Changing the Gendered Status Quo in Engineering? The Encouraging and Discouraging Experiences of Young Women with Engineering Aspirations

Abstract

Young women remain under-represented among engineering bachelor's degree holders. While there is a relatively large body of extant research on the many factors that curtail young women's interest in pursuing engineering, less is known about high school girls who are on an engineering pathway. Therefore, this study focuses on a select group of pre-college young women who express a strong interest in engineering. Specifically, informed by theories of gender as social system and previous empirical research, this mixed-methods study explores the constellation of significant actors within the daily lives of these young women, to understand from whom and how they are supported in pursuing this gender atypical field, and simultaneously, from whom and how they are discouraged. To do so, the researchers analyzed survey and interview data from a sample of diverse high school girls who participate in the Society of Women Engineers' (SWE) SWENext program. Quantitative results indicate that young women report high levels of encouragement from most sources, including parents, teachers, and other young women. However, across various peer contexts, they receive much more support from other young women than from young men. Qualitative results further reveal that parents and teachers stand out in young women's recollections of encouragement, often through advocating their participation in engineering activities or providing mentoring support. In contrast, young men in engineering spaces were recalled as particularly discouraging of their engineering participation, by socially or physically excluding them or refusing to provide recognition. Implications for future research and practice are discussed.

Keywords: gender, STEM, encouragement, discouragement, mixed-methods

Introduction

Despite concerted efforts to increase the representation of women in science, technology, engineering, and mathematics (STEM), national reports indicate that low proportions of women earn engineering degrees or even intend to major in engineering (NSF, 2021; Stolzenberg et al., 2020). Scholars largely attribute such patterns to the myriad of ways that young women[1] are deterred from developing an interest in these fields, as their experiences and decisions are shaped by gendered expectations and bias in their daily environments (Dasgupta & Stout, 2014; Xie et al., 2015). Yet while an abundance of research literature makes clear that by high school, the vast majority of young women are not interested or inclined towards pursuing engineering (Xie et al., 2015), we know very little about the young women who do have aspirations to pursue careers in the gender non-normative field of engineering.

Specifically, our mixed-methods study utilizes a unique sample of high school girls from diverse backgrounds across the country who participate in the Society of Women Engineers' (SWE) SWENext program, an outreach program for pre-college girls interested in engineering, to examine how and by whom they are supported in their daily lives in pursuing this gender atypical field, and at the same time, how and by whom they are discouraged in pushing past the gender boundary in engineering. To be clear, this group of young women do not represent a 'typical' group of high school girls, as the intent of this study is to explore the landscape of experiences of young women who have expressed a strong interest in engineering, and therefore stand as an exception to prevailing gender norms and patterns. Drawing on theories of gender as a social system (Ridgeway & Correll, 2004; Risman, 2004), and supported by empirical research (Robnett, 2016; Wade-Jaimes et al., 2021), we expect that within their local environments, young women will receive some discouraging and exclusionary messages that

reinforce larger social narratives about gender and STEM; yet it is also likely they will receive gender inclusive messages in the form of encouragement from others to pursue STEM. In contrast to extant research that tends to focus on one particular source of encouragement or discouragement, our study makes a unique contribution by considering a comprehensive array of the likely actors within young women's local environments, including their parents, teachers, friends, classmates, and peers in STEM clubs. Moreover, we attend to whether and how the sources of encouragement or discouragement are gendered, such that, for example, women may be more likely than men to encourage these high school girls to transgress gender boundaries.

Utilizing survey data collected from over 100 young women in SWENext, our quantitative analyses will address the following question: *across the array of individuals present in their local environments, from whom do these young women receive the most encouragement for their pursuit of engineering; for example, do they report more encouragement from peers (such as classmates or friends) than adults (parents or teachers), and do they perceive more encouragement from women than men?* (RQ 1) Subsequently, qualitative analyses of interviews conducted with 33 SWENext members enables us to highlight not just the source, but also to understand how both encouragement and discouragement are enacted in ways that are particularly salient in young women's pursuit of engineering. Specifically, we ask *how do these young women report being particularly encouraged by others to pursue engineering?* (RQ 2) Additionally, *how do young women report being discouraged by others to pursue engineering?* (RQ 3)

Theoretical Framework

Our study draws on the insights of gender theorists who articulate that gender is a social system that operates at multiple levels, including individual, interactional, and institutional levels

(Ridgeway & Correll, 2004; Risman, 2004). As explained by Ridgeway and Correll (2004), this system functions through the reproduction of cultural beliefs about gender, which begins at the institutional or macro level. Furthermore, gender is constructed and reinforced at each of the aforementioned levels to maintain gender inequality. This reproduction of gender inequality includes reifying broader gender stereotypes and mirroring larger societal messages about gender at the microcosm of local environments, such as home and school. As such, the gender system shapes the development of interests and preferences among both boys and girls (Authors 2016; Risman & Davis, 2013).

STEM domains such as engineering are key locations within the gender system, as women's under-representation in these fields (and men's over-representation) is supported by cultural beliefs about men's inherently greater mathematical ability and relatedly, the supposedly innate connection between math and masculinity (Cian et al., 2022; Leyva, 2017; Schmader et al., 2004). At the interactional level, such beliefs lead to biased expectations of who will succeed and who ultimately belongs in STEM fields, and consequently results in biased evaluations and related negative outcomes (Cheryan et al., 2013; Leaper & Starr, 2019; Ridgeway & Correll, 2004). As such, girls and young women pursuing male-dominated STEM fields often receive discouragement when interacting with others in school and at home who doubt their abilities and belongingness (Robnett, 2016; Tenenbaum & Leaper, 2003). Thus, the gender system can be maintained through negative sanctions aimed at young women to prevent them from transgressing gender norms.

Yet while the gender system is strongly implicated in shaping the choices and behaviors of women and men in a manner that reproduces inequality, individuals can and do develop interests and make choices that go against the norm. Indeed, gender theorists also posit that local

environments can be sites that disrupt broader gendered roles and expectations (Risman, 2009). That is, local contexts can be supportive environments where young women's and men's development and pursuit of different interests is more autonomous and less constrained (Bureau et al., 2022), where alternative views and counter-narratives regarding gender are also present. Thus, a challenge to the prevailing gender system can be found in interactions at home or in school where young women are actively encouraged by others, receiving inclusionary messages that they fully belong in engineering, and that engineering is perfectly compatible with their gender identities.

As local environments have the potential to either reify or disrupt the gender system, we next turn to the literature on the gender inclusionary and exclusionary messages from individuals across different contexts in which young women participate. Specifically, below we discuss how previous research describes parents, teachers, friends, and classmates, as encouraging and/or discouraging young women from participating in STEM. Where possible, we detail the ways in which these individuals encourage – or discourage – young women with STEM aspirations.

Literature Review

Encouragement for young women in STEM

The extant literature provides evidence that adults (including parents and teachers) and peers (including friends and classmates) can serve as important sources of inclusionary messages of encouragement for girls' participation in engineering and related STEM fields. First, many studies have documented how parents are often highly supportive of girls' STEM interests (Gilmartin et al., 2006; Leaper et al., 2012; Rice et al., 2013); this support is enacted through encouraging girls to work hard in STEM subjects and to participate in extracurricular STEM activities and more STEM courses, as well as paying for materials and participation in activities

(Archer et al., 2017; Aschbacher et al., 2010; Cian et al., 2022; Koch et al., 2019). Similar to parents, some research also finds that math and science teachers (as well as those in extracurricular spaces such as robotics) can support and further develop girls' STEM interests (George, 2000; Heaverlo et al., 2013; Hennessy Elliott, 2020; Stake, 2006), often by communicating helpful resources, holding high expectations for them, pushing them to participate in class, and recognizing them as capable of being successful in STEM (Archer et al., 2017; Carlone et al., 2014; Pinkard et al., 2017; Tan et al., 2013). Additionally, some research has found that young women report high levels of perceived STEM encouragement from friends, particularly in the form of valuing their success in STEM and taking an interest in STEM (Leaper & Starr, 2019; Rice et al., 2013; Robnett & Leaper, 2013). Finally, classmates in STEM spaces can sometimes provide similar levels of encouragement (DeWitt et al., 2013; Robnett, 2016). Importantly, across these studies, there are examples of both men and women (e.g., friends of different genders, mothers and fathers) providing support for young women to pursue gender non-normative STEM fields, and thus perhaps contributing even in a small way to disrupting current patterns of inequality.

Discouragement for young women in STEM

In contrast to the studies cited above, a separate body of work tends to point to the discouragement that young women interested in engineering and STEM fields can receive from those in their local environments. Regarding parents, for instance, Leaper and colleagues (2012) found that adolescent girls sometimes perceived pressure to conform to gender norms from their parents; this is consistent with studies finding that parents endorse stereotypes related to gender and STEM, which in turn are related to less recognition and lower perceptions of their daughters' STEM abilities (Eccles, 1994; Simpkins et al., 2015; Tenenbaum & Leaper 2003; Yee & Eccles,

1988). Similarly, a handful of research studies also observed that STEM teachers tend to hold gender biased beliefs related to STEM ability that advantage boys and result in them under-rating girls' performance (Carlone et al., 2014; Fennema et al., 1990; Shumow & Schmidt, 2013); other studies find that girls report (somewhat infrequently) experiencing academic sexism, gender bias, or sexual harassment from STEM instructors (Leaper & Brown, 2008; Leaper & Starr, 2019; Patall et al., 2018). Finally, STEM classmates and peers can also stand out for reinforcing the gender system, as young women report experiencing gender bias from this group of individuals, including negative comments about their ability (Foor, et al., 2013; Leaper & Starr, 2019; Robnett, 2016). Similar to the research on encouragement for girls in STEM, research implicates both women and men as potential sources of bias and exclusion. Yet the literature points to particularly pronounced experiences of gender bias from young men in their STEM classes, including taking over labs and experiments, as well as ignoring or undermining young women by questioning their STEM ability (Hennessy Elliott, 2020; Foor et al., 2013; Guzzetti & Williams, 1996; Tonso, 2006; Wieselmann et al., 2020).

Considering Variation across Sources: Encouragement/Discouragement from Peers and Adults

Based on the extant literature summarized above, we know that peers and adults of different genders *can be encouraging* of young women's participation and pursuit of engineering and *can also be discouraging.* Yet while highly informative, current research does not examine who girls find most supportive (or least supportive), and relatedly, from whom they experience the most discouragement. Specifically, studies tend to focus on either the positive or the negative—that is, exploring encouragement on the one hand (Leaper et al., 2012; Rice et al., 2013), or examining discouragement on the other (Leaper & Starr, 2019; Robnett, 2016).

