Can I really do this? Perceived benefits of a STEM intervention program and women's engineering self-efficacy

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Abstract

The low number of women that persist in science, technology, engineering, and mathematics (STEM) disciplines is a current problem that has manifested particularly in the engineering collegiate environment. Regardless of previous levels of academic achievement, women are more likely to leave engineering than their male counterparts. Self-efficacy, or the self-confidence to complete certain tasks, is attributed to attrition and persistence in engineering programs. STEM intervention programs that focus on improving the self-efficacy of students can lead to women's persistence in engineering programs. This study utilizes Bandura's Self-Efficacy Theory to investigate the relationship between engineering students' reports of the benefits of participating in a university STEM intervention program and self-efficacy in engineering, and how this changes over the first year of college. Preliminary findings indicate that women and men's engineering major confidence significantly increases after participation in the pre-college summer transition program. However, by the end of students' first academic year, their engineering major confidence is comparable to the levels reported prior to their participation in the summer program. These findings partially align with the extant literature on women's engineering efficacy but suggest the need for further investigation.

Introduction

Despite having the academic skills to succeed, women are pursuing and earning STEM degrees at a much lower rate than men[1]. Although women enter college with math and verbal skills comparable to or higher than their male peers, they often switch to non-STEM majors[2 3]. Recognizing that women's departure from STEM is not an issue of ability raises questions about what experiences may contribute to women's decisions to leave STEM majors. Research indicates that women typically enter college engineering programs with lower levels of self-efficacy than their male counterparts[4 5 6]; STEM intervention programs that focus on improving students' self-efficacy, may prove to be beneficial for women and men regarding their persistence and retention.

STEM intervention programs have proliferated on college campuses across the United States in response to the nation's demand for engineers and scientists. Varying in scale and scope, these programs are typically designed to broaden the participation of underrepresented students in STEM fields, including women. Additionally, STEM intervention programs seek to cultivate students' self-efficacy within their field[7]. Self-efficacy refers to a person's confidence in her or his ability to accomplish a particular task[8]. Gender-specific residential experiences and student organizations for women in STEM are examples of institutional interventions developed to improve women's self-efficacy, retention, and matriculation in STEM. Co-educational STEM intervention programs that share similar support structures could be just as beneficial for women and potentially influential on women's STEM self-efficacy and therefore persistence in these fields. In this study, we explore the relationship between participation in a co-educational, cohort-based engineering intervention program—the M-Engin program of the Michigan STEM Academies Scholars Program (M-STEM)—and women's self-efficacy in engineering.

Literature Review

STEM intervention programs that focus on increasing undergraduates' self-efficacy, or self-confidence in one's ability to accomplish a given task, are successful in contributing to students' persistence to STEM degree attainment and the pursuit of a STEM career[9]. Effective strategies implemented within STEM intervention programs include but are not limited to academic advising, faculty mentorship, tutoring, internship opportunities, and career and skill development. Such programs have the potential to be especially beneficial for women due to the development of a supportive community and integration into the academic environment, which are areas that women tend to struggle with when entering engineering programs[10].

Women in STEM often contend with a marginalizing academic environment, which can negatively influence their discipline-related self-efficacy and ultimately their persistence in the field[11 12 13 14 15]. In Brainaird and Carlin's[16] longitudinal study concerning women's STEM self-efficacy and their persistence in the field, the researchers found that women who entered college with high STEM self-efficacy experienced a decrease in self-efficacy during their first year. Although women's STEM self-efficacy increased as they approached graduation, it never returned to the highest level reported upon college entry. Marra et al.[17] conducted a longitudinal and multi-institution analysis regarding the engineering curriculum's influence on women's engineering self-efficacy. In the study, women of color reported feeling a lack of inclusion in the academic environment, which was associated with lower levels of engineering self-efficacy.

Jones et al.[18] also found that low levels of self-efficacy in women in engineering is due to environmental factors such as classroom climate and lack of female role models. To address women's feelings of exclusion in engineering disciplines, Marra and colleagues[19] suggest the development of co-curricular activities that focus on integrating women into the academic environment. Hackett and Betz[20] argue that women encounter more stress and anxiety in engineering programs, which results in lower academic and career self-efficacy. They contend that social support can counteract the stressful environment and its effect on women's self-efficacy. Women in their study experienced lower levels of encouragement and positive feedback from instructors. Hackett and Betz argue that this experience can negatively predict women's self-efficacy, thus leading to attrition in engineering and subsequently in an engineering career.

