students' intent to enter the STEM workforce, enter a STEM graduate program, or do both within six months of graduation were impacted by factors associated with their behavioral, subjective, and control beliefs. We computed Cronbach's Alpha to determine internal consistency for each set of data (Tables 1 through 3). Individual alphas ranged from 0.61 (questionable) to 0.93 (excellent). Average alphas were 0.76, 0.81, and 0.81 for workforce, graduate program, and both outcomes, respectively. The strongest alphas found were for control beliefs for workforce (0.87, good) and graduate school (0.93, excellent) outcomes and for behavioral beliefs for the combined outcome (0.86, good). Alpha was lowest (0.61, questionable) for normative beliefs about the STEM workforce outcome.

Table 1. Cronbach's Alpha Calculations: Students Intending to Enter the STEM Workforce

Statistic Parameters	Behavioral Beliefs	Normative Beliefs	Control Beliefs
k	4	5	2
k-1	3	4	1
σ^2_y	0.668	3.513	0.469
σ^2_x	1.624	6.855	0.833
α	0.785	0.609	0.873

Table 2. Cronbach's Alpha Calculations: Students Intending to Enter a STEM Graduate Program

Statistic Parameters	Behavioral Beliefs	Normative Beliefs	Control Beliefs
k	4	5	2
k-1	3	4	1
σ^2_y	1.040	4.129	0.789
σ^2_x	2.537	9.607	1.469
α	0.787	0.713	0.927

Table 3. Cronbach's Alpha Calculations: Students Intending to Enter the STEM Workforce and a STEM Graduate Program

Statistic Parameters	Behavioral Beliefs	Normative Beliefs	Control Beliefs
k	8	10	4
k-1	7	9	3
σ^2_y	1.709	7.763	1.301
σ^2_x	7.000	23.237	3.492
α	0.864	0.740	0.837

We used logistic regression to determine if behavioral, normative, and control beliefs were predictive of post-graduation intentions expressed by the students. Each post-graduation outcome – STEM career, STEM graduate program, and both STEM career and STEM graduate program – was set as the binary dependent variable, with the predicted value set to 1 (i.e., they intended to pursue the outcome). The totals of the behavioral, normative, and control beliefs were used as the independent variables.

STEM Workforce Intentions. Table 4 summarizes the logistic regression results for the STEM workforce outcome. The overall model was found to be significant ($\chi^2(3)=10.86$, p=0.012, n=49) in predicting a student would indicate an intent to enter the STEM workforce within six months after graduation with 85.7% accuracy.

Table 4. Logistic Model Results for STEM Workforce Intentions

	Coefficients	Standard Error	P-value	Odds Ratio	Lower 95%	Upper 95%	Lower 90%	Upper 90%
Intercept	5.158	2.106	0.014	173.858	2.801	10789.693	5.440	5556.122
Behavioral Beliefs	0.424	0.454	0.351	1.528	0.627	3.720	0.724	3.224
Normative Beliefs	-0.407	0.163	0.012	0.665	0.484	0.915	0.509	0.869
Control Beliefs	-1.046	0.604	0.083	0.351	0.108	1.147	0.130	0.948

The resulting model is shown in equation (1):

$$P(STEM\ Workforce) = \frac{1}{1+e^{-(5.16+0.424BB-0.407NB-1.046CB)}} \quad (1)$$

where BB=behavioral beliefs, NB=normative beliefs, and CB=control beliefs values ranging from (1=strongly agree) to (4=strongly disagree) on a four-point Likert scale.

The influence of normative beliefs and control beliefs was significant at the 95% and 90% confidence levels, respectively. The influence of behavioral beliefs was not significant at these levels. There were negative relationships between STEM workforce intentions and both normative and control beliefs, indicating decreased ratings of these beliefs were associated with increased intention to enter the STEM workforce. On our scale, lower ratings corresponded with stronger levels of agreement; therefore, the results show that students who agreed more strongly with normative and control beliefs items had higher probabilities of expressing intentions to enter the STEM workforce. On the contrary, behavioral beliefs had a positive relationship with STEM workforce intentions, indicating that higher ratings on these items (i.e., stronger disagreement) were associated with increased intention to enter the STEM workforce. The odds ratios indicated increases in each of the predictor beliefs variables would increase the likelihood of an expressed intent to enter the STEM workforce to varying degrees. We note that the large 90% and 95% confidence intervals for the intercept indicate a high degree of uncertainty.

STEM Graduate Degree Intentions. Table 5 summarizes the model output for the STEM graduate program outcome. The overall model was not significant ($\chi^2(3)=3.75$, p=0.29, n=50) in predicting if a student would indicate an intent to enter a STEM graduate program within six months after graduation. The accuracy was 58%.