Further, research very rarely compares the various actors within the constellation of their local environments to shed light on this issue. Thus, reviewing the literature prompts the following questions: do young women interested in engineering receive more encouragement from peers or adults in their local environments?; and likewise, do they receive more discouragement from peers or from adults?

Both developmental theories and empirical studies of gender norms and beliefs suggest that peers might be viewed as more supportive on the one hand, and less discouraging on the other, compared to the adults in young women's lives. First, during adolescence, the salience of same-age peers increases, such that girls may be more attuned towards and pay attention to messages from peers regarding what careers, interests, and goals are appropriate and acceptable for their gender, and likewise less oriented towards or more likely to ignore messages from adults (Furman & Buhrmester, 1992; Simpson & Oliver, 1990). Further, among recent studies of high school and college students, levels of endorsement of gender/STEM stereotypes are generally quite low, suggesting that current cohorts of adolescents are less bound to traditional gender norms and narratives than older cohorts and contemporary adults (Forgasz et al., 2004; Plante et al., 2013; Schmader et al., 2004). Thus, peers may be more likely to support girls in transgressing gender boundaries in their pursuit of engineering, and less likely to dissuade them.

Yet at the same time, the adolescent peers in young women's lives are also grappling with their own sense of identity, such as defining or accepting their own gender identity and the related behaviors that are expected from others (Leaper et al., 2012; Salikutluk & Heyne, 2017). To the extent that they also anticipate sanctions from others, they may be somewhat reluctant to support gender transgressions. Adults, however, can perform an important advocacy role in supporting young people to follow their interests and curiosity (Bureau et al., 2022); they also

have the possible vantage point of being highly aware of gender inequality and wanting to improve things for future generations. Further, parents are likely aware of engineering as an in-demand and lucrative career, while math and science teachers perhaps are likely personally invested in having more of their students successfully pursue these subjects (Puccia et al., 2021; Tan et al., 2013). For these reasons, it is possible that the adults in girls' local environment are more inclined than peers to encourage them to participate in engineering, and less inclined to discourage their pursuit of this non-gender-normative field. Our study will investigate this possibility.

Considering Variation Across Gender: Encouragement/Discouragement from Women and Men

Within the literature on encouragement or discouragement of girls' interest and pursuit of STEM fields, relatively little attention has been paid to examining potential differences according to the gender of the source (Leaper et al., 2012; Leaper & Starr, 2019). Logically, there is reason to expect that women and girls in the local environment (e.g., mothers, women teachers, girl classmates) would be more likely to encourage girls, and less likely to discourage them, compared to men and boys. As discussed earlier, the gender system advantages men, as they are accorded higher social status and dominate elite positions and fields within the gender system, including within the field of engineering (Dahl et al., 2015; Leyva, 2017; Risman, 2009). As such, they benefit from the relative exclusion of young women from the space and have ample reasons to dissuade them (either consciously or subconsciously) from participating and pursuing these hegemonically male spaces. From this lens, as the contemporary gender system disadvantages women, then the women and young women within girls' local environments likely share the same motivation to break down restrictive boundaries and should be more likely to

encourage their engineering interests. Further, research finds that adolescent girls likely identify and connect with women and girls more than men and boys, and therefore may be more attuned to the messages and support offered by the former group than the latter (Archer et al., 2017; Dasgupta, 2011).

Yet while empirical research finds that overall, women are less likely to endorse gender/STEM stereotypes than men (Authors, 2017; Authors, 2021; Nosek & Smyth, 2011) at the same time women have been raised and socialized within a gender system that discounts their social status and skills. To the extent that women then internalize social messages about their relative inferiority and accept prevailing norms regarding gender and STEM fields, they may subsequently doubt the capabilities and belonging of other women, leading them to discourage pursuit of fields like engineering (Copur-Gencturk et al., 2020; Robinson-Cimpian et al., 2014). Alternatively, women may understand that narratives of inferiority of women in STEM fields are blatantly false, but not want to encourage young women to pursue paths that are likely to be hostile or difficult. Thus, while men may guard the gender boundary for different reasons (because it advantages them), encouragement and discouragement to engage in engineering may be similar or comparable between the men and women in young women's local environments. Our study will examine this issue.

How is Gender Inequality Reproduced or Disrupted: Examining Forms of Encouragement and Discouragement

Finally, we know little about the particular *forms* of both encouragement and discouragement that young women find most salient in their pursuit of engineering, and whether and how this might differ by the source. Reading across the array of past research, it is clear that both encouragement and discouragement can occur via concrete behaviors and actions of others

(Archer et al., 2017; Foor et al., 2013; Koch et al., 2019), as well as in the form of social/psychological messages from others (Carlone et al., 2014; Tan et al., 2013; Tonso, 2006). Yet beyond this, prior studies do not provide a clear sense of the specific types of encouragement on the one hand, and discouragement on the other, that appear most powerfully in the lives of young women who are pursuing the male-dominated field of engineering. Understanding not just the *who* of the source, but the *how* of what is happening in their daily lives is important to shed light on the likely contradictory messages and experiences that occur. Specifically, examining how and from whom young women poignantly experience exclusion, and how and from whom they most powerfully experience inclusion, is critical to capture the complexity of the path these young women traverse as they seek to overcome the gender boundary in engineering.

Current Study

The objective of this mixed-methods study is to explore the constellation of significant actors within the daily lives of young women in SWENext, who represent a unique group of young women with a strong interest in engineering. We seek to understand who is encouraging of girls pushing the gender boundary in engineering and how such encouragement is enacted, and at the same, who appears to discourage girls' participation and how. First, utilizing quantitative analyses of survey data collected from adolescent girls in SWENext, we pose the following question: *across the array of individuals present in their local contexts or daily lives,* ***from whom*** *do these young women receive the most encouragement for their pursuit of engineering; for example, do they report more encouragement from peers (such as classmates or friends) than adults (parents or teachers), and do they perceive more encouragement from women than men?* (RQ 1)

Further, our qualitative analyses of interviews conducted with girls in SWENext allows us to delve deeper to capture those particularly salient experiences that are positive and inclusionary in nature, as well as those that are negative and exclusionary. Specifically, we ask ***how*** *do these young women report being particularly encouraged by others to pursue engineering?* (RQ 2) Additionally, ***how*** *do young women report being discouraged by others to pursue engineering?* (RQ 3) In addressing these latter questions, we highlight not only the source (e.g., fathers) but the particular actions or behaviors by others that young women invoke.

Methods

Data and Participants

Data for the current study are from a larger longitudinal research project funded by the National Science Foundation, with the broad goal of exploring how persistence in engineering is related to different social and academic experiences (both inside and out of school) among a sample of young women who potentially comprise the next generation of women engineers. Quantitative data collection for this study occurred in the spring of 2019 while accompanying qualitative data was obtained in the summer of 2019. Specifically, we utilized a mixed methods triangulation design, which consists of concurrent quantitative and qualitative data components (Creswell & Plano Clark, 2007). In this design, both qualitative and quantitative methods are equally important as they provide complementary data on the encouragement and discouragement young women report receiving. Specifically, through the quantitative survey data, we are able to identify the extent to which young women perceive support from different individuals and whether any gendered patterns arise. Simultaneously, the qualitative data (interviews) allow us to parse out how they are particularly encouraged and discouraged from pursuing engineering. Quantitative surveys were conducted using the online Qualtrics survey

tool, and the hour-long, in-depth semi-structured interviews were conducted over the phone or online.

The participants in the study were recruited through the SWENext program. SWENext is the youth outreach program for SWE, where pre-college girls are provided with online resources to support their engineering pursuits. Our recruitment of study participants was made with the strategic purpose of understanding the experiences of a group of young women who do not resemble 'typical' high school girls given their strong engineering commitment. The focus on unique cases or samples, such as ours, is common in mixed-methods research designs (Onwuegbuzie & Collins, 2007; Teddlie & Yu, 2007) as well as in educational research on the experiences of youth who are under-represented in STEM (Archer et al., 2017; Tan et al., 2013; Wade-Jaimes et al., 2021). By centering the experiences of this select group of young women, we can glean how they are particularly encouraged and discouraged, and the extent to which these experiences reflect gendered interactions that effectively maintain (or disrupt) the gender hierarchy.

We note that membership in the SWENext program is open to all who identify as girls. All parents of SWENext members were contacted via an email that specified the study's goals, including learning "more about young women's opinions and experiences with engineering and other STEM fields," and parents were asked to provide consent for their daughters to participate in the study. After receiving parental consent, assent for both survey and interviews was obtained by asking SWENext members to participate in a study on "young women's interest in engineering." Further, those who were interviewed were asked to self-identify their gender, and all identified as girls or young women. Therefore, based on the recruitment process described, it

is reasonable to conclude that our study participants identify (at least in some way) as girls or young women.

The quantitative sample was composed of 133 SWENext high school girls from across the United States. The racial/ethnic composition of the sample is 7.5% Latinx, 5.3% Black, 15.8% Asian, 61.7% White, and 9.8% multi-racial or other. The sample also consists of young women from different socioeconomic backgrounds and grade levels (as shown in Table 1). This group of young women is indeed unique in terms of their interest and participation in engineering and other STEM subjects. For instance, approximately 73% of SWENext girls expressed strong engineering major intentions (i.e., indicated on a Likert scale that they were 'very likely' to major in engineering). Moreover, about 75% of SWENext girls indicated they participated in an engineering or STEM club outside of school, 43% were enrolled in an engineering, robotics, or computer science class, and 58% reported taking two or more science classes. The young women in our sample also excel academically, with all participants self-reporting earning grades that are B's or above.[2]

Table 1. Descriptive Statistics for Quantitative Sample

[Insert Table 1 about here]

To further illustrate the exceptionality of this group of young women, we compared their self-reported math and science identities to a nationally representative sample of young women from the High School Longitudinal Study of 2009 (HSLS:09) (Ingels et al., 2013). As shown in Figure 1, over half of SWENext girls strongly agreed that they see themselves as math people, compared to just 13% of high school girls nationwide. Similarly, about 47% of SWENext girls strongly agreed that they view themselves as science people compared to only 8% of girls nationwide. Clearly as evidenced by these comparisons, the young women who comprise our

sample are not 'typical' high school girls, but rather represent a very small and important group of young women who have strong inclinations towards engineering.