Ramsey, Betz, and Sekaquaptewa[21] studied a living-learning community to determine if supporting women's STEM identity, connecting women to female mentors and role models, and reducing stereotyping could increase the participation and persistence of women in STEM. The authors discovered that the program strengthened women's STEM identity but did not reduce the stereotypes that they encountered or felt. It could be argued that androcentric, or male-centered, academic environments in engineering contribute to women's negative experiences, which motivate women to leave STEM majors, despite their aptitude and potential to succeed. Thus, STEM intervention programs could be a particularly useful resource for women in engineering as they focus on improving student's self-efficacy by providing the necessary academic and social support to successfully integrate students into the academic environment.

STEM intervention programs such as the Meyerhoff Scholars Program (MSP) at the University of Maryland are successful in having long-term effects on persistence and retention of high-achieving underrepresented students[22]. The program focuses on integrating the population of students socially and academically while also providing skill development, consistent motivational support, and intrusive advising. These program elements increase students' self-efficacy leading to persistence in STEM in college and beyond. A study of the MSP revealed that perceptions of program benefits were accompanied by a sense of community, science identity, and research self-efficacy. Additionally, student participants in the program were more likely than the comparison group to persist and achieve PhDs in STEM[23]. The researchers attribute the development of a community of STEM students as being the primary factor influencing both science identity and research self-efficacy. Programs like the MSP can potentially contribute to women's self-efficacy since one of the main barriers for women entering the engineering academic environment tends to be a lack of support and inclusion[24].

Modeled after the Meyerhoff Scholars Program at the University of Maryland-Baltimore and the Biology Scholars Program at the University of California Berkeley, the Michigan Science, Technology, Engineering, and Mathematics Academies Program at the University of Michigan, provides a diverse group of high-achieving STEM students with academic and social support beginning the summer of their first year to the end of the second year[25]. The M-STEM program specifically invites students to participate that are of lower socioeconomic status, first generation, and/or traditionally underrepresented in STEM by race or gender[26]. In addition, M-STEM is comprised of two sub-programs: M-Sci which caters specifically to STEM students in the College of Literature, Science, & Arts and M-Engin which supports the engineering students in the College of Engineering. In this study we limit our focus to the experiences of engineering students in the M-Engin program. Specific elements of the M-Engin program include: a summer transition program in which students gain exposure to the engineering curriculum, academic coaching, study skill building, as well as career and professional development. Our study explores the relationship between students' perceptions of the M-Engin program's benefits and their engineering major confidence (a measure of self-efficacy) after their first year in college. We hypothesize that perceived program benefits of the M-Engin program will be positively related to women's engineering major confidence. Considering the importance of engineering major confidence as it relates to women's persistence in the field, we use Bandura's[27] Self-Efficacy Theory to frame our empirical investigation.

Theoretical Framework

Self-efficacy Theory is used to describe how self-confidence in one's ability relates to task completion. Thus, Bandura's theory can be used to examine how women's engineering major confidence can affect their persistence in completing the task of attaining a degree in engineering. Bandura's Self-efficacy Theory[28] discusses how self-efficacy is influenced by four sources: mastery experiences, vicarious experience, verbal and social persuasion, and emotional and physiological states. He explains that an individual's belief in effectively completing a task affects whether or not he or she chooses to engage in a specific task. One's expectations of achieving success affect the amount of time and energy expended on a task, and his or her ability to persist despite barriers. Higher levels of self-efficacy lead to more effort and stamina toward persistence. Therefore, a woman with high engineering self-efficacy is more likely to persist toward achieving a degree in engineering despite barriers or obstacles encountered.

