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An Examination of Factors Predicting Academic Engagement and Commitment Among Science, Technology, Engineering, and Mathematics Students: The Moderating Role of Gender

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AN EXAMINATION OF FACTORS PREDICTING ACADEMIC ENGAGEMENT AND COMMITMENT AMONG SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS STUDENTS: THE MODERATING ROLE OF GENDER

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ABSTRACT

AN EXAMINATION OF FACTORS PREDICTING ACADEMIC ENGAGEMENT AND COMMITMENT AMONG SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS STUDENTS: THE MODERATING ROLE OF GENDER

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The purpose of the present study was to examine the role of gender on the relationships between the predictor variables (i.e., sense of belonging, grit, and support systems) and academic engagement and commitment to major among science, technology, engineering, and mathematics (STEM) students. Specifically, this study proposed that gender would act as a moderator of these relationships such that the relationships between the predictor variables and the outcome variables would be stronger for women than for men in STEM. A total of 254 undergraduates from a university in Northern California participated in an in-person survey. Although results did not show that gender was a moderator of these relationships, it showed a tendency to moderate the relationship between parental support and academic engagement such that men who experienced greater levels of support from parents/guardians were more likely to experience academic engagement. Furthermore, it was found that sense of belonging, grit, and certain types of support were contributors to academic engagement and commitment to one's major. Based on these findings, it is suggested that academic institutions allocate resources to facilitate belongingness and foster a supportive environment for students. As the demand for STEM workers continues to grow, it would be beneficial to conduct further research in order to look for ways to combat the leaky pipeline and chilly climate that minorities, such as women, face in STEM.

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Introduction

In recent years, STEM fields have become a topic of increasing interest among industries in the United States, producing an abundance of research on these fields. Although there have been some variations, the acronym STEM has been widely adopted to encompass fields concerning science, technology, engineering, and mathematics (Breiner et al., 2012). As the United States becomes more technologically developed and reliant on the use of technology, skilled workers in STEM are becoming increasingly sought after (Hossain, 2012).

According to the U.S. Department of Commerce (Noonan, 2017), STEM industries have been growing exponentially, boasting high salaries and job security, which have caused many students to enroll as STEM majors in post-secondary educational institutions in order to pursue these highly sought-after careers (Langdon et al., 2011). As reported by the U.S. Bureau of Labor Statistics (Fayer et al., 2017), the national average salary for STEM professions was nearly double the national average salary for non-STEM professions. The same report states that STEM employment increased by 10.5% between 2009 and 2015, as compared with a 5.2% increase for non-STEM jobs, and the projected growth for STEM careers continues to grow at a greater rate than most non-STEM professions.

Education plays a key role within STEM fields, as 68% of STEM workers reported to have a bachelor's degree or higher as compared to 31% of non-STEM workers (Langdon et al., 2011). In a more recent report, the U.S. Bureau of Labor Statistics shows that over 99% of STEM employment is in "occupations that typically require some type of postsecondary education for entry, compared with 36% of overall employment" (Fayer et al., 2017, p. 13), suggesting that STEM workers generally have an associate's degree, a bachelor's degree, or some type of higher education as compared to non-STEM workers. Due to these findings, pursuing a STEM degree offers many benefits to students, thus, it is no surprise that the United States has seen increases in enrollment into STEM majors across college campuses over past years (National Science Foundation, 2014).

STEM Leaky Pipeline and Chilly Climate

Despite the increase in STEM major enrollment in post-secondary education institutions, there seems to be an issue regarding STEM attrition rates: although there has been an increase in demand for STEM workers, it appears that students are leaving STEM majors. According to the National Center for Education Statistics (X. Chen, 2013), it was found that 48% of students pursuing a bachelor's degree and 69% of students pursuing an associate degree in a STEM field left these tracks. Additionally, the data also showed that students in a STEM major were 6% more likely to change their major as compared to non-STEM students (Musto & Bryant, 2018). A phenomenon known as the "leaky pipeline," in which students interested in pursuing a STEM career "leak" out at varying stages, such as during post-secondary education or after graduation, has emerged and appears to be a persistent problem within STEM fields, especially when it comes to minority groups within STEM (Alper & Gibbons, 1993).