[Insert Figure 1 about here]

Figure 1. Comparing math and science identities of SWENext and HSLS girls

From the larger group of survey participants, we invited 40 girls to participate in an interview. To maximize the diversity of the sample, all Black and Latinx survey participants were invited, and White and Asian girls were chosen at random so as to try to maintain a balance by grade level (e.g., upper and lower high school grade levels). In all, 33 SWENext girls accepted and participated in the interviews. The racial/ethnic composition of the qualitative sample was as follows: 5 Black, 9 Latinx, 9 Asian, and 10 White girls.

Positionality of the Authors

Author 1 identifies as a Latinx-Asian cisgender woman with a B.S. in engineering, pursuing a doctoral degree in STEM Education focused on exploring issues of inequality by race and gender. Her lived experiences as a Woman of Color in engineering spaces, who received support and encouragement from a variety of different sources, helped to inform the survey and interview protocol development, as well as the qualitative and quantitative data analyses. Author 2 identifies as a Latinx cisgender woman and Author 4 as a White genderqueer woman. Both have STEM undergraduate and research backgrounds and, as such, they have experienced racialized and/or gendered exclusion in hegemonically White and male STEM spaces; at the time this manuscript was written, both were PhD students in STEM Education. Author 3 identifies as a White cisgender woman and is a professor and sociologist with extensive experience researching gender inequality in STEM fields, including work on how the gender system shapes the educational and occupational decisions of young women and young men. All the authors

brought in their lenses informed by their lived experiences and expertise in the field to enhance the analytic process, and they recognize that these perspectives may lead to blind spots. Thus, they constantly engaged in reflection and discussion about alternative interpretations they may have overlooked or dismissed.

Quantitative Component

Quantitative Measures

We utilized previously validated items from Leaper and colleagues (2012) regarding math and science support to capture the STEM encouragement girls reported from various groups of individuals, including: mothers, fathers, teachers, friends, classmates, and STEM club peers. Specifically, participants were asked to report the extent to which they "personally felt supported and encouraged to do well" from different people in three different STEM subjects: math, science, and engineering. While adapting the previously validated survey items by Leaper and others (2012), we also attempted to distinguish between encouragement from men/boys and women/girls. Therefore, we added the verbiage "female" and "male" to questions asking young women to report support from friends, classmates, and STEM club peers, which also reflects terminology used in other survey items related to encouragement and discouragement (Leaper & Brown, 2008; Robnett, 2016). To create separate STEM encouragement variables for men and women STEM teachers, we asked SWENext participants to report whether each STEM teacher is female or male. The specific items that are included in each of the STEM encouragement scale variables are provided in Table 2. Responses to these survey items ranged from a score of 1, 'not at all' to 5 'a great deal'. Cronbach's alpha values for these scale variables ranged from 0.74 to 0.95, indicating high reliability. Notably, these STEM encouragement measures only capture the degree of positive messages girls report; in other words, a low score on the scale could be due to

a lack of positive messages—or alternatively—it could be due to active discouragement or biased experiences.

In addition, we distinguish between friends, classmates, and extra-curricular STEM peers to best approximate the different types of peer groups young women may interact with; this is a clear departure from the extant literature as most research studies either do not differentiate across various peer groups, or instead solely focus on select peer groups (e.g., friends or classmates). Yet we are cognizant of the fact that different peer groups occupy different places and may have different meaning in young women's lives. For instance, while friends are peers whom young women have selected to form affective ties with, STEM extracurricular peers represent a group with whom girls share similar STEM interests. Thus, these different groups of peers may provide young women with different levels and types of encouragement.

Table 2. Scale variables measuring perceived STEM encouragement from various sources

[Insert Table 2 about here]

Quantitative Analyses

Paired samples t-tests with Bonferroni correction were utilized to compare the STEM encouragement provided by women/girls and men/boys from across different contexts. For example, STEM encouragement from girl friends at school was compared to that from boy friends, mothers' STEM encouragement was compared to fathers' STEM encouragement, and so on. Cohen's d, which is a measure of effect size in standard deviation units, was calculated to determine the magnitude of significant gender differences.

We also conducted repeated measures ANOVAs to compare the means of the STEM encouragement variable from sources of the same gender to determine whether young women perceived a higher level of STEM support from particular groups or individuals. We note that the

sample size will vary across analyses as participants were not required to answer questions that are not applicable to them. For example, if SWENext girls participated in girls-only STEM clubs, then they did not provide perceptions of STEM encouragement from boys in these contexts. Sensitivity analyses utilizing an analytic sample (N= 49) without missing data on any of the STEM encouragement variables reveal parallel findings as those reported here, particularly around the gendered nature of perceived encouragement from peers. Finally, we utilized ANOVA to explore whether there were racial/ethnic differences in the level of support from different sources; we found no statistically significant differences, which could be at least partly due to the relatively small numbers of Black and Latinx respondents.

Qualitative Component

Qualitative Data

For the qualitative component, in-depth, semi-structured interviews were utilized. As stated earlier, we utilized a mixed methods triangulation design, and so the questions developed for the interview protocol were meant to delve deeper into some of the topics included in the survey as well as address other topics (Creswell & Plano Clark, 2007). Importantly, the responses and discussions from the interviews provide details, context, and nuance to the survey data. As described earlier, the STEM encouragement variable itself only captures the degree of encouragement, so a low score on this variable does not necessarily mean discouragement. Rather, a low score may signal a lack of active encouragement but not represent explicit negative messages or actions from others. Further, our quantitative data capture the degree or level of encouragement young women receive, but do not capture the specific ways that this is transmitted. Therefore, the qualitative data component is crucial to understand how they are particularly encouraged and discouraged from pursuing engineering by the people around them.

For the current study, we draw on girls' responses to questions that asked them to actively reflect on their positive and negative experiences related to engineering and STEM. These questions include: "Give me an example of how you have been discouraged from engineering (or from math or science)?" and "Give me an example of how you have been encouraged about something related to engineering (or math or science)?" We also included other instances from the interviews where respondents indicated a person or a group of persons as either actively encouraging or discouraging them in their engineering experiences. As such, most girls in the sample reported multiple experiences of encouragement and discouragement by others. These interviews were conducted and audio-recorded by Authors 2 and 4. Interviews were professionally transcribed, and transcripts were revised for accuracy.

Qualitative Analyses

Our research team performed Thematic Analysis using MAXQDA20 software to support in the labeling, organizing, quantification, and relationships of codes and themes developed by researchers. We iteratively coded interview transcripts for instances of encouragement and discouragement in engineering shared by participants, relying on both inductive and deductive approaches to generate codes. Initially, deductive coding was utilized to identify and examine which sources young women cited as being encouraging and discouraging. We also referred to the conceptual and theoretical frameworks guiding this study to interpret girls' lived experiences regarding instances of being encouraged and discouraged by others. For example, we analyzed how certain interactions young women had with some individuals (e.g., young men) in specific local contexts led to the maintenance of the gender system.

Generated codes were then utilized to identify underlying patterns and construct broader themes and sub-themes to describe the data for the study. The final themes capture salient

experiences of encouragement and discouragement by others articulated by the young women in our study, as well as from whom the young women received such encouragement and discouragement.

Trustworthiness. Trustworthiness, which is a form of validity in qualitative research, was established through data triangulation between interviews, field memos, and analytic memos. In particular, themes were compared between interviews to check for frequencies and relationships. Further, members of the research team met on a regular basis to further develop or discard initial codes or themes. Any discrepancies that occurred were discussed among research team members until reaching a consensus.

Results

RQ1: Quantitative results on who offers the most encouragement

[Insert Figure 2 about here]

Figure 2. STEM encouragement

Overall, young women in SWENext report high levels of encouragement from various individuals, including parents, teachers, and other young women. Generally, girls reported higher levels of support from adults, particularly from both parents, than from peers (see Figure 2). Further, when considering patterns within gender groups, we find that among men/boys, respondents rated encouragement from their fathers and STEM teachers significantly higher than encouragement from boys in their peer groups, including friends and STEM classmates. Among women/girls, mothers provided the most support while STEM teachers were perceived to provide similar levels of STEM support as girls in their peer groups (both friends and those in their STEM clubs).

Turning to comparisons across gender groups, we found mixed evidence regarding whether there were gender differences in support. Specifically, young women indicated that STEM support provided from mothers was significantly higher than that from fathers, $t(129) = 4.15$, $p<0.001$. However, the difference was small in scope (about one-third of a standard deviation), and overall, parents (fathers and mothers) provided the highest levels of encouragement. Further, the young women in SWENext indicated that support provided by teachers of different genders in their STEM courses was comparable, such that no significant difference was observed in perceived STEM encouragement, $t(77) = 1.54$, $p=0.13$.

Yet turning to results comparing STEM encouragement across gender groups from various peer sources, SWENext girls reported comparatively higher levels of encouragement from girls than from boys. The means in STEM support from young men ranged from 2.61 to 3.32, hovering around "a moderate amount." Specifically, the average level of support from boys in their STEM classes was well below a score of 3. Among their friends from school, girls provided higher levels of STEM encouragement than boys, $t(117) = 6.93$, $p<0.001$, and the effect size was moderately sized at 0.64 standard deviation units. A slightly larger effect size was observed when comparing perceived STEM encouragement between high school girls and boys from their STEM courses, $t(119) = 7.13$, $p<0.001$. Moreover, the largest effect size was observed among STEM club peers, where participants reported STEM support from young women at 0.86 standard deviation units higher than from young men in STEM clubs, $t(89) = 8.14$, $p<0.001$. Taken together, these quantitative results show that on average, respondents not only perceive substantially more STEM support from other young women than from young men, but, specifically, young men in their STEM classes provide the lowest levels of support to pursue STEM.

As described earlier, the STEM encouragement variable only captures the degree of encouragement our respondents perceive from a specific source. However, with this data, we are unable to parse out how these young women are particularly encouraged or discouraged by these individuals, or distinguish whether a low score is due to explicit discouragement or a lack of support. Therefore, we turn to the qualitative results to understand how young women in SWENext are encouraged and discouraged from pursuing engineering in their everyday lives. Moreover, the qualitative results complement the quantitative component as it not only echoes the sources of encouragement girls report, but they also provide a richer description of specific experiences of encouragement and discouragement articulated by these young women.