Table 5. Logistic Model Results for STEM Graduate Program Intentions

	Coefficients	Standard Error	P-value	Odds Ratio	Lower 95%	Upper 95%	Lower 90%	Upper 90%
Intercept	1.399	1.350	0.300	4.052	0.288	57.092	0.440	37.313
Behavioral Beliefs	-0.028	0.240	0.908	0.973	0.608	1.557	0.655	1.444
Normative Beliefs	0.018	0.101	0.857	1.018	0.835	1.242	0.862	1.203
Control Beliefs	-0.456	0.320	0.154	0.634	0.339	1.187	0.375	1.073

The resulting model is shown in equation (2):

$$P(STEM\ Graduate\ Program) = \frac{1}{1+e^{-(1.399-0.028BB+0.018NB-0.456CB)}} \qquad (2)$$

The influence of behavioral beliefs, normative beliefs, and control beliefs was not significant. There were negative relationships between STEM graduate degree intentions and both behavioral and control beliefs; students who agreed more strongly with these belief items had higher probabilities of expressing intentions to enter a STEM graduate program after graduation. On the contrary, normative beliefs had a positive relationship with STEM graduate degree intentions. Odds ratios indicated that changes in behavioral and normative beliefs would result in nearly no change in the likelihood of expressed intent to enter a STEM graduate program.

Both STEM Workforce and STEM Graduate Degree Intentions. Table 6 summarizes the model output for the combined STEM workforce and STEM graduate program outcome. The overall model was not significant ($\chi^2(3)=1.56$, p=0.67, n=45) in predicting a student would indicate an intent to enter a STEM graduate program within six months after graduation. The accuracy was 64.4%.

Table 6. Logistic Model Results for Both STEM Workforce and STEM Graduate Degree Intentions

	Coefficients	Standard Error	P-value	Odds Ratio	Lower 95%	Upper 95%	Lower 90%	Upper 90%
Intercept	-0.044	1.704	0.979	0.957	0.034	26.981	0.058	15.772
Behavioral Beliefs	0.145	0.186	0.436	1.156	0.803	1.666	0.851	1.571
Normative Beliefs	-0.015	0.071	0.837	0.985	0.857	1.133	0.876	1.108
Control Beliefs	-0.273	0.261	0.296	0.761	0.456	1.270	0.495	1.169

The resulting model is shown in equation 3:

$$P(STEM\ Workforce + Graduate\ Program) = \frac{1}{1+e^{-(-0.044+0.145BB-0.015NB-0.273CB)}} \qquad (3)$$

The influence of behavioral, normative beliefs, and control beliefs was not significant. There were negative relationships between STEM graduate degree intentions and both normative and control beliefs; students who agreed more strongly with these belief items had higher probabilities of expressing intentions to enter a both the STEM workforce and a STEM graduate program after graduation. On the contrary, behavioral beliefs had a positive relationship with these intentions. The odds ratio for normative beliefs (≈1) indicated an increase would result in nearly no change in the likelihood of expressed intent to enter both the STEM workforce and a STEM graduate program.

Influence of Predictor Variables by Pell Grant Status

We repeated logistic regression as before, this time separating data for Pell Grant recipients from non-Pell Grant recipients. Only the STEM workforce model for non-Pell Grant recipients (Table 7) was significant ($\chi^2(3)=7.93$, p=0.047, n=26), and it had an accuracy of 80%.

Table 7. Logistic Model Results for Both STEM Workforce and STEM Graduate Degree Intentions

	Coefficients	Standard Error	P-value	Odds Ratio	Lower 95%	Upper 95%	Lower 90%	Upper 90%
Intercept	2.000	2.894	0.052	273.435	0.942	79412.114	2.343	31907.759
Behavioral Beliefs	0.304	0.504	0.546	1.355	0.505	3.636	0.592	3.102
Normative Beliefs	-0.453	0.225	0.044	0.635	0.408	0.988	0.439	0.921
Control Beliefs	-0.828	0.835	0.321	0.437	0.085	2.245	0.111	1.725

The resulting model is shown in equation (4):

$$P(STEM\ Workforce) = \frac{1}{1+e^{-(2.00+0.304BB-0.453NB-0.828CB)}} \quad (4)$$

Within that model, normative beliefs were significant predictors of expressed intentions to enter the STEM workforce at the 95% confidence level. Odds ratios for this model indicated increases in each of the predictor beliefs variables would increase the likelihood of an expressed intent to enter the STEM workforce to varying degrees. As before, there was a great deal of uncertainty associated with the intercept, as indicated by the large confidence intervals.

The Chi-squared and related statistics are summarized in Table 8. They indicated none of the remaining models were significant. Despite this, the STEM workforce model showed a strong degree of accuracy (80%) for Pell Grant recipients.

