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Examining the Association between Peer Support and Young Women's Engineering Identity and Major Intentions

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Introduction

In recent years, approximately 60% of college students are women, and they comprise an even larger percentage of degree earners [1]. However, women are still drastically under-represented in engineering majors, earning about 20% of undergraduate degrees in this relatively elite and lucrative field [2]. As gender persistence rates of those who enter engineering majors are comparable [3], it appears that the primary hurdle to achieving parity among engineering degree holders is the fact that so few young women choose engineering in the first place. Yet there are few studies that examine their experiences with engineering in high school, when their engineering identity and intentions are likely at a formative stage [4].

Therefore, this quantitative study will utilize a purposive sample of high school girls who have expressed an interest in engineering with the aim of understanding their experiences as they grapple with consequential decisions about who they are and who they want to be. Our sample is comprised of young women who are members of SWENext, an organization that is part of the Society for Women Engineers (SWE). As young women interested in engineering, they have what can be viewed an 'exceptional' or non-gender-normative status. What we seek to understand is whether their peers (both male and female) are supportive of their interest in engineering, and whether such support bolsters young women's engineering identity and intentions to major in engineering.

Background

Engineering identity and major intentions

Broadly, *engineering identity* has been conceptualized as the extent to which an individual sees or identifies themselves as an engineering person [5], [6]. Most research studies have focused on the role of individual-level attributes in predicting engineering students' engineering identities [7], [8]. For example, while some research has investigated the influence of students' academic background on their engineering identities [9], [10], other studies have examined the relationship between their personal attitudes and experiences, such as students' perceptions and STEM engagement, and their engineering identities [11], [12]. One study found that among first-year college students interested in engineering, self-reported engagement in various STEM-related experiences were predictive of their engineering identities [13]. However, young women's engagement with tinkering and computer programming was associated with lower levels of identification with engineering. Overall, research reveals that understanding the factors that contribute to young women's engineering identities is critical, as those with strong identities are more likely to persist in engineering [14], [15].

Similar to engineering identity, *intentions to pursue an engineering major* are highly predictive of STEM college persistence and interest in a STEM career [16], [17]. Young people's consideration of entry into an engineering major has been studied extensively and linked to student sociodemographic and academic factors [18], [19], [20]. In one study, researchers found

that advanced science course-taking positively predicted students' likelihood of deciding to major in STEM fields [21]. Moreover, researchers have linked students' attitudes and beliefs to their intentions to major in engineering [15], [21], [22]. To illustrate, one longitudinal study on undergraduate students found that their self-efficacy was positively related to their decision to major in engineering [23]. In another longitudinal study, the researchers noted a significant association between adolescent girls' counter-stereotypic beliefs about scientists and their intentions to pursue an engineering major [24]. Thus, prior research has established the importance of individual beliefs and actions in predicting young women's major intentions.

Peer support

Relatively absent in the research described above is the examination of supportive environments in relation to students' engineering identities and decision to enter an engineering major. Certainly, prior research has highlighted the importance of peer support in young women's STEM interest and aspirations [25], [26]. This is not surprising as peers tend to occupy a more prominent role in the lives of young people during adolescence [27]. Therefore, we would expect that young women with strong engineering aspirations would turn to their peers as important sources of support. Indeed, there are a few studies that find peer STEM support to be predictive of students' engineering identity [6], [11]. There is also emerging evidence of the positive effects of peers' supportive climate on students' decision to pursue STEM majors [21].

Yet it is important to recognize that peer support may differ depending on the gender of the source, such that young women may perceive more support from other young women their age. We note that while some research finds that young women's choices are particularly influenced by peers who are also young women [28], [29], there is also evidence that in some instances, peers that are girls may be perceived to provide less support for girls' STEM aspirations [30]. In this latter study, researchers observed that belonging to a friendship group composed mostly of girls with a lower STEM climate was related to a lower STEM interest for adolescent girls. Further, there is some evidence that boys may serve as allies and colleagues in their pursuit of engineering [31]. Therefore, prior research provides mixed evidence on the importance of support from different gender groups

Current Study

This quantitative study seeks to examine the relationship between young women's perceived peer support and their engineering identities and engineering major intentions. Previous research has largely focused on individual attributes, such as self-efficacy and STEM course-taking, in predicting these important engineering outcomes, without considering STEM support within peer contexts. Moreover, most of the research that examines young women's engineering identity has been at the post-secondary level, when young women have already entered an engineering major. Therefore, our study is relatively unique in considering the experiences of a group of young women in high school who have professed a commitment to engineering. We also make a significant contribution by distinguishing between the support offered by girls and boys, with the goal of understanding which may be more impactful in bolstering the engineering identity and future plans of young women in SWENext. Specifically, we investigate the following research questions:

(1) Do SWENext young women receive similar levels of peer support from girls and boys?
(2) Does peer support predict young women's strong engineering identity and engineering major intentions?
    (a) Is it gendered, such that, for example, support from girls is more important than boys, in predicting engineering outcomes?
(3) Do patterns in peer support and their relation to engineering outcomes vary by girls' race/ethnicity?