There are many proposed explanations concerning the leaky pipeline phenomenon, and several researchers have examined antecedents of why interested students are choosing to major in a STEM field only to end up leaving. The pipeline model was coined by the National Science Foundation in the 1970s and describes the general sequence of steps needed to progress into a STEM career, further citing that those who enter this STEM pipeline but do not emerge in a STEM profession are considered “leaks” (Metcalf, 2010). Within the STEM pipeline model, there are specific points that produce more leaks than others, such as the leaks within the postsecondary educational stage (Blickenstaff, 2005). It has been proposed that the difficulty of STEM courses in postsecondary curriculums may serve as a contributor to the leaky pipeline through a process known as “weeding out,” in which STEM courses are purposely made more difficult than necessary in an attempt to screen out students (Heilbronner, 2011; Reyes, 2011).

Additionally, there appears to be a “chilly climate” within STEM fields, referring to the culture of STEM education that may cause students, especially minority groups in STEM, to feel unwelcomed and leave these majors (Walton et al., 2015). Historically, STEM fields have been largely dominated by White males, which contributes to the chilly climate for minority groups within STEM, in which women and ethnic minorities are underrepresented and may feel excluded from STEM environments (Johnson, 2012; Walton et al., 2015). In the STEM pipeline model, women and ethnic minorities leak out of STEM education at a higher rate than their White male peers, creating an industry that is then dominated by White male workers and perpetuating a cycle of underrepresentation (Metcalf, 2010; Riegle-Crumb & King, 2010).

In a study that examined chilly climate in male-dominated higher education, it was found that female students perceived more “exclusions from academic departments with a low representation of women” (Maranto & Griffin, 2011, p. 140), which can serve as another barrier for women trying to enter STEM teaching careers; thus, perpetuating lower populations of female STEM professors and role models for female STEM students. There has also been a history of conflicting stereotypes when it comes to women in STEM fields. That is, traditional gender characteristics appear to conflict with the perceived attributes needed to succeed in a STEM field and suggest that STEM is suited for only men (Stout et al., 2011). For example, Simon et al. (2017) found that masculine-associated traits such as assertiveness and competitiveness are more prominent in STEM cultures, suggesting that individuals with more feminine personality traits may face a chilly climate due to the lack of persons with similar traits in STEM settings in addition to the lack of perceived attributes necessary to succeed in STEM fields.

There appears to be an underlying belief that men are more suited for mathematical fields than women, and this phenomenon is seen throughout STEM fields through gender stereotypes and biases (Shapiro & Williams, 2012). The preconceived belief that men might be more suited for STEM than women manifest as barriers for women in STEM fields that can prevent them from pursuing these paths. Stereotype threat, defined as the concern of confirming negative stereotypes about one's social identity groups (Steele & Aronson, 1995), can also affect women choosing to pursue a STEM track such that women may be unmotivated to pursue a STEM education because they do not wish to confirm the negative stereotypes of women in STEM fields (Shapiro & Williams, 2012).

Because it appears that students are leaving the STEM path despite having the initial intention of pursuing a STEM education, it would be beneficial to examine factors that may address student attrition rates. In this study, it was proposed that increasing student engagement and commitment may combat the chilly climate and leaky pipeline that women in STEM fields experience. The following section describes why studying academic engagement and commitment to major in STEM are important, in addition to reviewing research on other factors (i.e., sense of belonging, grit, and support systems) as predictors of student engagement and commitment. It is argued that the gender of students will act as a moderator of the relationships between these factors and those of academic engagement and commitment to major.

Student Engagement in Academic Work

In broad terms, engagement can be defined as "active involvement, commitment, and concentrated attention" as opposed to "superficial participation, apathy, or lack of interest" in a specific activity or interest (Lamborn et al., 1992, p. 11). Lamborn et al. (1992) also state that in an academic setting student engagement can be defined as the time and energy students devote towards "learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote" (p. 11), which may include activities inside and outside of the classroom (Kuh, 2003). For example, time devoted to studying or participating in activities geared toward furthering one's education can be considered forms of engagement, as it encompasses a student's level of concentration and effort to learn (Wolf-Wendel et al., 2009).