RQ2: Qualitative results on salient experiences of encouragement

Overview

Participants' reports of encouraging experiences most often centered parents and teachers, while peers (friends or classmates) were mentioned less frequently— which is consistent with the patterns shown in our quantitative findings. Further, instances of encouragement by adults were evenly distributed between mothers, fathers, and teachers of different genders. The next group of people reported to be encouraging were peers. Other less frequently cited sources included brothers, or other adults (mentors or presenters at events, and family friends). Regarding race/ethnicity, instances of encouragement were slightly more common for White and Asian girls than among Black and Latinx girls. However, the relative occurrence of different themes (described below) was comparable across young women from all racial identity groups. Below we use the qualitative data to describe the types of encouragement reported by participants, including the most common sources of each type of encouragement.

Four themes were developed to describe the types of encouragement reported by participants: *pushes or advocates*; *provides academic assistance or mentoring; recognizes or believes in them*; and *promotes sense of belonging*. The first two experiences depict more tangible or active types of encouragement; whereas the latter two are less tangible, perhaps more implicit, as they are capturing the sociopsychological encouragement that comes from messages sent by others. Pushes/Advocates was the most common theme, as 70% of the sample shared examples of this type of encouragement. Providing academic assistance/mentoring and recognizing or believing in them, were each brought up by about 40% of the sample. Finally, about 35% of the sample discussed how others helped to promote a sense of belonging in engineering.

Table 3. Encouragement themes descriptions and sample quotes

[Insert Table 3 about here]

Pushes or Advocates

This theme describes instances when participants were encouraged to do something specific (e.g., participate in a class or join a club), or where someone actively recruited them for an engineering activity, team, event, or workshop. As such, these forms of encouragement were active, explicit, and directed to an outcome. Pushes/Advocates was the most common type of encouragement reported by our participants— and primarily the domain of adults (parents and teachers). While mothers were the most commonly invoked among those who pushed/advocated for participants, this was closely followed by mentions of fathers as well as teachers in this regard.

Participants mentioned how their mothers encouraged them to explore engineering or computer science courses by insisting they "just give it a try" to see if they like it, or by cheering

them on and telling them they "knew that I could do it." Participants often claimed to be thankful and "really glad I listened to her." Lisa explains how her mother supports her:

> Yeah, my mom is very encouraging. She really pushes me to do well in what I do. If she sees things that I could do better, she pushes me that I should do better in succeeding in whatever program I'm doing or whatever project I'm doing....I think that my mom's really good at pushing me to the best with my ability. That really helps me out. *Lisa, Asian, 9th grade*

The young women also referred to fathers as encouraging them to search for summer programs and pursue engineering courses. Participants described fathers as suggesting they "just try one" engineering course, which in turn, led them to realize they liked those courses and "enjoyed being able to create a lot of things." Similarly, participants described teachers encouraging them to take on leadership positions, to enroll in challenging STEM courses, or sign up for out-of-school activities related to STEM. For example, one girl shared that her teacher and robotics coach, who was a man, proposed that she "should be captain of the team." Another girl discussed how her 9th grade teacher encouraged her to take an International Baccalaureate engineering course and explained how she has "been pushing me to explore the things I could do" and "got me in contact with people" doing a research project on robotics in which she was now participating.

Provides Academic Assistance or Mentoring

This theme captures the encouragement that participants felt from receiving various types of assistance and mentorship including: help learning engineering content and mastering engineering activities, help navigating engineering or other STEM academic spaces, and providing information (academic or logistical) to help them succeed. This theme was most often

reported in relation to fathers, and to a lesser extent, teachers of different genders. Prisha shares how her father encouraged her when she was struggling with an engineering project at school:

> My dad definitely encouraged me a lot. 'Cause I remember when I was making that projectile cannon thing, he sat with me for two hours one day and he was like, "Okay, so let's figure out what was wrong with your last one." That also ended up being one that did not work, but it was still nice to see that he was trying to understand what I was working on. *Prisha, Asian, 11th grade*

Participants also stated how their teachers took the time to help them learn content or navigate STEM spaces, with one girl sharing that a teacher taught her "a lot of things related to computer science and also how to handle high school life," and another stating how her teacher "always made sure we understood the concepts" and was "like a driving factor for my interest in engineering."

Recognizes or Believes in Them

This theme depicts instances when participants felt seen as capable and skilled in engineering, or when others believed in their capacity or potential to become engineers. This type of messaging was usually explicit, and generally came from adult sources (parents and teachers), and sometimes from older brothers and peers. Olivia shares how her teacher recognized her potential as a leader in engineering:

> For a while I was the only girl on the team... My teacher really noticed how I was working with different groups at school. He saw me as a natural leader and someone who could bring more girls into our program. It just developed from there. *Olivia, White, 11th grade*

Being recognized by the teacher as both an engineer and a role model for other girls was pivotal in encouraging Olivia to recruit more young women to the team and eventually take on the role of captain of an all-girls robotics team— the first team in the school to make it to the state competition. Recognition also came from family members. One participant shared how her mother believed that "the engineering field needs bright young women [like] me"; and another mentioned that her brother said she was "too good at math" to not be an engineering major. Mentors also played a role, as one participant shared how validated she felt after asking for a recommendation letter for university applications from an internship mentor who proceeded to tell her "I know you are gonna do well."

Promotes Sense of Belonging

This theme illustrates how girls were encouraged by others who, often implicitly, made them feel like they belonged in engineering spaces— they felt a sense of fit, comfort, and of being welcome. This type of encouragement was often present within a STEM space populated by others who were like them— those interested in and highly engaged in engineering and robotics. Thus, in contrast to the other themes, sense of belonging was primarily discussed in relation to peers and women mentors. For example, Aliyah describes how she got involved in a robotics team that she considers "just really fun":

> Well, my friend—she started the robotics team two years earlier than she was supposed to because she had a parent that helped out with the team. She was allowed to hang around and get more involved. She suggested that I should join because it not only is about creating a robot from the start, it's just more than that. It's like creating a bond with other people and creating bonds with other teams. *Aliyah, Black, 9th grade*

Some participants similarly shared how engineering affinity groups like SWENext, Girls who

code, Introduce a Girl to Engineering Day —"programs that were not only fun, but also inspiring" — supported their sense of belonging. One participant who was initially nervous about her summer college orientation reported her relief after attending a Women in Engineering meeting, where she met other prospective engineering women students and "just hung out together" and "ended up clicking." Others discussed how women mentors supported their sense of belonging. One girl shared how her mentor took her and other girl teammates to "see a company that was actually 51% female" which showed them that they could belong because they "were able to see that our [exclusionary] robotics team isn't all that engineering consists of, and there are environments [where] women are having positive experiences."

Clearly then, study participants' interests and aspirations to pursue engineering were encouraged in multiple ways, by multiple people in their lives, in their homes as well as in formal and informal STEM environments. However, as the reference to negative experiences in robotics teams in the above quote indicates, their experiences were not always positive. We now turn to the types of exclusionary, and therefore, discouraging experiences our participants reported having to contend with, as they attempted to navigate male-dominated engineering learning environments.

RQ3: Qualitative results on salient experiences of discouragement

Overview

A stark difference emerged between the reported experiences of encouragement and the reported experiences of discouragement, in that a single group stood out as the most discouraging: young men. While young men were sometimes mentioned as supportive or inclusive, discouraging and exclusionary experiences were almost unanimously tied to young men who were peers in STEM learning environments such as courses and clubs. Further, with

the exception of one young woman who reported discouragement from a woman high school counselor, the few instances of discouragement from adults came from men in out-of-school STEM settings.

Three themes were constructed to describe the types of discouragement and exclusion: *social exclusion*; *physical exclusion*; and *exclusion of ownership or identity*. Table 4 describes the themes and provides sample quotes for each. Similar to the encouragement themes, the first two themes are more embodied or active, while the last theme encompassed more of a sociopsychological component—although some examples of this theme also show others actively taking credit or discrediting. Further, sometimes participants described experiences that encompassed more than one theme. For example, a discouraging experience could involve both social and physical exclusion. Finally, we did not observe racial differences in either the occurrence or type of discouragement reported by participants.

Table 4. Discouragement themes descriptions and sample quotes

[Insert Table 4 about here]

Social exclusion

This theme captures instances when participants report being socially excluded such that others ignored or actively avoided them in STEM environments. Kiara describes her experience with this and makes sense of it by explaining how boys feel insecure early on and do not want to be around girls who like STEM or seem smarter than them:

> The guys would get really insecure if they weren't better at math or science than some of the girls…they would almost bully the girls because they made them feel bad about their own ability […] a lot of the talk in elementary/middle school around a lot of girls who were interested in STEM was like a lot of guys have the idea that if the girl is smarter

than them, it automatically makes her not less than, but not cool to be around, or like undesirable as a person. *Kiara, Black, 12th grade*

Most other occurrences of social exclusion are discussed in the context of their present high school experiences. Some participants were more certain than others about why high school boys were actively excluding them. One girl tried to make sense of why she and members of her all-girls team have had a hard time communicating with boys in other teams during competitions: "it's hard to tell… if it's because we're all girls." Two other participants made more concrete connections by explaining that "different groups of males congregate and become good friends, and none of the females are usually included" and "when you're in a group where all the boys are like a little group… you're kind of like the intruder girl in their group."

Physical exclusion

This theme describes instances when young men asserted ownership or control over physical material and environments, thereby excluding young women from access to engineering spaces, activities, or objects. This involved young men not allowing them to use certain tools, assigning them administrative responsibilities, or not giving them opportunities to take on certain roles in STEM activities or group projects. Below, Jaya describes how she was excluded from access to roles involving building a robot in her team:

> My freshman year…most of the time they never let me actually do anything hands-on with the robot. They gave me the role as a writer for our engineering notebook. I wasn't actually directly doing any software development or doing any building. … I really wanted to leave that role after my freshman year 'cause that wasn't what I signed up for when I wanted to do robotics. I wanted to do the hands-on engineering and building and problem solving with the robot. *Jaya, Asian, 11th grade*

Jaya shares that, in the following year, “again, I see that thing where the girls are not given roles relating to the robot, and the guys usually have roles related to the robot...The guys are still taking charge.” Similarly, another participant shared how the girls in her team asked boys who “took charge of the design” what they could do to help, and boys “would give us really menial tasks. I remember one of them was gluing two spacers together, which is like – I don't even know what that was for.”

Idea/Identity ownership

This theme, which was the most common, illustrates when young men dismissed and/or took credit for young women’s ideas; or when they doubted that young women could be engineers or good at engineering. In these ways, high school boys excluded girls by asserting ownership over who could have both engineering ideas and identities. One participant reported feeling discouraged because “even after I had proof that I qualified, a lot of the boys wouldn’t believe” that she advanced to the State Science Fair. Another young woman recalled how her “suggestions were not taken very seriously” by the young men in her group, while yet another stated that the “biggest challenge” she had to deal with was how often she had to “voice [my] opinion and stay strong to try to get [my] point across.”