Bandura[29] indicates that there are conditions of the environment that influence a person's expectations of mastering a particular skill. The first source of self-efficacy beliefs is mastery experiences, which consists of modeled or guided assistance that helps the person acquire the skill needed to overcome stressful experiences. This includes changing the environment so that the individual can feel less threatened in the beginning as they learn coping mechanisms. Long-term efforts, rather than short-term efforts, are more effective since there is follow through until the person has achieved the task successfully. Therefore, the M-Engin program, which focuses on creating a non-threatening environment and providing mentorship and guidance throughout the student's time as an undergraduate can increase a student's self-efficacy as they move through college. Women pursuing engineering degrees may especially benefit from a sustained community and mentorship from within the academic department.

The second source of self-efficacy is vicarious experiences, which explains that witnessing another person with a shared identity successfully overcome obstacles encourages the observer to do the same. The M-Engin program offers a cohort-style model in which first year students in the program are mentored by advanced students and, through the community, they are able to interact with upperclassmen informally. Thus, women pursuing engineering are able to receive mentorship from other female engineering students in the program as well as meet them through activities offered through the program. They thus vicariously experience the success of students who are like them in at least one way, and potentially multiple ways (e.g., socioeconomic status, race/ethnicity).

The third source for increased self-efficacy is verbal and social persuasions, which involves telling the individual that they can accomplish the task and that they have the skills to do so. Women in engineering may benefit from consistent coaching and verbal affirmation to develop self-confidence and belief that they can persist in their particular major. M-Engin manifests this idea through required academic and career coaching meetings in which students are "coached" through struggles with academic or career-related tasks.

The final source for increased self-efficacy is the emotional and physiological state of the person who, when encountering stressful situations, can develop anxiety based on aptitude which contributes to low self-efficacy. Bandura explains that to increase self-efficacy through this source, the person must be influenced to believe that they can accomplish the task and develop an increased perception of self-confidence. The overall mission of the M-Engin program is to develop self-confidence in students by providing a community and connecting the students to a number of resources including academic assistance, relationships with faculty, and career guidance. Women in engineering may benefit from their involvement in the M-Engin program in that they are able to develop a network and believe in their abilities to successfully persist to graduation.

Bandura's explanation of sources that impact an individual's self-efficacy indicates that a program like the M-Engin can affect the self-efficacy of its participants. Women in engineering, a group that typically has lower levels of self-efficacy, may benefit substantially from programmatic elements that embody Bandura's sources of self-efficacy. The participation of women in engineering in the M-Engin program through program components such as academic and career coaching, peer and faculty mentorship, and development of a sense of community through a cohort model, could possibly relate to increased levels of self-efficacy, which can lead to both retention and persistence in engineering.

Data

Data was collected through M-Engin cohort surveys (2013-2015) administered electronically through Qualtrics. M-Engin students are surveyed prior to their participation in the summer transition program, immediately following their participation in the summer program, at the end of their first year, and every subsequent year until students graduate from college. For the purposes of this study, we examined student responses prior to participating in the summer program to the end of their first year. Pre-summer program response rates for cohort 2013, 2014, and 2015 were 100% (62 students), 93.6% (58 students), and 100% (62 students), respectively. Post-summer program response rates were, respectively, 63.8%, (37 students) 91.9% (57 students), and 95% (59 students). Finally, end of year response rates were 62.1% (36 students), 71% (44 students), and 76.7% (48 students). Respondents with missing data on survey items of interest for this study were excluded from the analytical sample. The final sample for analysis included 111 students (55 women and 56 men) from the M-Engin program.

Measures

Engineering Major Confidence

The dependent variable of interest for this study is students' end-of-year engineering major confidence. This is a continuous variable ranging from 1-5, with 5 being the highest rating a student could self-report (Strongly Disagree = 1, Strongly Agree = 5). Prior to this study, an exploratory factor analysis was performed on the engineering efficacy measure with student responses from the 2013 cohort; that analysis produced two distinct factors. For this study, we used one of these factors—the engineering major confidence factor—which captures students' belief in their ability to succeed as an undergraduate majoring in engineering. Items in this factor are:

- I can succeed in an engineering major
- I can complete the math requirements for most engineering majors
- I can succeed in an engineering major while not having to give up participation in my outside interests
- I can excel in an engineering major during the current academic year
- I can succeed (earn either an A or B) in an advanced physics course
- I can complete any engineering degree at this institution
- I can succeed (earn either an A or B) in an advanced math course
- I can complete the physics requirements for most engineering majors
- I can succeed (earn either an A or B) in an advanced engineering course
- I can complete the chemistry requirements for most engineering majors

The Cronbach's alpha for the engineering major confidence factor is 0.92, indicating high internal consistency. This factor was used for subsequent cohorts. The engineering major confidence variable was developed by taking the numerical average of students' Likert scale ratings (e.g. Strongly Disagree = 1 and Strongly Agree = 5) of items included in the engineering major confidence factor.