In a longitudinal study, Klem and Connell (2004) found that higher levels of engagement led to higher attendance rates and test scores among elementary and middle school students. Hodge et al. (2018) also found that engagement led to increased academic productivity among Australian university students. Engagement can affect not only attendance and academic performance, but also attrition rates of students. In a study surveying high school dropouts, it was found that 47% of participants cited a major reason for dropping out was due to classes being perceived as uninteresting, and 69% of participants stated that they were unmotivated and uninspired to work hard in school, suggesting that a lack of engagement in school can lead to high rates of attrition (Bridgeland et al., 2008). Similarly, individuals lacking academic engagement were more at risk to leave their major in postsecondary education. For instance, Gasiewski et al. (2012) found that a lack of student engagement in introductory college science courses led to students leaving their science major.

Although lack of engagement can lead to students dropping out or leaving their major, fostering engagement in students can lead to a multitude of other positive and beneficial outcomes. Students who experience high levels of engagement show higher rates of persevering from their first year to second year of university, especially for first year minority students (Kuh et al., 2007). Svanum and Bigatti (2009) also found that highly academically engaged students were 1.5 times more likely to graduate, often needing one less semester to do so. Additionally, in a study surveying undergraduate students from various colleges across Lithuania, it was found that engagement directly led not only to higher grade point averages (GPA), but also to higher academic major satisfaction and life satisfaction (Akkermans et al., 2018).

Current literature suggests that engagement can not only lead to higher student academic performance, but also increased persistence, improved graduation rates, and higher levels of academic and personal satisfaction. These positive outcomes of engagement can have implications for those majoring in STEM fields, as students who are engaged are more likely to remain and persist in their field of study, while those who lack engagement are more prone to leave. Focusing on studying academic engagement can aid in combating the leaky pipeline within STEM, preventing students from "leaking" out at various stages, especially during postsecondary education, a stage in which many interested students tend to leave (Blickenstaff, 2005). Examining potential predictors of academic engagement may especially be important for minority groups in STEM, such as women, in order to increase retention rates and representation in these fields.

Student Commitment to Major

In general, commitment can be defined as the desire to stay involved to achieve an interesting and meaningful experience in contrast to alienation or withdrawal (Maddi, 2004). This can include the desire to engage in activities that are deemed important and worthwhile in order to achieve a long-term goal (Sheard & Golby, 2007). Sheard and Golby (2007) further define academic commitment as a "deep involvement in studies" in which students are willing to expend "extra time and effort" to achieve academic goals (p. 581). Human-Vogel and Rabe (2015) have also conceptualized student level of commitment as long-term persistence with their academic studies, as determined by the amount of satisfaction and investment placed in studying, in addition to the "quality of alternatives" (p. 63) to studying; that is, whether students would rather spend time doing an activity other than studying.

Student commitment to an academic institution is important because commitment has been linked to a greater probability of persisting in college as well as overall student attrition rates (Cabrera et al., 1993; Hackman & Dysinger, 1970). For example, Davidson et al. (2009) found that institutional commitment positively predicted retention among college undergraduates. Additionally, Shcheglova et al. (2020) found that students who were committed to a degree (e.g., setting long-term goals to obtain a high academic degree) were less likely to drop out of college. Commitment is an important factor in education, as it can also contribute to higher graduation rates and persistence in STEM fields. For instance, in a study examining the effects of fit with postsecondary education on academic major and major-related outcomes, it was found that students who experienced high levels of affective commitment were able to develop confidence in their academic abilities, leading them to remain in college and complete their degree (Wessel et al., 2008). Conklin et al. (2012) also found that students' affective commitment to their major was positively related to expected career satisfaction and performance.