Andrea explains a particularly discouraging experience where young men not only actively took over the tools and space (physical exclusion) but also took credit for the ideas and work of a group of young women on the team:

> We basically made this mechanism. We designed it. We brought the design back to our team to start building it at our workshop. Once we started building it, we realized that there was a small design flaw—the mechanism didn't fit inside the frame perimeter, so we had to make slight changes to the design... As soon as we discovered that—it was

> actually one of the boys who discovered the issue—they went full speed ahead and took the mechanism from us in a way where we were trying to work on it, but they started going so fast and took our design and started building it.[…] Then the mechanism in the future started being called… *his group of friends' mechanism* instead of *our*— it was our design and no one gave us credit. *Andrea, White, 12th grade*

In addition to these discouraging instances of exclusion by high school boys, some girls also shared they had to contend with exclusionary behavior by adults. These were generally from professionals in STEM that volunteered to mentor or coach students in internships or competitions. For example, following the occurrence discussed above, Andrea further shares that:

> Then we reached out to our team's mentors, and we explained to them what had happened. Instead of supporting us and trying to make a better environment for our team, they actually started blaming us and started telling us that we didn't do enough to work on the mechanism, and it was our fault that it was taken from us. *Andrea, White, 12th grade*

Another girl described a moment that left her speechless when a man coach from a losing team mentioned that her all-girl team "kind of got a pass" from the judges. Again, while these moments were not as common, they are worth highlighting as these experiences in informal STEM learning spaces seems to further confirm to girls that gendered exclusion will continue to occur beyond high school.

Discussion

This study illustrates the support young women with strong engineering aspirations receive from different groups of individuals in their lives, and importantly, the ways in which

they are encouraged and, simultaneously, discouraged by these individuals. Specifically, the mixed-methods investigation allowed for us to parallel and extend findings from quantitative and qualitative analyses and converge on key results. In doing so, our study makes several contributions. To our knowledge, it is the first study to compare support from across several important local contexts in which adolescent girls engage, including home and school. Furthermore, we also consider support provided by men/boys and women/girls, as well as disentangle the different types of peers with whom they interact, such as friends, classmates, and peers who participate in their extracurricular STEM clubs. Our study calls attention to potential sites of resistance and instances of pushing the gender boundary in engineering as young women are encouraged by others, yet also reveals concerning patterns of discouragement further discussed below.

Patterns of encouragement and discouragement

In addressing our first research question regarding who provides the most support to young women, we find that overall, the young women in SWENext report high levels of STEM encouragement from across various sources. Consistent with some studies on the importance of parents as sources of STEM encouragement for young women (Leaper et al., 2012; Puccia et al., 2021; Rice et al., 2013), our study finds that among a sample of young women interested in engineering, adults are generally perceived as more supportive than peers. Attending to our second research question on how young women in SWENext are encouraged, we find that consistent with the quantitative results, our qualitative results revealed that teachers and parents were discussed as being their primary motivators, encouraging them to take actionable steps (e.g., enrolling in a class or joining a club) that will lead them to engineering. While memorable instances of encouragement provided by mothers appeared somewhat concentrated to nudging

them to action, fathers often performed this function in addition to providing them with specific academic support. We argue that both types of encouragement (i.e., pushes/advocates and academic support/mentoring) are powerful as they propel young women to engage with engineering in concrete ways. Further, SWENext participants also describe other ways in which they are encouraged, including how adults and peers alike promote their sense of belonging and recognize them as engineers.

As evidenced by both the lowest scores on scales of STEM encouragement, and explicit discussion of discouragement in interviews, young men in STEM spaces are the predominant source of discouragement for young women with engineering aspirations. Consistent with some prior literature (Archer et al., 2017; Dasgupta, 2011), our quantitative analyses revealed that young women in SWENext reported significantly lower levels of encouragement from young men when compared to the young women within each peer group, including among friends, STEM classmates, and STEM club peers. A similar gendered pattern emerged in the qualitative findings. Referring to our third research question on how young women are discouraged, SWENext young women articulated problematic ways in which young men actively worked to maintain those STEM spaces as exclusively male. To illustrate, high school girls in our study recounted how boys took extreme measures to socially exclude them within STEM spaces, by either ignoring them or avoiding them completely. These young men also asserted their dominance physically and ideologically. In the former, girls described boys taking control over physical STEM environments and materials. The latter was often exemplified through unnerving experiences told by SWENext girls in which boys took credit for girls' ideas as well as undermined not only their work but also their place in engineering. To this, we add that the pervasiveness of hegemonic masculinity was also evident in the (in)actions from other men,

including mentors, who only discouraged girls further. Taken together, young men in STEM engaged in behaviors that can only be described as sexist and limiting young women's participation in engineering.

While these discouraging experiences are not new, they shed light on and inform the insidious ways in which the gender hierarchy that positions masculinity as dominant is reinforced and maintained in engineering. Moreover, these forms of discouragement enacted by young men can be considered as responses to threats to masculinity in engineering (Dahl et al., 2015; Rudman et al., 2012). That is, the mere presence of young women in STEM spaces may be perceived as a threat to young men's dominant position in engineering, which can, in turn, lead young men to behave in ways that effectively maintain the gender boundary in engineering. Prior research studies have shown how women outperforming men in male-dominated fields are perceived as challenging their privilege and are met with backlash from men, including men's promotion of ideologies that defend the gender system (Dahl et al., 2015; Rudman et al., 2012). Indeed, these studies describe such backlash as subverting women's power and diminishing their agency, which, at the core, is what young women in our study detailed as exclusionary experiences at the hands of young men.

Current findings suggest that these sexist actions perpetrated by young men are troublesome given that they were reported by young women who were as young as 9th grade high school students. These findings underscore the value of differentiating across multiple peer groups, which our study does, to shed light on the ways in which different peers (e.g., STEM classmates, friends) are encouraging or discouraging. As indicated earlier, we were able to discern that these behaviors were concentrated among high school boys, namely young men in their STEM classes and extracurricular clubs. While these peers may not necessarily be

individuals with whom young women choose to engage, their exclusionary behaviors may foreshadow future interactions with similar STEM peers (e.g., classmates, coworkers) if SWENext girls decide to enter the field of engineering. Hence, attending to these physical and ideological acts are of utmost importance as these inflict harm to young women, particularly for those who have expressed a strong interest or otherwise would be committed to engineering. As we know, their position in engineering is precarious because they comprise the numerical minority, and this precarity is only exacerbated when they must also contend with blatant and sometimes subtle sexist acts.

Potential allies and creating inclusive STEM environments

It is also important to point to how our quantitative and qualitative results elucidate ways in which sexism can be resisted and contested to create inclusive STEM environments. To be sure, in our quantitative analyses, teacher gender appeared to be inconsequential for how young women perceived support from their STEM teachers. Similarly, as seen in our qualitative results, SWENext girls expressed how teachers of any gender, as well as mothers and fathers, were central as sources of encouragement and inclusionary experiences. As stated earlier, adults paved the way for them to be recognized as legitimate participants in STEM spaces, and their mentoring was critical for young women to view engineering as a viable career pathway. While we know women role models are important for young women with STEM aspirations (Dasgupta & Asgari, 2004; Stout et al., 2011), we also observed the potential role for men, including fathers and men STEM teachers, to serve as allies in these environments. Further, because of male privilege, men tend to be listened to when they confront sexism and promote gender-egalitarian ideologies (Gervais & Hillard, 2014; Moser & Branscombe, 2021). Thus, men have a

responsibility to use their privilege to combat sexism and resist the gender hierarchy in STEM environments.

Further, our results have implications for practice for all STEM teachers, who regardless of gender, can be powerful sources of encouragement. While STEM teachers should be aware of how certain robotics and other similarly competitive environments may be particularly salient gendered spaces where exclusionary behaviors of young men may be heightened, gender scholars have discussed how young men in high school tend to assert their masculinity through dominance and competence across various heteronormative contexts (Pascoe, 2003; Robnett et al., 2018). Indeed, the young women in our study reported discouraging experiences across various STEM spaces. Thus, we suggest that STEM teachers engage in evidence-based inclusive practices that have been found to counter these masculine behaviors and in turn, create more gender equitable environments. These include facilitating intergroup dialogues centered on addressing gender inequity in STEM, developing students' active listening skills, assigning group roles and intentionally positioning young women in leadership roles, and teaching young men to recognize the contributions of their peers who are young women (Hennessy Elliott, 2020; White et al., 2021). We also believe these implications for practice are applicable to adults embedded in young women's extracurricular and informal STEM spaces, such as robotics and engineering clubs. Additionally, we posit that addressing exclusionary practices needs to also occur within STEM occupations, as research shows that women engineers in the labor force also experience exclusion and gender bias (Khilji & Pumroy, 2019; Williams et al., 2016). Therefore, our findings have important implications that extend beyond K-12 education to the STEM workforce.

Moreover, our interview respondents almost exclusively discussed peers in STEM spaces as particularly important in promoting their sense of belonging. This finding makes sense, such that young women turn to STEM peers (e.g., classmates and club mates), who likely represent future peers with whom they may engage, to ascertain the extent to which the STEM spaces they participate in exhibit a welcoming atmosphere. Previous studies have demonstrated the importance of being included by STEM peers to foster young women's STEM identity and persistence (Dennehy & Dasgupta, 2017; Hilts et al., 2018). Therefore, young men and women can take notable actions to more readily include young women in STEM spaces, which in turn may contribute to young women's positive experiences and sense of belonging in STEM. Further, the inclusive behaviors exhibited by young men can be particularly salient to young women, as they constitute the numerical majority in these spaces, and so, their actions are essential for welcoming young women in participating in STEM.

Limitations

The young women in this study represent a self-selected group as they have chosen to participate in SWENext. At the same time, our intention was not to generalize across young women in high school, rather we intended to examine the inclusionary and exclusionary experiences of a group of young women who are relatively understudied, those with a strong commitment to engineering. Findings are based on cross-sectional data and, therefore, reflect a snapshot of young women's engineering experiences. Yet young women were still able to articulate the varied ways in which they were encouraged and discouraged in STEM. Hence, future studies should consider how different forms of encouragement and discouragement accumulate over time, and whether they either bolster or dampen young women's future participation in engineering and STEM.