Table 8. Chi-squared Statistics for All Post-Graduation Outcomes by Pell Grant Status

Intention	Pell Grant?	$\chi^2(3)$	p	n	Accuracy	Significant?
STEM Workforce	Yes	2.48	0.460	20	80.0%	No
	No	7.93	0.047	26	84.6%	Yes
STEM Graduate Program	Yes	0.19	0.979	21	66.7%	No
	No	4.57	0.206	26	65.4%	No
STEM Workforce + Graduate Program	Yes	3.85	0.278	17	70.6%	No
	No	1.21	0.750	25	76.0%	No

Tables 9a and 9b summarize the coefficients, p-values, and odds ratios obtained from the logistic regression analyses. Except for control beliefs for non-Pell Grant recipients intending to enter the workforce, none of the results were statistically significant.

For both Pell Grant and non-Pell Grant recipients, normative and control belief coefficients had negative associations with students' intentions to enter the STEM workforce. As a reminder, because of the scale used, this means students who more strongly agreed with statements related to those beliefs had higher probabilities of expressing intentions to enter the STEM workforce. The coefficients for control beliefs indicated negative associations with STEM graduate program intentions for both Pell Grant recipients and non-Pell Grant recipients (i.e., strongly positive control beliefs) were associated with higher probabilities of expressing intentions to enter a STEM graduate program. The same held true for control beliefs associated with intentions to both enter the STEM workforce and enter a STEM graduate program. Interestingly, the models yielded opposite signs for behavioral and normative beliefs coefficients associated with intentions to enter a STEM graduate program. Similarly, coefficients for normative beliefs for the two groups yielded opposite signs when modeling intentions to pursue both outcomes. Finally, coefficients for behavioral beliefs for both Pell Grant and non-Pell Grant recipients had positive associations with intentions to both enter the STEM workforce and a STEM graduate program, indicating students who held beliefs that more strongly disagreed with control beliefs had a higher probability of expressing the intention to pursue both outcomes. Further analyses are needed to understand these phenomena; more granular assessments may be needed to understand why some of these differences exist.

Table 9a. Logistic Regression Results – Pell Grant Recipients

Intention	β_0	p	OR	β_1	p	OR	β_2	p	OR	β_3	p	OR
STEM Workforce	1.938	0.808	6.943	1.189	0.579	3.285	-0.239	0.624	0.787	-1.623	0.287	0.197
STEM Grad. Prog.	0.995	0.651	2.705	0.002	0.997	1.002	-0.011	0.947	0.989	-0.171	0.736	0.843
STEM Wkfc. + Grad.	-6.557	0.144	0.001	0.937	0.109	2.551	0.156	0.337	1.169	-0.875	0.172	0.417

β_0=intercept, β_1=behavioral beliefs coefficient, β_2=normative beliefs coefficient, β_3=control beliefs coefficient, OR=odds ratio

Table 9b. Logistic Regression Results – Non-Pell Grant Recipients

Intention	β_0	p	OR	β_1	p	OR	β_2	p	OR	β_3	p	OR
STEM Workforce	2.000	0.052	273.435	0.304	0.546	1.355	-0.453	0.044	0.635	-0.828	0.321	0.437
STEM Grad. Prog.	1.774	0.339	5.897	-0.042	0.897	0.959	0.084	0.526	1.088	-0.745	0.126	0.475
STEM Wkfc. + Grad.	0.611	0.767	1.843	0.085	0.713	1.088	-0.008	0.924	0.992	-0.312	0.388	0.732

β_0=intercept, β_1=behavioral beliefs coefficient, β_2=normative beliefs coefficient, β_3=control beliefs coefficient, OR=odds ratio

CONCLUSION

We examined first-semester undergraduate engineering students' intentions to enter the STEM workforce, pursue a STEM graduate degree, or do both within six months after they graduate. We sought to understand the extent to which factors associated with their behavioral, normative, and control beliefs influenced their decisions and if any differences existed based on income status.

We found that most first semester EESI students intended to enter the STEM workforce after graduation, and that students from low-income backgrounds, operationalized by self-reported Pell Grant recipient status, were more likely to express intentions to enter the STEM workforce, enter a STEM graduate program, or to do both than their peers who were not Pell Grant recipients. We obtained a strong predictive model for STEM workforce intentions, with normative beliefs (i.e., how students perceived influential people in their lives felt about them entering the STEM workforce) and control beliefs (i.e., the extent to which students expressed confidence in their ability to enter and to succeed in the STEM workforce) being significant predictor variables. When analyzed by Pell Grant status (as an indicator of income status), only the model predicting workforce intentions for non-Pell Grant recipients was significant, and within that model, normative beliefs proved to be the significant predictor variable.