Data and Methods

Survey data for this study come from a larger research project funded by the National Science Foundation (NSF Award No. 1825328, EEC), and study participants are members of SWENext, which is the youth division program of the Society of Women Engineers (SWE). We first obtained parental consent, and SWENext members who assented completed an online survey. Approximately 135 girls from across the U.S. participated in the survey. Due to some missing data, our final analytic sample is 122 young women from diverse backgrounds and is composed of 16% Asian, 64% White, and 20% Black, Latinx, Native American, other, and multi-racial young women (see Table 1 for sample characteristics).

Measures

Dependent measures include girls' engineering identity, measured as the extent that they see themselves as an engineering person. This item is an adaptation of mathematics and science identity measures used in national longitudinal studies and has been utilized in other research studies [6], [32]. We dichotomize this measure to distinguish between those that strongly agree (about 58%) and those that do not (about 42%). A second dependent measure captures the strength of girls' intentions to major in engineering in college; this is also a dichotomous measure distinguishing between those who indicate that it is very likely (about 72%) and those who do not (about 28%). This item has also been utilized in prior research studies [24], [29].

The key independent measures are perceived STEM support from girls and STEM support from boys. STEM support from girls is a scale variable, which was constructed by averaging perceived STEM support across different peer contexts, including friends from school, classmates, and STEM club mates. Specifically, these items were adapted from previously validated scales and asked young women to report how much they felt personally encouraged to do well in math, science, and engineering [25]. Similarly, we constructed a parallel scale for STEM support from boys, which measures the average perceived STEM support from boys that are friends from school, classmates, and STEM club mates. The Cronbach's alpha for STEM support from girls (alpha=0.83) and STEM support from boys (alpha=0.87) indicate that these scale variables have high reliability. We also included other student background and control variables, including girls' race/ethnicity, mother's highest level of education, grade level, and STEM club participation.

Results

Referring to our first research question, we found a significant and large gender difference in perceived STEM support, $t(121)=9.81$, $p<0.001$. Specifically, young women in SWENext report much more STEM support from girls than from their peers who are boys. The magnitude of difference is almost 1 standard deviation difference, which is considered a large effect.

To address our second research question, we present the results from logistic regression analyses as shown in Table 2. Beginning with the model predicting engineering identity, results indicate that girls who report higher levels of STEM support from girl peers are more likely to report a strong engineering identity; this effect remains significant and robust with the inclusion of control variables (see models 3 and 4). On the contrary, there is no significant effect of support from boys on SWENext girls' strong engineering identities. Turning to results of analyses predicting a strong intention to major in engineering (see Table 3), consistent with the results for engineering identity, girls who report higher levels of STEM support from girl peers have a stronger intention of majoring in engineering, but the effect is not statistically significant. We also found no evidence that support from boy peers is predictive of a strong intention to major in engineering.

Focusing on our third research question, we found a significant gender difference in peer STEM support across all racial/ethnic groups (results not shown). Additionally, there was no significant interaction effect between girls' race/ethnicity and peer STEM support (see model 5 in Tables 2 and 3), such that the effect of STEM support from girls on both engineering outcomes does not vary according to girls' racial/ethnic identities.

Discussion and Conclusion

This study examined the relationship between peer support and young women's identification with engineering and intention to major in engineering among a select group of young women who are members of SWENext and who will potentially join the next generation of engineers. Given the strong under-representation of women in engineering nationwide, their current interest in engineering makes them stand out as exceptional. At the same time, this group of young women must also navigate a field that is highly male-dominated, and so despite their strong aspirations to pursue engineering, they may also be dissuaded from continuing on this engineering pathway. Put simply, identifying the factors that bolster their engineering identities and engineering intentions is crucial to support this group of young women in persisting in engineering.

Therefore, our analyses examined how STEM support from girl and boy peers were associated with the strength of SWENext girls' engineering identity and intentions. Overall, our results demonstrate a clear gendered pattern in STEM support, in which support from young women peers is associated with both strong engineering identity, while support from young men does not appear to be consequential. These findings are consistent with previous research on the role of young women as compared to young men on providing more support for young women's STEM aspirations [28], [33]. Thus, the support from other young women may offer legitimation for

their participation in engineering, such that they are able to see themselves as engineers and extend their commitment to engineering.