Table 1: Continuous variable means and standard deviations

Variable	**N**	**M (S.D.)**
End-of-Year Engineering Major Confidence	111	4.04 (0.55)
Pre-Summer Engineering Major Confidence	111	3.99 (0.55)
Post-Summer Engineering Major Confidence	99	4.10 (0.59)
M-Engin Program Benefits	111	3.64 (0.61)

Note: Minimum = 1, Maximum = 5

Student Background Variables

The independent variables related to student background for this study include: gender, race, high school GPA, and advanced coursework in math or science taken in high school. Gender is measured dichotomously (0 = male, 1= female), as is race (0 = Person of Color, 1 = White). In this study, a Person of Color refers to African Americans, American Indians or Native Americans, Asian Americans or Pacific Islanders, Latino/as, and any non-White race specified by the respondents. As mentioned previously, students who are invited to participate in the M-Engin program are of lower socioeconomic status, first generation, and/or traditionally underrepresented in STEM by race or gender [30]. The high school GPA variable was also recoded as a dichotomous variable to indicate whether students earned above or below a 3.5 GPA (0 is $\geq$ 3.5 GPA, 1 is $<$ 3.5 GPA). Advanced math or science course taking in high school was also measured dichotomously. If a student took Calculus 1, advanced Physics, or advanced Chemistry in high school he or she received a 1 (did have advanced coursework). Students who did not take any of these classes received a 0 (did not have advanced coursework).

Table 2: Categorical variable frequencies

Variable		**N**	**%**
Gender	Women	55	49.55
	Men	56	50.45
Race	Person of Color	61	54.95
	White	50	45.05
High School GPA	3.5 or above	108	97.30
	Below 3.5	3	2.70
Adv. Math or Science in HS	Did have advanced coursework	107	96.40
	Did not have advanced coursework	4	3.60

M-Engin Perceived Program Benefits

Students also responded to survey questions asking how beneficial they found specific components of the M-Engin program (Not at all helpful = 1 to Extremely helpful = 5). These components consist of family meetings, peer mentor meetings, academic coaching, engineering advising center appointments, personal and professional skill development, and math supplemental instruction sessions. For example, in 2013 and 2014 students were asked: How helpful did you find family meetings? Students participating in cohort 2015 were asked to evaluate program component helpfulness in multiple ways. Specifically, the 2015 cohort students were asked: How helpful were the family meetings in providing social support? Providing academic support? Equipping you with academic skills? Providing information that confirmed your choice of major? Assisting you in getting good grades? For the 2015 cohort, we took the numerical average of students' Likert-scale ratings of helpfulness for all items pertaining to a specific program component (e.g. family meetings) to derive a single measure. Finally, for all cohorts, 2013-2015, we took the numerical average of a student's program component helpfulness ratings as reported at the end of year one survey to develop the continuous M-Engin program benefit variable, a single rating of a student's perceived benefit of participating in M-Engin.

Analysis

In this study, we addressed the following research question: What is the relationship between perceived program benefit in the M-Engin program and women's engineering major confidence? To answer this question, we conducted two sets of analyses. First, to determine whether there was a difference between reports of engineering major confidence between men and women students, we conducted a series of t-tests. The t-tests compared men and women's engineering major confidence at three time points during their first year of college: 1) before their participation in the summer transition program, 2) after the summer transition program, and 3) at the end of their first year to determine how students' engineering major confidence changes after the initial academic year. Given that the data for this analysis was not collected from a random sample, we cannot generalize these findings beyond the M-Engin group, but academic and social programs with similar components and student populations might expect similar results. Next, we performed a nested multiple linear regression analysis to determine the relationship between students' perceived benefit ratings of the M-Engin program and their engineering major confidence as reported at the end of their first year in the program. One hundred and eleven students (55 women and 56 men) were included in the final analytical sample. Descriptive statistics for each variable are found in Tables 1 and 2.