Limitations

This research was a single-institution study, which may limit the generalizability of the results. Further, students' self-reported Pell Grant status was used as an indicator of socioeconomic status, which may introduce errors (Trusheim, 1994). Students may misreport Pell Grant status because they do not fully understand the sources of their funding or, for students later in their academic journeys, they may not remember whether they received a Pell Grant. A better approach would be to use institutional data. For this study, identifying information that would allow us to link survey responses to institutional data on financial need was not collected.

Future Research

Our future research will track these findings longitudinally through graduation to determine if changes occur in intentions and influences over time. In addition, students' actual post-graduation pursuits will be incorporated into the model as the dependent variable, using the refined analyses to determine the influence of predictor variables on the targeted outcomes. Further, we will conduct more granular analyses to better understand the unexpected differences we found when comparing the logistic regression results based on income status.

ACKNOWLEDGEMENTS

We gratefully acknowledge all the EESI scholars who took time to participate in this study.

Support for this work was provided by the National Science Foundation's Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) program under award number 1930354 to Florida A&M University under contract with The PEER Group. The opinions, findings, and conclusions or recommendations expressed are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

REFERENCES

Abe, E.N., Chikoko, V. (2020). Exploring the factors that influence the career decision of STEM students at a university in South Africa. *International Journal of STEM Education,* 7(60). https://doi.org/10.1186/s40594-020-00256-x

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211.

Almonteros, J. R., Matias, J. B., & Pitao, J. V. S. (2024). Forecasting Students' Success to Graduate Using Predictive Analytics. *International Journal of Computing and Digital Systems*, 15(1), 697-711.

Armitage, C. J., & Conner, M. (1999). The theory of planned behaviour: Assessment of predictive validity and 'perceived control. *British Journal of Social Psychology*, *38*(1), 35–54. https://doi.org/10.1348/014466699164022

Caldwell, C., & Perry, R. J. (2023), Educating Engineering Students Innovatively: A Model for Improving Retention and Academic Performance of Black Upper-Level Students Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2—43220

He, L., Levine, R. A., Bohonak, A. J., Fan, J., & Stronach, J. (2018). Predictive Analytics Machinery for STEM Student Success Studies. *Applied Artificial Intelligence*, 32(4), 361–387. https://doi.org/10.1080/08839514.2018.1483121

Lenning, O.T., Ebbers, L. H. (1999). The Powerful Potential of Learning Communities: Improving Education for the Future. *ASHE-ERIC Higher Education Report* 26(6), Washington, DC. The George Washington University, Graduate School of Education and Human Development.

Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A comparison of the theory of planned behavior and the theory of reasoned action. *Personality and social psychology Bulletin*, *18*(1), 3-9.

Moore, R., & Burrus, J. (2019). Predicting stem major and career intentions with the theory of planned behavior. *The Career Development Quarterly*, *67*(2), 139–155. https://doi.org/10.1002/cdq.12177

Ong, A. K. S., Prasetyo, Y. T., Pinugu, J. N. J., Chuenyindee, T., Chin, J., & Nadlifatin, R. (2022). Determining factors influencing students' future intentions to enroll in chemistry related courses: integrating self-determination theory and theory of planned behavior. *International Journal of Science Education*, *44*(4), 556–578. https://doi.org/10.1080/09500693.2022.2036857

Park, J.J., Kim, Y.K., Lue, K. et al. (2022). What's Next? Soon-to-be STEM Graduates on Their Post-graduate Plans. *Research in Higher Education,* 63, 1343–1367. https://doi.org/10.1007/s11162-022-09685-9

Patrick, A., Borrego, M. & Riegle-Crumb, C. (2021). Post-graduation Plans of Undergraduate BME Students: Gender, Self-efficacy, Value, and Identity Beliefs. *Annals of Biomedical Engineering,* 49, 1275–1287. https://doi.org/10.1007/s10439-020-02693-9

Pearson, Y. E., & Crosby, K. E., & Blevins, E. R., & Isbell, B. R., & Kruzic, A. P., & Mattingly, S. P., & Peterson, L. L., & Tiernan, J. C. (2016). Challenges, Opportunities, and Impacts of S-STEM Projects: Insights for Institutional Capacity Building at Minority-serving Institutions Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26472

Trusheim, D. (1994). How valid is self-reported financial aid information?. *Research in Higher Education,* 35, 335–348. https://doi.org/10.1007/BF02496827

Veenstra, C.P., Dey, E.L. & Herrin, G.D. (2009). A Model for Freshman Engineering Retention. *Advances in Engineering Education*, 1(3): 1-33.

Walton, D. I. (2023). *The Correlation Between Math Achievement Scores, STEM Benchmark Scores, and Academic Majors*. ProQuest Dissertations & Theses.

Weatherton, Y. P., & Kruzic, A. P., & Isbell, B. R., & Peterson, L. L., & Tiernan, C., & Pham, V. V. (2011). Mathematics Performance and First Year Retention of Students in Engineering Learning Communities Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18328