While we initially considered young women's intersectional identities, we found no differences by race/ethnicity or social class in perceived STEM support nor in the ways in which young women in SWENext were encouraged or discouraged by others. We are aware that young Women of Color often experience multiple forms of discrimination (Crenshaw, 1989; Ong et al., 2020; Wade-Jaimes et al., 2021), however, we did not detect significant differences in the survey results. Yet as the quantitative sample was comprised of mostly White and Asian high school girls and those whose mothers had attained high levels of education, it does not escape us that self-selection into SWENext may already reflect the limited access high school Girls of Color may have to STEM opportunities. Future work should include more diverse samples where possible to better capture how encouragement and discouragement perceived by young women varies by their intersectional identities.

Conclusion

Building on prior work, our mixed-methods study makes several new contributions that detail the multiple and varied ways in which young women with strong inclinations towards engineering are encouraged and discouraged. We have described their exceptionality given their strong yet gender non-normative interest in engineering. Further, guided by gender theories and pointing to the positioning of engineering as masculine, we demonstrate how the problematic and sexist behaviors enacted by young men contribute to how young women in SWENext experience exclusion and discouragement. Thus, these actions by young men are fraught with enactments that reestablish male domination, and in turn, serve as gatekeepers to these privileged spaces. While prior research has articulated how women can be implicated in maintaining the gender system (Copur-Gencturk et al., 2020; Robinson-Cimpian et al., 2014), notably, our respondents overwhelmingly discussed salient experiences with other women and girls as encouraging.

While initial reactions to such findings may be to advocate for single-sex education and extracurricular clubs to shelter young women from negative and blatantly sexist experiences interacting with young men, this may be a disservice to young women as this does nothing to disrupt the gender hierarchy (Halpern et al., 2011). Moreover, young women are very likely to encounter these same behaviors at a future juncture in their lives, as engineering college courses and workplaces may mirror those –or be worse than– those experienced in high school as women's representation wanes across the engineering pathway.

To repudiate the gender hierarchy, change is needed across all levels of the gender system. Yet local STEM environments in which young women participate are prime locations where individuals can problematize sexist behaviors and resist broader gender norms and create truly inclusive STEM environments that affirm young women's identities and welcome their participation. Indeed, our findings offer substantial hope in this regard, as mothers and fathers, and STEM teachers who were women and men, were highly supportive of our respondents' participation in this currently gender-atypical field. To this end, we can and should design STEM contexts in which all young women and members of other historically minoritized groups can fully participate and thrive.

Notes:

1. We note that we use the terms "girls" and "young women" interchangeably for readability purposes and, given that interviews participants in our study do refer to themselves and other young women as "girls." Still, we are aware that the term "girls" can be derogatory in (itself/ some contexts) as it is used to infantilize young adult women, such as the adolescent participants in our study, and adult women. Similarly, we use the terms "boys" and "young men" interchangeably for the reasons described above.

2. We did not observe any differences in grade-level, self-reported grades, STEM club participation, math and engineering identities, multiple science course-taking, and engineering, robotics, or computer science course-taking by girls' race/ethnicity. The only variables for which we found a significant racial difference were science identity and strong engineering intentions, which were significantly higher for White and Asian girls compared to Black and Latinx girls.

References

Archer, L., Moote, J., Francis, B., DeWitt, J., & Yeomans, L. (2017). The "exceptional" physics girl: A sociological analysis of multimethod data from young women aged 10–16 to explore gendered patterns of post-16 participation. *American Educational Research Journal*, *54*(1), 88-126.

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*(5), 564-582.

Authors (2016).

Authors (2017).

Authors (2021).

Bureau, J. S., Howard, J. L., Chong, J. X., & Guay, F. (2022). Pathways to student motivation: A meta-analysis of antecedents of autonomous and controlled motivations. *Review of Educational Research, 92*(1), 46-72.

Carlone, H. B., Scott, C. M., & Lowder, C. (2014). Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science. *Journal of Research in Science Teaching*, *51*(7), 836-869.

Cheryan, S., Drury, B. J., & Vichayapai, M. (2013). Enduring influence of stereotypical computer science role models on women's academic aspirations. *Psychology of Women Quarterly*, *37*(1), 72-79.

Cian, H., Dou, R., Castro, S., Palma-D'souza, E., & Martinez, A. (2022). Facilitating marginalized youths' identification with STEM through everyday science talk: The critical role of parental caregivers. *Science Education*, *106*(1), 57– 87.

Copur-Gencturk, Y., Cimpian, J. R., Lubienski, S. T., & Thacker, I. (2020). Teachers' bias against the mathematical ability of female, Black, and Hispanic students. *Educational Researcher*, *49*(1), 30-43.

Crenshaw, K. (1989). Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. *University of Chicago Legal Forum*, *1*(8), 139-167.

Creswell, & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research.* Thousand Oaks, CA: SAGE Publications.

Dahl, J., Vescio, T., & Weaver, K. (2015). How threats to masculinity sequentially cause public discomfort, anger, and ideological dominance over women. *Social Psychology, 46*(4), 242-254.

Dasgupta, N. (2011). Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry*, *22*(4), 231-246.

Dasgupta, N., & Asgari, S. (2004). Seeing is believing: Exposure to counterstereotypic women leaders and its effect on the malleability of automatic gender stereotyping. *Journal of experimental social psychology*, *40*(5), 642-658.

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 21-29.

Dennehy, T. C., & Dasgupta, N. (2017). Female peer mentors early in college increase women's positive academic experiences and retention in engineering. *Proceedings of the National Academy of Sciences*, *114*(23), 5964-5969.

DeWitt, J., Osborne, J., Archer, L., Dillon, J., Willis, B., & Wong, B. (2013). Young children's aspirations in science: The unequivocal, the uncertain and the unthinkable. *International Journal of Science Education*, *35*(6), 1037-1063.

Eccles, J. S. (1994). Understanding women's educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *Psychology of women quarterly*, *18*(4), 585-609.

Fennema, E., Peterson, P. L., Carpenter, T. P., & Lubinski, C. A. (1990). Teachers' attributions and beliefs about girls, boys, and mathematics. *Educational studies in Mathematics*, *21*(1), 55-69.

Forgasz, H. J., Leder, G. C., & Kloosterman, P. (2004). New perspectives on the gender stereotyping of mathematics. *Mathematical Thinking and Learning*, *6*(4), 389-420.

Foor, C. E., Walden, S. E., Shehab, R. L., & Trytten, D. A. (2013). *"We weren't intentionally excluding them. . . just old habits": Women,(lack of) interest and an engineering student competition team.* Paper presented at the IEEE Frontiers in Education Conference, Oklahoma City, OK.

Furman, W., & Buhrmester, D. (1992). Age and sex differences in perceptions of networks of personal relationships. *Child development*, *63*(1), 103-115.

George, R. (2000). Measuring change in students' attitudes toward science over time: An application of latent variable growth modeling. *Journal of Science Education and Technology*, *9*(3), 213-225.

Gervais, S. J., & Hillard, A. L. (2014). Confronting sexism as persuasion: Effects of a confrontation's recipient, source, message, and context. *Journal of Social Issues*, *70*(4), 653-667.

Gilmartin, S. K., Li, E., & Aschbacher, P. (2006). The relationship between interest in physical science/engineering, science class experiences, and family contexts: Variations by gender and race/ethnicity among secondary students. *Journal of Women and Minorities in Science and Engineering*, *12*(2-3), 179-207.

Guzzetti, B. J., & Williams, W. O. (1996). Gender, text, and discussion: Examining intellectual safety in the science classroom. *Journal of Research in Science Teaching*, *33*(1), 5-20.

Halpern, D. F., Eliot, L., Bigler, R. S., Fabes, R. A., Hanish, L. D., Hyde, J., ... & Martin, C. L. (2011). The pseudoscience of single-sex schooling. *Science*, *333*(6050), 1706-1707.

Heaverlo, C. A., Cooper, R., & Lannan, F. S. (2013). STEM Development: Predictors for 6th-12th Grade Girls' Interest and Confidence in Science and Math. *Journal of Women and Minorities in Science and Engineering*, *19*(2), 121-142.

Hennessy Elliott, C. (2020). "Run it through me:" Positioning, power, and learning on a high school robotics team. *Journal of the Learning Sciences*, *29*(4-5), 598-641.

Hilts, A., Part, R., & Bernacki, M. L. (2018). The roles of social influences on student competence, relatedness, achievement, and retention in STEM. *Science Education*, *102*(4), 744-770.

Ingels, S.J., Pratt, D.J. Herget, D.R., Dever, J.A., Fritch, L.B., Ottem, R., Rogers, J.E., Kitmitto, S., and Leinwand, S. (NCES 2014- 361). *High School Longitudinal Study of 2009 (HSLS:09) Base Year to First Follow-Up Data File Documentation*. National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Khilji, S. E., & Pumroy, K. H. (2019). We are strong and we are resilient: Career experiences of women engineers. *Gender, Work & Organization*, *26*(7), 1032-1052.

Koch, M., Lundh, P., & Harris, C. J. (2019). Investigating STEM support and persistence among urban teenage African American and Latina girls across settings. *Urban Education*, *54*(2), 243-273.

Leaper, C., & Brown, C. S. (2008). Perceived experiences with sexism among adolescent girls. *Child development*, *79*(3), 685-704.

Leaper, C., Farkas, T., & Brown, C. S. (2012). Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and English. *Journal of youth and adolescence*, *41*, 268-282.

Leaper, C., & Starr, C. R. (2019). Helping and hindering undergraduate women's STEM motivation: experiences with STEM encouragement, STEM-related gender bias, and sexual harassment. *Psychology of Women Quarterly*, *43*(2), 165-183.

Leyva, L. A. (2017). Unpacking the male superiority myth and masculinization of mathematics at the intersections: A review of research on gender in mathematics education. *Journal for Research in Mathematics Education*, *48*(4), 397-433.

Moser, C. E., & Branscombe, N. R. (2021). Male allies at work: Gender-equality supportive men reduce negative underrepresentation effects among women. *Social Psychological and*

Personality Science. Advance online publication. https://doi.org/10.1177/19485506211033748.

National Science Foundation (NSF), National Center for Science and Engineering Statistics. (2021). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2021.* Special Report NSF 21-321. Alexandria, VA: National Science Foundation. Available at https://ncses.nsf.gov/wmpd.

Nosek, B. A., & Smyth, F. L. (2011). Implicit social cognitions predict sex differences in math engagement and achievement. *American Educational Research Journal*, *48*(5), 1125-1156.