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Table 1. Sample Characteristics

	Proportion or Mean (SD)
Dependent variables	
Strong engineering identity	58.2%
Strong engineering major intentions	72.1%
Key independent variables	
STEM support from girl peers	3.83 (.76)
STEM support from boy peers	3.07 (.85)
Student background variables	
Race/Ethnicity	
White	63.9%
Asian	16.4%
URM (Black, Latinx, Native American, Other, and Multi-racial)	19.7%
Mother's highest level of education (SES proxy)	
Less than a bachelor's degree	15.6%
Bachelor's degree	43.4%
More than a bachelor's degree	41.0%
Grade level	
9th	19.7%
10th	19.7%
11th	20.5%
12th	40.2%
STEM club participation	74.6%
N	**122**

Table 2. Results of logistic regression models predicting girls' strong engineering identity

	Model 1 STEM support from girls	Model 2 STEM support from boys	Model 3 Both STEM support variables	Model 4 Full model	Model 5 Full model + interactions
Key independent variables					
STEM support from girl peers	**1.752***		**2.031***	**2.111***	1.485
	(0.440)		(0.594)	(0.674)	(0.543)
STEM support from boy peers		1.019	0.757	0.816	0.960
		(0.222)	(0.197)	(0.226)	(0.308)
Interactions					
STEM support from (girl/boy) peersXRace (ref: STEM support from (girl/boy) peersXWhite)					
STEM support from girl peersXAsian					2.227
					(2.416)
STEM support from girl peersXURM					9.199
					(12.184)
STEM support from boy peersXAsian					0.618
					(0.578)
STEM support from boy peersXURM					0.402
					(0.346)
Student Background Variables					
Race/Ethnicity (ref: White)					
Asian				0.549	0.111
				(0.309)	(0.402)
URM				0.393	0.001
				(0.208)	(0.006)
Mother's highest level of education (ref: less than a bachelor's degree)					
Bachelor's degree				1.955	2.795
				(1.169)	(1.851)
More than a bachelor's degree				1.141	1.495
				(0.691)	(0.980)
Grade level (ref: 9th grade)					
10th grade				1.146	1.377
				(0.744)	(0.920)
11th grade				0.886	1.123
				(0.562)	(0.755)
12th grade				0.629	0.768
				(0.348)	(0.441)
STEM club participation				**2.649***	2.478
				(1.262)	(1.231)
Constant	0.165	1.315	0.222	0.084	0.129
	(0.160)	(0.911)	(0.224)	(0.112)	(0.193)

Odds ratios are from logistic regression models, $N = 122$ SWENext young women; robust standard errors are in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Table 3. Results of logistic regression models predicting girls' strong engineering major choice

	Model 1 STEM support from girls	Model 2 STEM support from boys	Model 3 Both STEM support variables	Model 4 Full model	Model 5 Full model + interactions
Key independent variables					
STEM support from girl peers	1.408		1.547	1.417	0.885
	(0.369)		(0.467)	(0.492)	(0.400)
STEM support from boy peers		1.003	0.832	0.892	1.039
		(0.240)	(0.232)	(0.276)	(0.395)
Interactions					
STEM support from (girl/boy) peersXRace (ref: STEM support from (girl/boy) peersXWhite)					
STEM support from girl peersXAsian					4.520
					(6.063)
STEM support from girl peersXURM					3.384
					(3.057)
STEM support from boy peersXAsian					1.582
					(1.828)
STEM support from boy peersXURM					0.468
					(0.345)
Student Background Variables					
Race/Ethnicity (ref: White)					
Asian				0.771	0.001
				(0.503)	(0.003)
URM				**0.242***	0.025
				(0.135)	(0.078)
Mother's highest level of education (ref: less than a bachelor's degree)					
Bachelor's degree				2.400	2.602
				(1.538)	(1.792)
More than a bachelor's degree				1.373	1.432
				(0.879)	(0.965)
Grade level (ref: 9th grade)					
10th grade				2.684	3.037
				(1.795)	(2.059)
11th grade				2.126	2.212
				(1.381)	(1.542)
12th grade				**6.024****	**7.837****
				(3.794)	(5.339)
STEM club participation				2.054	2.017
				(1.034)	(1.083)
Constant	0.710	2.567	0.874	0.197	0.630
	(0.711)	(1.957)	(0.917)	(0.268)	(1.059)

Odds ratios are from logistic regression models, $N = 122$ SWENext young women; robust standard errors are in parentheses

*** p<0.001, ** p<0.01, * p<0.05