It appears that students who experience high levels of commitment to their major not only complete their degree, but also have higher levels of anticipated satisfaction and performance in their professional career. Thus, examining one's level of commitment to their major may be vital in combating student attrition rates and increasing STEM graduation rates, as well as bolstering the number of graduates entering and remaining in STEM professions. Due to the importance of commitment in student retention, it would be beneficial to review potential predictors of commitment, especially among minority groups in STEM, such as women. The following sections review literature on the predictors of academic engagement and commitment to major, with an emphasis on sense of belonging, personality trait grit, and social support systems.

Antecedents of Academic Engagement and Commitment to Major

Sense of Belonging

Past literature has established that sense of belonging is a predictor of STEM engagement. Having a sense of belonging in a community has been considered a basic human need, which is dependent on personal and frequent social connections for fulfillment (Wilson et al., 2015). In an academic context, sense of belonging can be defined as a student's personal belief that they are an accepted member of an academic community whose presence and contributions are valued (Good et al., 2012).

Belongingness has been found to contribute to persistence, interest, and academic engagement of STEM students (Wilson et al., 2015). Wilson et al. (2015) explain that experiencing belongingness positively affects the level of effort and participation students put into class as well as how STEM students perceive their classroom experience, bolstering academic engagement. A student's perceived sense of belonging can also affect their level of commitment, as minorities majoring in STEM may experience lower levels of commitment due to a lack of representation in STEM fields (Holland et al., 2012). In a study examining White and African American students from various majors, it was found that sense of belonging positively contributed to institutional commitment and persistence among college students at the start of the academic school year, even after controlling for variables such as race, gender, and perceived support (Hausmann et al., 2009).

In addition, it seems that sense of belonging has a relationship with retention rates in STEM fields. For example, having a low sense of belonging was positively related to students' decisions to leave engineering (Marra et al., 2012). Making the decision to leave engineering or such STEM fields contradicts factors associated with commitment, such as the desire to stay involved and accomplish long term goals. Additionally, Strayhorn (2015) found that having higher sense of belonging led to less intention to leave STEM fields among Black male college students. These studies suggest that students' sense of belonging can affect not only their classroom experience and persistence to remain in their field of study, but also academic engagement and commitment. Experiencing a sense of belonging is important due to its impact on engagement and persistence in a STEM field (Wilson et al., 2015). Therefore, sense of belonging is especially important to examine among underrepresented groups such as women, as educational STEM environments often privilege White men while marginalizing minority groups, leaving underrepresented groups with a diminished sense of belonging (Seymour & Hewitt, 1997).

Personality Trait Grit

The personality trait grit can be defined as the perseverance and passion for long-term goals, as well as the ability to maintain consistent effort and interest despite challenges or adversaries that may arise (Duckworth et al., 2007). Duckworth and Quinn (2009) further define grit as the "perseverance of effort and consistency of interest to succeed in the most demanding domains" (p. 172). Those high in grit are more likely to persist in their field and commit to long-term goals, as opposed to changing objectives, especially in challenging environments. Duckworth et al. (2007) found that grittier individuals were able to attain higher levels of education than less grittier peers of the same age, finding that post-college graduates had higher levels of grit than those with less education. Thus, it may be the case that an individual's level of personality trait grit can contribute to staying within an academic major, affecting academic engagement and commitment to major among college students in STEM fields.

In a study that examined grit and academic engagement among Australian university students, Hodge et al. (2018) found that engagement mediated the relationship between personality trait grit and academic productivity such that students higher on grit were more likely to have higher levels of engagement, which then led to greater academic performance. Although few studies exist examining the relationship between grit and engagement, indirect evidence shows that grittier students have higher rates of engagement (Hodge et al., 2018). Additionally, Bowman et al. (2015) found that grittier individuals had a greater sense of belonging in college and a tendency to report more interactions with faculty which led to a greater satisfaction and less intention to change majors and careers.

In terms of the relationship between grit and commitment to a university major, there appears to be gaps in the literature. Previous research shows that although grittier individuals appear to report greater purpose commitment, it is unclear if this finding would also be generalizable to students, as the study defined purpose commitment as long-term life goals, rather than academia-based long-term goals (Hill et al., 2016). Although there appears to be a gap in literature examining grit and its specific relationship to commitment to a college major, there are existing data that suggest grit is associated with increased academic engagement among primary school students (Tang et al., 2019).