Results

The preliminary findings of this study demonstrate that women and men's engineering major confidence significantly increases after participation in the pre-college summer program. However, by the end of students' first academic year, their engineering major confidence is comparable to the levels reported prior to their participation in the summer program. Additionally, M-Engin students' ratings of perceived program benefit do not appear to have a significant relationship with men and women's end-of-first-year engineering major confidence. Although perceived program benefit was not statistically significant in this analysis, there are other ways to consider possible relationships between the utility of M-Engin program participation and students' engineering major confidence. For instance, further exploration of the qualitative data could provide additional insight into beneficial aspects of the program that may not be captured in the end-of-first-year survey. A more detailed description of the analysis results is discussed in the sections that follow.

Comparing Men and Women's Mean Engineering Major Confidence

T-tests comparing men and women's mean pre-summer engineering major confidence ratings revealed that the difference in means is not statistically significant. Specifically, prior to participation in the M-Engin summer transition program, men and women's mean engineering major confidence levels were comparable (Table 3). T-tests comparing men and women's engineering major confidence ratings after completing the summer program indicate that men's engineering major confidence is significantly higher than their female counterparts. However, it is important to note that although women's post-summer program engineering major confidence is lower than their male peers, it is still relatively high. On a scale of 1 to 5, women's mean engineering major confidence rating was 4.01 ($SD = 0.54$) as compared to men's mean engineering major confidence of 4.21 ($SD = 0.63$). Further, t-tests comparing men and women's engineering major confidence ratings at the end of their first year of college indicated that the difference between men and women's mean engineering major confidence is not statistically significant. This finding demonstrates that although women may have lower engineering major confidence after participating in M-Engin summer program than their male counterparts, the difference between men and women's engineering major confidence prior to entering the program and at the end of their first year, on average, is negligible.

Table 3: Comparison of engineering major confidence means and standard deviations between women and men

	Women		Men	
Engineering Major Confidence	N	M (S.D.)	N	M (S.D.)
Pre-Summer Program	55	3.92 (0.48)	56	4.07 (0.61)
Post-Summer Program	52	4.01 (0.54)	47	4.21 (0.63)
End-of-Year	55	3.98 (0.54)	56	4.10 (0.56)

Note: Minimum = 1, Maximum = 5

Examining Men and Women's Mean Engineering Major Confidence Over Time

To determine if men and women's engineering major confidence changed over the course of their first year in college, t-tests were conducted to compare students' mean engineering major confidence ratings prior to the summer transition program (Time 1), after the summer program (Time 2), and at the end of the first year (Time 3). T-tests were performed on the samples of men and women separately to identify differences in engineering major confidence over time by gender. For women, t-tests comparing mean engineering major confidence at Time 1 and Time 2 revealed a significant difference in means. Women's engineering major confidence was significantly higher after participating in the summer program that it was prior to the summer program. Comparisons of mean engineering major confidence ratings at Time 1 and Time 3, as well as Time 2 and Time 3 revealed no statistically significant differences between means. These results indicate that women experienced an increase in engineering major confidence after participating in the summer program. Additionally, although women's engineering major confidence decreased by the end of the first academic year, it remained comparable to the level reported prior to participation in the summer transition program.

Similarly, for men, t-tests comparing mean engineering major confidence ratings at Time 1 and Time 2 revealed a statistically significant difference in means. Men's mean engineering major confidence after participation in the summer transition program is significantly higher than their efficacy prior to participating in the summer program at the $p < 0.05$ level. In other words, men experienced an increase in their engineering major confidence after completing the summer transition program. Additionally, the difference between mean engineering major confidence ratings for men at Time 1 and Time 3, as well as Time 2 and Time 3 are not statistically significant. These findings reveal a similar pattern in the engineering major confidence trajectory for male and female M-Engin participants. For men and women, engineering major confidence increases after participating in the summer transition program. However, by the end of the first academic year, it decreases to a level comparable to their efficacy ratings prior to the summer program.