Ong, M., Jaumot-Pascual, N., & Ko, L. T. (2020). Research literature on women of color in undergraduate engineering education: A systematic thematic synthesis. *Journal of Engineering Education*, *109*(3), 581-615.

Onwuegbuzie, A. J., & Collins, K. M. (2007). A typology of mixed methods sampling designs in social science research. *Qualitative Report*, *12*(2), 281-316.

Pascoe, C. J. (2003). Multiple masculinities? Teenage boys talk about jocks and gender. *American Behavioral Scientist*, *46*(10), 1423-1438.

Patall, E. A., Steingut, R. R., Freeman, J. L., Pituch, K. A., & Vasquez, A. C. (2018). Gender disparities in students' motivational experiences in high school science classrooms. *Science Education*, *102*(5), 951-977.

Pinkard, N., Erete, S., Martin, C. K., & McKinney de Royston, M. (2017). Digital youth divas: Exploring narrative-driven curriculum to spark middle school girls' interest in computational activities. *Journal of the Learning Sciences*, *26*(3), 477-516.

Plante, I., De la Sablonnière, R., Aronson, J. M., & Théorêt, M. (2013). Gender stereotype endorsement and achievement-related outcomes: The role of competence beliefs and task values. *Contemporary Educational Psychology*, *38*(3), 225-235.

Puccia, E., Martin, J. P., Smith, C. A., Kersaint, G., Campbell-Montalvo, R., Wao, H., ... & MacDonald, G. (2021). The influence of expressive and instrumental social capital from parents on women and underrepresented minority students' declaration and persistence in engineering majors. *International Journal of STEM Education*, *8*(1), 1-15.

Rice, L., Barth, J. M., Guadagno, R. E., Smith, G. P., & McCallum, D. M. (2013). The role of social support in students' perceived abilities and attitudes toward math and science. *Journal of youth and adolescence*, *42*(7), 1028-1040.

Ridgeway, C. L., & Correll, S. J. (2004). Unpacking the gender system: A theoretical perspective on gender beliefs and social relations. *Gender & society*, *18*(4), 510-531.

Risman, B. J. (2004). Gender as a social structure: Theory wrestling with activism. *Gender & society*, *18*(4), 429-450.

Risman, B. J. (2009). From doing to undoing: Gender as we know it. *Gender & society*, *23*(1), 81-84.

Robinson-Cimpian, J. P., Lubienski, S. T., Ganley, C. M., & Copur-Gencturk, Y. (2014). Teachers' perceptions of students' mathematics proficiency may exacerbate early gender gaps in achievement. *Developmental psychology*, *50*(4), 1262.

Robnett, R. D. (2016). Gender bias in STEM fields: Variation in prevalence and links to STEM self-concept. *Psychology of women quarterly*, *40*(1), 65-79.

Robnett, R. D., Daniels, E. A., & Leaper, C. (2018). Growing up gendered: Feminist perspectives on development. In *APA handbook of the psychology of women: History, theory, and battlegrounds, Vol. 1* (pp. 437-454). American Psychological Association.

Robnett, R. D., & Leaper, C. (2013). Friendship groups, personal motivation, and gender in relation to high school students' STEM career interest. *Journal of Research on Adolescence*, *23*(4), 652-664.

Rudman, L. A., Moss-Racusin, C. A., Phelan, J. E., & Nauts, S. (2012). Status incongruity and backlash effects: Defending the gender hierarchy motivates prejudice against female leaders. *Journal of Experimental Social Psychology*, *48*(1), 165-179.

Salikutluk, Z., & Heyne, S. (2017). Do gender roles and norms affect performance in maths? The impact of adolescents' and their peers' gender conceptions on maths grades. *European Sociological Review*, *33*(3), 368-381.

Schmader, T., Johns, M., & Barquissau, M. (2004). The costs of accepting gender differences: The role of stereotype endorsement in women's experience in the math domain. *Sex roles*, *50*(11), 835-850.

Shearer, C. L., Crouter, A. C., & McHale, S. M. (2005). Parents' perceptions of changes in mother-child and father-child relationships during adolescence. *Journal of Adolescent Research*, *20*(6), 662-684.

Shumow, L., & Schmidt, J. A. (2013). Academic grades and motivation in high school science classrooms among male and female students: Associations with teachers' characteristics, beliefs and practices. *Journal of Education Research*, *7*(1), 53-71.

Simpkins, S. D., Price, C. D., & Garcia, K. (2015). Parental support and high school students' motivation in biology, chemistry, and physics: Understanding differences among Latino

and Caucasian boys and girls. *Journal of Research in Science Teaching*, *52*(10), 1386-1407.

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science education, 74*(1), 1-18.

Stake, J. E. (2006). The Critical Mediating Role of Social Encouragement for Science Motivation and Confidence Among High School Girls and Boys 1. *Journal of Applied Social Psychology*, *36*(4), 1017-1045.

Stolzenberg, E. B., Aragon, M. C., Romo, E., Couch, V., McLennan, D., Eagan, M. K., & Kang, N. (2020). *The American Freshman: National Norms Fall 2019*. Los Angeles: Higher Education Research Institute, UCLA.

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of personality and social psychology*, *100*(2), 255.

Tan, E., Calabrese Barton, A., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching*, *50*(10), 1143-1179.

Teddlie, C., & Yu, F. (2007). Mixed methods sampling: A typology with examples. *Journal of mixed methods research*, *1*(1), 77-100.

Tenenbaum, H. R., & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequities?. *Developmental psychology*, *39*(1), 34-47.

Tonso, K. L. (2006). Teams that work: Campus culture, engineer identity, and social interactions. *Journal of engineering education*, *95*(1), 25-37.

Updegraff, K. A., Delgado, M. Y., & Wheeler, L. A. (2009). Exploring mothers' and fathers' relationships with sons versus daughters: Links to adolescent adjustment in Mexican immigrant families. *Sex roles*, *60*(7), 559-574.

Wade-Jaimes, K., King, N. S., & Schwartz, R. (2021). "You could like science and not be a science person": Black girls' negotiation of space and identity in science. *Science Education, 105*(5), 855-879.

White, B. A., Miles, J. R., & Frantell, K. A. (2021). Intergroup dialogue: A justice-centered pedagogy to address gender inequity in STEM. *Science Education, 105*(2), 232-254.

Wieselmann, J. R., Dare, E. A., Ring-Whalen, E. A., & Roehrig, G. H. (2020). "I just do what the boys tell me": Exploring small group student interactions in an integrated STEM unit. *Journal of Research in Science Teaching*, *57*(1), 112-144.

Williams, C. (1989). *Gender differences at work: Women and men in nontraditional occupations.* University of California Press.

Williams, J., Li, S., Rincon, R., & Finn, P. (2016). *Climate control: Gender and racial bias in engineering?*. Center for Worklife Law & Society of Women Engineers. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4014946

Xie, Y., Fang, M., & Shauman, K. (2015). STEM education. *Annual review of sociology*, *41*, 331-357.

Yee, D. K., & Eccles, J. S. (1988). Parent perceptions and attributions for children's math achievement. *Sex roles*, *19*(5), 317-333.

Table 1. Descriptive Statistics of Sample Characteristics

	n	%
Race		
Black	7	5.26%
Latinx	10	7.52%
Asian	21	15.79%
White	82	61.65%
Multi-racial or Other	13	9.77%
Mother's highest level of education (Social class proxy)		
Earned less than a bachelor's degree	22	16.5%
Earned a bachelor's degree	56	42.1%
Earned more than a bachelor's degree	54	40.6%
Grade level		
9th grade	25	18.80%
10th grade	26	19.55%
11th grade	30	22.56%
12th grade	52	39.10%
Self-reported grades		
Mostly A's	112	84.21%
A's and B's	19	14.29%
Mostly B's	2	1.50%
N	133	

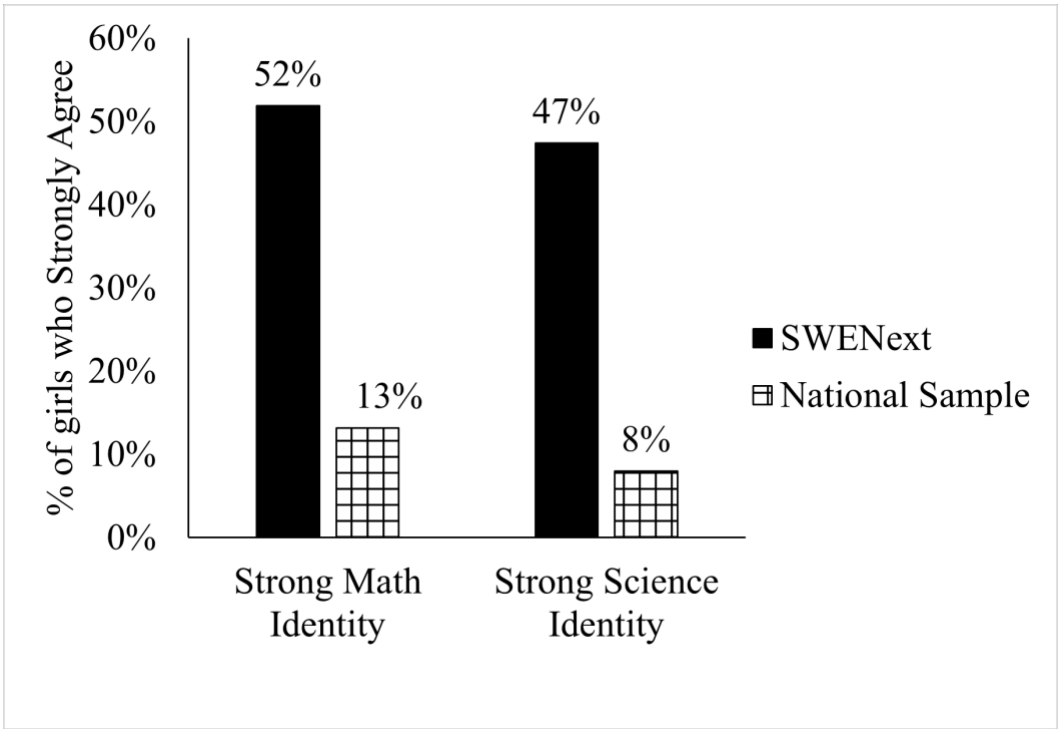

Figure 1. Comparing math and science identities of SWENext (n= 133) and HSLS (n= 10,500) high school girls

Note: HSLS = High School Longitudinal Study (HSLS:09, Ingels et al., 2013)

Table 2. Scale variables measuring perceived STEM encouragement from various sources