In a study conducted by Strayhorn (2014), it was found that grit was positively related to academic success, as measured by GPA, when examining the role of grit among Black male college students in predominantly White institutions. Because earning higher GPAs has been linked to higher levels of commitment to a STEM field among students (Wilson et al., 2015), the implication that grittier Black male students can lead to academic success may indicate that grittier STEM students may display more commitment to their major, potentially making them less likely to change their STEM major despite having a minority group status.

Support Systems: Peers, Faculty, and Parents/Guardians

Maintaining a social support network has been linked to higher levels of psychological adjustment within communities (Gottlieb, 1979) and can be defined as seeking help through any means of communication which is aimed towards obtaining "support, advice, or assistance" (Gourash, 1978, p. 414) in times of distress. These networks can come from many sources, such as friends and family, and can provide psychological assistance to the individual. It has been found that perceived social support systems can act as an external coping resource that can reduce stress-related impediments to engagement within academic fields (London et al., 2011). Lundberg (2014) identified that support received from peers and faculty was beneficial for student learning among those attending community college. Additionally, Garmezy (1991) proposed that support from family members, such as parents, can serve as a protective factor in academically challenging environments. Due to these findings, it may be the case that support from peers, faculty, and parents/guardians are likely to contribute to the overall academic engagement and commitment to major among STEM undergraduates.

In a study examining the mediating role of academic engagement on the relationship between social support and adolescent academic achievement, J. J. L. Chen (2005) found that students' academic engagement mediated the relationship between perceived support and academic achievement among students in Hong Kong. This finding suggests that receiving support from peers, teachers, and parents/guardians increased engagement among students, which encouraged them to do better in school, resulting in higher academic achievement. Similarly, Klem and Connell (2004) found that teacher support contributed to academic engagement and commitment among elementary and middle school students. It was also found in the same study that in environments in which teacher support was prominent, there was a trend in higher attendance, persistence, and graduation rates within secondary schools. University students were also found to be more engaged when supported by faculty; that is, when teachers developed academic relationships with their students and facilitated participation among them, they were more likely to be engaged (Bryson & Hand, 2007).

In a longitudinal study focusing on motivational characteristics and support in college, it was found that a lack of peer support contributed to lower amounts of college adjustment among first-generation college students (Dennis et al., 2005). Although support from peers and family both contributed to higher levels of college adjustment, it was found in the same study that peer support was a stronger predictor of college adjustment than family support. This finding suggests that perhaps peers can offer more relevant support as they share the same classes rather than parental support, which may be limited due to a lack of shared experiences between first-generation college students and their parents. Sanchez et al. (2006) also found that students who partook in peer mentoring experienced greater affective commitment and satisfaction with their university.

Previous literature has established that students who are more adjusted to campus life are more likely to be committed to their university and complete a college degree (Grant-Vallone et al., 2003). Thus, it may be the case that students receiving higher levels of support from peers could be more well-adjusted to a college lifestyle which could have an impact on overall commitment to major. Additionally, Hackman and Dysinger (1970) found higher levels of commitment in students when parental expectations of completing college were present, suggesting that the more parental support a student receives, the more likely they will continue pursuing an education following their first year of college.

Based on the review of literature, the present study expected that the predictor variables (i.e., sense of belonging, grit, and support systems) would be positively related to academic engagement and commitment to major, however, these relationships might differ as a function of students' demographic information such as gender. It has been shown that women are underrepresented in STEM fields, often facing discrimination and enduring a chilly climate that can potentially cause them to leave (Walton et al., 2015). Therefore, this study proposed that gender would act as a moderator among these relationships due to women's minority status in STEM. Very few studies have examined gender as a moderator of these relationships; thus, this study proposed that gender would impact the strength of these relationships. The following section describes how gender might moderate these relationships.