Table 4. Comparison of engineering major confidence means and standard deviations over time for women and men, respectively

Women				Men			
Pre-Summer		Post-Summer		Pre-Summer		Post-Summer	
N	M (S.D.)	N	M (S.D.)	N	M (S.D.)	N	M (S.D.)
52	3.91 (0.48)	52	4.01* (0.54)	47	4.05 (0.66)	47	4.21* (0.63)
Pre-Summer		End-of-Year		Pre-Summer		End-of-Year	
N	M (S.D.)	N	M (S.D.)	N	M (S.D.)	N	M (S.D.)
55	3.92 (0.48)	55	3.98 (0.54)	56	4.07 (0.61)	56	4.10 (0.56)
Post-Summer		End-of-Year		Post-Summer		End-of-Year	
N	M (S.D.)	N	M (S.D.)	N	M (S.D.)	N	M (S.D.)
52	4.01 (0.54)	52	3.98 (0.54)	47	4.21 (0.63)	47	4.09 (0.58)

Significant differences between means p < *0.05, **0.01, ***0.001

Examining the Relationship between Students' Perceived Benefits of M-Engin Participation and Engineering Major Confidence

To better understand the relationship between students' ratings of the perceived benefit of the M-Engin program and engineering major confidence, we performed a nested multiple linear regression. In the first model, student background variables (gender, high school GPA, and advanced courses taken in math or science) were included to determine their relationship with engineering major confidence. In the second model, students' pre-summer transition program engineering major confidence ratings were added. In our final model, students' assessment of program benefit was included along with the variables in Model 1 and Model 2 (Table 5). Initially, we intended to include post-summer transition program engineering major confidence in the regression analysis, but after testing for collinearity between pre- and post-summer engineering major confidence, we found that the variables were collinear. This prompted us to remove the post-summer engineering major confidence from the regression models.

Results from Model 1 indicate that none of the student background variables are significantly related to end-of-first-year engineering major confidence for M-Engin participants. In Model 2, students' pre-summer transition program engineering major confidence has a positive significant relationship with end-of-first-year engineering major confidence ($p < 0.001$). The program benefit variable added in Model 3 was not statistically significant. However, pre-summer transition program engineering major confidence remained positively associated ($p < 0.001$) with engineering major confidence at the end of the first year in the third model.

Table 5: Estimated coefficients and standard errors of three nested linear regressions of end-of-year engineering major confidence on select independent variables

Variables	End-of-Year Engineering Major Confidence (N=111)		
	Model 1 **β (S.E.)**	**Model 2** **β (S.E.)**	**Model 3** **β (S.E.)**
Female	-0.11 (0.11)	-0.05 (0.10)	-0.05 (0.10)
White	-0.10 (0.11)	-0.05 (0.10)	-0.06 (0.10)
High School GPA	-0.36 (0.33)	-0.17 (0.30)	-0.16 (0.30)
Adv. Math or Science in HS	0.23 (0.28)	-0.12 (0.27)	-0.07 (0.27)
Pre-Summer Engineering Major Confidence		0.43 (0.09)***	0.43 (0.09)***
M-Engin Program Benefits			0.13 (0.08)
r^2	0.03	0.20	0.22

Significance levels: p < *0.05, **0.01, ***0.001

Limitations

As mentioned previously, the analytical sample for this study was 111 students (55 women and 56 men). The sample size in this analysis may not have enough power to demonstrate significance. Thus, our results should be interpreted with caution. However, data is currently being collected for another cohort, which will increase the sample size in future analyses. Additionally, we focused the analysis on data collected during the students' first year; yet, the M-Engin program provides formal support until the end of the students' second year. Further research examining the relationship between perceived program benefits and women's engineering major confidence throughout the duration of the M-Engin program is warranted. Finally, the findings of this study should not be generalized beyond the M-Engin program. However, programs of similar design that are developed to serve a comparable student population might expect similar results.