Actor	Items in scale	Cronbach's alpha
Mother	How much have you personally felt supported and encouraged to do well in math by your mother? (math support)	0.87
	How much have you personally felt supported and encouraged to do well in science by your mother? (science support)	
	How much have you personally felt supported and encouraged to do well in engineering by your mother? (engineering support)	
Father	How much have you personally felt supported and encouraged to do well in math by your father? (math support)	0.93
	How much have you personally felt supported and encouraged to do well in science by your father? (science support)	
	How much have you personally felt supported and encouraged to do well in engineering by your father? (engineering support)	
Girl friends	How much have you personally felt supported and encouraged to do well in math by your female friends from school? (math support)	0.86
	How much have you personally felt supported and encouraged to do well in science by your female friends from school? (science support)	
	How much have you personally felt supported and encouraged to do well in engineering by your female friends from school? (engineering support)	
Boy friends	How much have you personally felt supported and encouraged to do well in math by your male friends from school? (math support)	0.89
	How much have you personally felt supported and encouraged to do well in science by your male friends from school? (science support)	
	How much have you personally felt supported and encouraged to do well in engineering by your male friends from school? (engineering support)	
Girl STEM club peers	How much have you personally felt supported and encouraged to do well in math by your female peers from STEM club? (math support)	0.92
	How much have you personally felt supported and encouraged to do well in science by your female peers from STEM club? (science support)	
	How much have you personally felt supported and encouraged to do well in engineering by your female peers from STEM club? (engineering support)	

Boy STEM club peers	How much have you personally felt supported and encouraged to do well in math by your male peers from STEM club? (math support)	0.95
	How much have you personally felt supported and encouraged to do well in science by your male peers from STEM club? (science support)	
	How much have you personally felt supported and encouraged to do well in engineering by your male peers from STEM club? (engineering support)	
Girl STEM classmates	How much have you personally felt supported and encouraged to do well in math by the girls in your math class? (math support)*	0.74
	How much have you personally felt supported and encouraged to do well in science by the girls in your science class? (science support)*	
Boy STEM classmates	How much have you personally felt supported and encouraged to do well in math by the boys in your math class? (math support)*	0.81
	How much have you personally felt supported and encouraged to do well in science by the boys in your science class? (science support)*	
Women STEM teachers	How much have you personally felt supported and encouraged to do well in math by your math teacher? (math support)*	0.84
	How much have you personally felt supported and encouraged to do well in engineering by your math teacher? (engineering support)*	
	How much have you personally felt supported and encouraged to do well in science by your science teacher? (science support)*	
	How much have you personally felt supported and encouraged to do well in engineering by your science teacher? (engineering support)*	
Men STEM teachers	How much have you personally felt supported and encouraged to do well in math by your math teacher? (math support)*	0.76
	How much have you personally felt supported and encouraged to do well in engineering by your math teacher? (engineering support)*	
	How much have you personally felt supported and encouraged to do well in science by your science teacher? (science support)*	
	How much have you personally felt supported and encouraged to do well in engineering by your science teacher? (engineering support)*	

* Denotes items that were asked multiple times for respondents taking more than one class (i.e., one question asked per class taken)

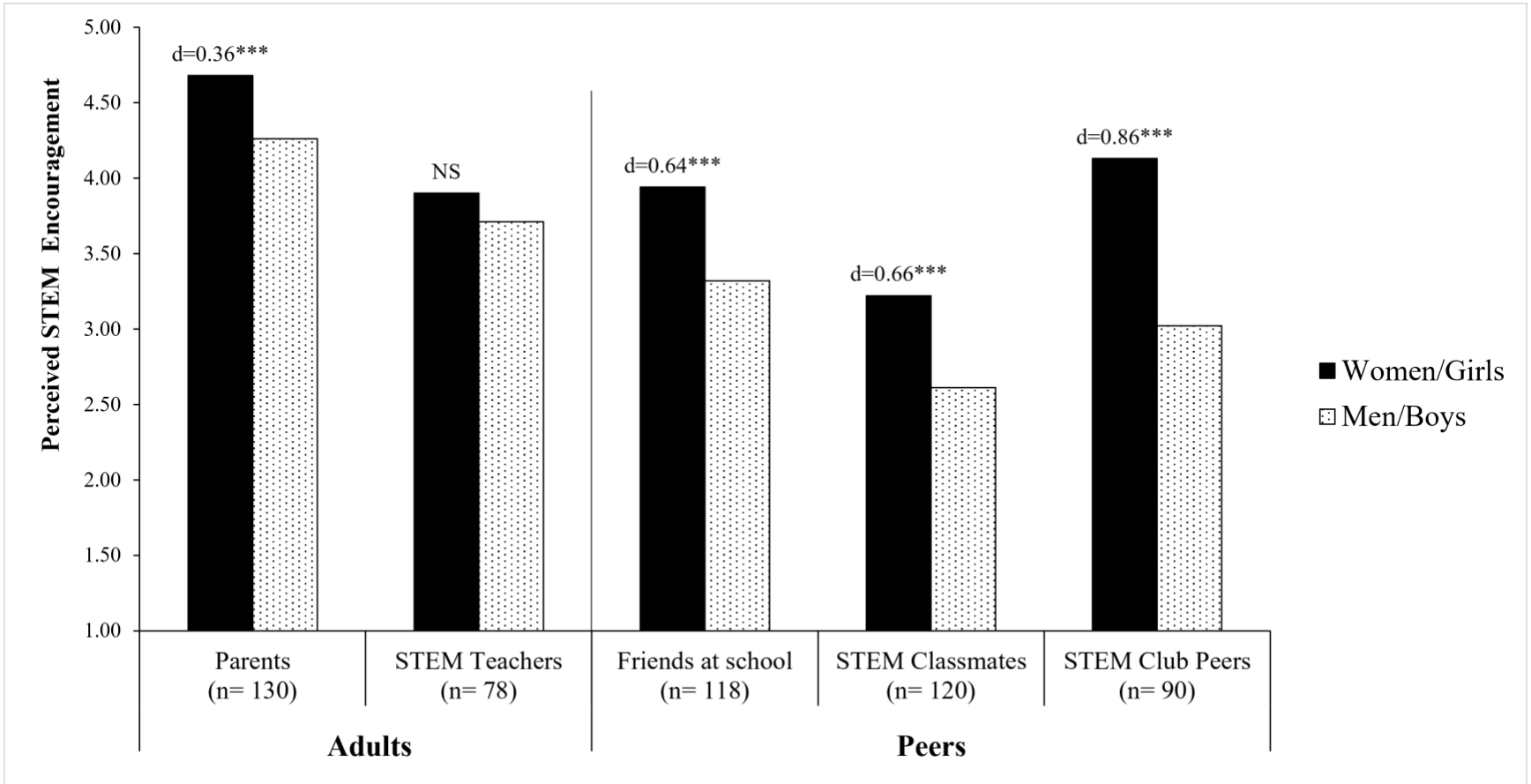

Figure 2. Perceived STEM encouragement

Table 3. Encouragement themes descriptions and sample quotes

Theme	Description	Sample Quote
Pushes or Advocates	Others encourage them to do something specific, such as participate in a class or join a club; or to persist in engineering via recruitment to workshops or teams; this is a form of encouragement that is more directed to an outcome.	Probably the great mentor I had in engineering was a male teacher who was the Way to Technology for middle school. My 6th and 7th grade year as a teammate on a robotics team, I was with a team of boys who were older than I was. They graduated middle school before me. Going into eighth grade, he encouraged me to start up my own all-girls' team. I was really unsure about it at first, but he continually pushed me and would help me out. I recruited enough girls to have not one, but two all-girls' teams for our middle school. We worked to make history at our middle school, actually being the first middle school team to compete at our state competition, not only as the first one, but it was the first all-girls' team to do so. That was so inspiring to me for going from that middle school and being so unsure about, can I do this… Olivia, White, 11th grade
Provides Academic Support or Mentoring	Others offer engineering or technological knowledge; help them learn engineering content and master engineering activities; help them navigate engineering or other academic spaces; gives them information either academic or otherwise to help them succeed.	I guess my brother is very encouraging in that manner…. I was very confused on what kind of engineering I wanted to do. He was very supportive in explaining different things to me. When I finally chose to do computational engineering, he was very supportive in getting me a meeting with the academic advisor at [university] and meeting with her, and talking with some of his friends, and just getting me anything that I needed, and helped me answer questions to get me excited about going into that program. Rebecca, Latinx, 12th grade
Recognizes or Believes in Them	Others see them as someone capable and skilled in engineering, or believe that they have the potential of being an engineer.	Whenever we're doing kinda arts and crafts thing or something and I suggest something, they're like, "See, this is why you're gonna be the engineer"— where it's like, "Emily's gonna be a doctor." It's just kind of different. They're all really encouraging. I've never had a friend tell me that I can't be an engineer. Camilla, Latinx, 12th grade
Promotes Sense of Belonging	Being with others in an engineering space and feeling a sense of fit/comfort/welcome. Feelings of encouragement within a context populated by others who are like them.	I started going to [robotics] team meetings in the summertime, and I just fell in love with the environment, so I just kept going. I felt really encouraged by everybody. There weren't a lot of girls on the team. For my first year, there were five of us. Everybody was just so nice to me and so brotherly that the mentors, which were mostly male, and then most of my team members were also boys—they were very encouraging. They basically supported me the entire time.

		Camilla, Latinx, 12th grade

Table 4. Discouragement themes descriptions and sample quotes

Theme	**Description**	**Sample Quote**
Social Exclusion	Boys ignore, avoid, or exclude girls in STEM spaces.	There are some [male] students who will not talk to me just because I'm female. That's really frustrating to me…It's never easy responding to that situation. I have tried persistence and just trying to be friendly. Olivia, White, 11th grade
Physical Exclusion	Boys assert ownership or control of physical material and spaces.	I can distinctly remember one time my group, we had to build instruments. We built a washtub base, and one of the guys in my group would not let me drill holes in the base or cut anything because he was like no, no, no, it's like 'this is like a guy's work'. It's okay. You can chill for right now. Kiara, Black, 12th grade
Idea/Identity Ownership	Boys dismiss and/or take credit for ideas; or doubt that girls can be engineers/good at engineering.	It feels weird when you're working with a group of boys, and some boys are not as nice…[W]hen I'm in group work, and then I say something, and it sometimes feels like they didn't really process what I said, but then this other guy says something similar, and then they're like, "Oh, yeah, that's right." I'm like, "Whoa, I just said the same thing." Isabella, Latinx, 11th grade