Gender as a Moderator

The Relationships Between Sense of Belonging and Academic Engagement and Commitment to Major

Negative stereotypes such as the belief that women have less mathematical skill than men contribute to gender biases across STEM fields that favor men over women, which impacts women's sense of belonging in such fields (Good et al., 2012). Moss-Racusin et al. (2018) conducted two experiments and found that gender bias contributed to gender gaps in STEM engagement, and that women projected less sense of belonging than men when exposed to gender biases, such as negative stereotypes, ultimately leading to less engagement. Additionally, Johnson (2012) found that being a woman of color in a STEM major had a negative relationship with overall sense of belonging, arguing that being a woman of color in traditionally male-dominated academic fields and predominantly White institutions negatively affected sense of belonging due to having a minority status in both gender and race. It appears that having a minority status negatively impacts students' sense of belonging due to stereotyping and being underrepresented in the field. Given these challenges that women face in STEM, the present study expected that the relationship between sense of belonging and engagement and commitment would be moderated by gender.

Hundera (2014) examined the moderating effect of gender on the relationship between situational factors (i.e., role stress, job satisfaction, and organization commitment) and turnover intention among academic staff in Ethiopia. Hundera reasoned that because female academic staff experience a challenging working environment, one that typically involves lower status and lower paid jobs than their male counterparts, women would experience role stress differently from men, leading to dissatisfaction and intent to leave their job. One component of role stress is role conflict, defined as the mismatched expectations between two domains that can fulfil one role while hindering the other, similar to the conflicting gendered attributes and stereotypes women may face in STEM. Hundera found that the relationship between role stress and turnover intention was stronger for women than for men. Additionally, Hundera found that the relationship between job satisfaction and commitment was stronger for female staff than for male staff. Although this study examined intention to leave jobs among academic staff, it may be the case that students feel similarly such that satisfaction, experienced by students through sense of belonging or receiving support, can influence their commitment to their STEM major. Likewise, perhaps this effect would be stronger for female students than for male students majoring in STEM due to their minority status.

Khalid et al. (2009) also found that gender played a moderating role in the relationship between helping behavior and turnover intention among nonmanagerial hotel staff in Malaysia such that more acts of help performed decreased turnover intention, and this relationship was stronger among female staff than male staff. Active contribution in the workplace through helping behaviors can foster an environment with social connectedness and feelings of acceptance associated with belongingness. Although these studies examined employee turnover, it may be the case that student turnover in terms of leaving their major are also similarly affected such that female students may be less engaged and committed to their STEM major due to the lack of belongingness created by the chilly climate and challenging environment faced by minorities in STEM. Based on these findings, the present study tested the following hypotheses.

Hypothesis 1: Gender will moderate the relationship between sense of belonging and academic engagement such that the relationship between sense of belonging and academic engagement will be stronger for women than for men majoring in STEM.

Hypothesis 2: Gender will moderate the relationship between sense of belonging and commitment to major such that the relationship between sense of belonging and commitment to major will be stronger for women than for men in STEM.

The Relationships Between Grit and Academic Engagement and Commitment to Major

Although the literature is scarce and conflicting concerning grit and gender, Knežević et al. (2021) found that gender moderated the relationships between personality traits and facets of job satisfaction, defined as a “pleasant and positive emotional state arising from the evaluation of the job or overall work experience” (p. 2) which may be comparable to the active involvement necessary for engagement or the meaningful experience associated with commitment. Knežević et al. specifically examined the personality dimension of conscientiousness and found that women higher in conscientiousness were more likely to have lower job satisfaction regarding their work benefits than men. Knežević et al. identified that women generally tended to score higher on the personality dimension of conscientiousness, which can manifest as persistence and being highly motivated and dedicated to work, similar to the perseverance associated with grit; however, due to the potential discrepancy in female employees’ expected and realized rewards in the workplace, women were more prone to feel dissatisfied if they felt that they were not being adequately rewarded for their work. It is further suggested in the study that because the personality dimension of conscientiousness had been found to be correlated with gender, gender acted as a moderator of the relationship between these variables.