Discussion

Findings from this preliminary analysis of data from a longitudinal study of the M-Engin program partially align with those in the literature, which suggests that women's self-efficacy in engineering is expected to decrease over time[31 32 33 34]. While our preliminary findings demonstrate a decrease in women's engineering major confidence between the conclusion of the M-Engin summer transition program and the end of their first academic year, women's confidence levels do not decrease beyond their levels prior to participating in the summer program. Examining men's engineering major confidence over time reveals a similar pattern.

This could be an indication that the M-Engin program has a buffering effect in helping to maintain women and men's engineering major confidence. In addition, men and women's engineering major confidence by the end of the first year is not significantly different. It appears that participating in the M-Engin program bolsters students' engineering major confidence to such a degree that even after their confidence decreases during the academic year, it remains just as high as it was prior to participation in M-Engin. Further analyses will determine whether this effect persists over students' time in the program and its relation to students' level of engagement in the various components of the M-Engin program. Additionally, analyses of the qualitative data we have collected as a part of this study may help us understand when and why this buffering effect happens.

We expected that the increase in engineering major confidence experienced by students after the summer transition program would persist to the end of the first year. The decline, however, might not be surprising if it were related to students' academic performance in the engineering program. Bandura's theory[35] suggests that students' mastery experiences, which would be affected by their academic performance during their first year, will influence their self-efficacy. Thus, future analyses should examine whether M-Engin participants' GPAs during the first year could are related to students' engineering major confidence at the end of their first year.

A recent study of the Meyerhoff program may provide further insight into our finding that M-Engin students' engineering major confidence increases after participating in the summer transition program. The Meyerhoff program is similar to the M-Engin program in that it focuses on improving self-efficacy through social and academic integration. It also offers, as does M-Engin, programmatic elements that include skill development, motivational support and intrusive advising. The Meyerhoff study[36] found these program elements were linked to student's self-efficacy and therefore persistence in achieving a STEM degree and pursuing graduate study. Maton et al.[37] also concluded that a sense of community contributed to a salient science identity and research self-efficacy. The intentional and ongoing efforts of the M-Engin program to build a student community throughout the summer program might similarly affect self-efficacy of women participants. Marra et al.[38] found that women pursuing engineering degrees respond positively to efforts that provide a supportive community and assist with the transition to the academic environment.

Because participation in M-Engin is required of students invited to the program, we utilized a measure of perceived program benefits to investigate whether there was a relationship between students' assessment of the benefits of the program as a whole and their reports of engineering major confidence. The absence of a relationship between perceived benefit and engineering major confidence suggests that we need to examine whether and how components of the M-Engin program that we did not capture in this measure may be contributing to the self-efficacy of women. Qualitative data from student interviews throughout the program may provide some clues. Additionally, we will analyze data from a comparison group to determine whether there is a significant difference in engineering major confidence between students in the M-Engin program and those who were eligible for the program but who either were not selected to participate or who declined the invitation to participate.

Conclusion

Understanding the ways in which co-educational, cohort-based engineering intervention programs such as M-Engin influence the self-efficacy of women is a critical and timely endeavor. Results from this study demonstrated that the engineering major confidence of women participating in the M-Engin program increased after participating in the summer transition program. Although women's efficacy decreased between the conclusion of the program and the end of the first academic year, it was still comparable to their self-reported confidence prior to participation in summer program. Men experienced a similar pattern in their engineering major confidence. Despite the absence of a significant relationship between students' reports of perceived program benefits and their end-of-year engineering major confidence, the results of this study suggest that the M-Engin program may help sustain women's engineering major confidence during their first year.

This study contributes to the current literature by providing evidence that participation in a summer transition program is positively related to increased engineering major confidence for women. If women are to persist in engineering majors, intervention programs that bolster their engineering major confidence and support their pursuit of STEM degrees are essential. This study reveals that programs such as M-Engin have the potential to make a critical investment in this nation's STEM talent pool by cultivating the next generation of highly skilled and efficacious women in engineering. Career-related self-efficacy may be particularly important for women who will need to navigate challenges of the engineering workplace[39]. Further research on programs like M-Engin will help engineering educators understand how such programs promote women's self-efficacy and may enable them to persist in engineering majors and careers.

Endnotes

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