In terms of personality trait grit and gender, findings have been mixed. Previous studies have indicated either women having higher grit scores than men (Rojas et al., 2012), or there being no relationship between grit and gender (Batres, 2011; Bazelais et al., 2016; Flanagan & Einarson, 2017). Although there are discrepancies in whether or not grit is associated with gender, it may be the case that the relationship between the personality trait grit and engagement and commitment in STEM will differ as a function of gender. Similar to Knežević et al.'s (2021) findings, perhaps if female students high on grit feel that they are not receiving adequate achievements and academic rewards in equal return for their efforts, the likelihood that they would be more affected in terms of engagement and commitment would increase. It may be the case that the discrepancy between expected and realized rewards will create a more challenging environment for women in STEM, causing grittier women to persevere and experience higher levels of engagement and commitment in order to persist in their STEM major.

Gender has also been found to play a moderating role between personality and counterproductive work behaviors, defined as behaviors that can harm or oppose the general interests of the organization (Spector & Zhou, 2014). Specifically, among employed students at a Southeastern public university in the United States, men low on the personality dimensions of agreeableness, conscientiousness, and emotional stability were most likely to report engaging in counterproductive work behaviors. Spector and Zhou (2014) suggest that gender acted as a moderator due to gender role theory and stereotypes that support the notion that aggression, and perhaps other forms of disruptive behaviors associated with counterproductive work behaviors, are more acceptable to engage in for men than for women, which affects personality as gendered social roles and norms are learned from adolescence to adulthood.

Disruptive and counterproductive behaviors may be at odds with the meaningful experience and deep involvement aspects associated with commitment, which may have implications for the potential moderating effect that gender can have on the personality trait grit and commitment to major among STEM students. It may be the case that women higher on traits such as conscientiousness, which shares the facet of perseverance with grit (MacCann et al., 2009), are less likely to engage in counterproductive behaviors, both in the workplace and in an academic setting. Additionally, perhaps the tenacity associated with personality trait grit may help women in STEM overcome conflicting gender roles and negative stereotyping minorities face in these fields. Based on these findings, it may be the case that the relationships between personality trait grit and academic engagement and commitment to major will be moderated by gender amongst students studying STEM. Because the relationship between grit and gender has yielded mixed outcomes, the present study sought to test the following hypotheses.

Hypothesis 3: Gender will moderate the relationship between grit and academic engagement such that the relationship between grit and academic engagement will be stronger for women than for men majoring in STEM.

Hypothesis 4: Gender will moderate the relationship between grit and commitment to major such that the relationship between grit and commitment to major will be stronger for women than for men in STEM.

The Relationships Between Support Systems and Academic Engagement and Commitment to Major

Support from peers, faculty, and parents/guardians may additionally have varying levels of influence on academic outcomes depending on the minority status of a student. In a study that examined Latino STEM majors, it was proposed that Latino students utilized interpersonal interactions with peers as a support mechanism in response to feelings of alienation and marginalization experienced within academic programs (Cole & Espinoza, 2008). Perhaps this reasoning may be applicable to female STEM students as well, as women are also an underrepresented group in STEM, often enduring a chilly climate in such fields. Additionally, Cohoon (2001) found that support from faculty had an effect on gendered attrition rates; for instance, faculty who expressed a strong appreciation for their female students' abilities and work styles were able to retain female students at similar rates to male students among computer science majors. Bystydzienski et al. (2015) also found that female students were more likely to leave their engineering major if they experienced lack of support from peers and faculty.

In a study regarding graduate students in the life sciences, Clark et al. (2016) found that there was a positive relationship between perceived advisor support and gender-STEM compatibility, defined as one's belief that their gender "overlaps with or is compatible" (p. 3) with their identity as a scientist, and that higher gender-STEM compatibility predicted higher STEM importance which, in turn, predicted higher self-efficacy for women in STEM fields, but not for men. Clark et al. further state that perceived faculty support through advising may promote engagement in STEM fields specifically among women. Due to the negative stereotypes and expectations women face in STEM, Clark et al. reasoned that advisor support is crucial in protecting women's perception of their gender-STEM compatibility, providing reassurance and acceptance in what may otherwise be an unwelcoming STEM environment. Additionally, because higher gender-STEM compatibility predicted higher STEM importance, it can also lead to higher levels of engagement for women. These findings suggest that perhaps women and other minorities in STEM may be more strongly affected by social support systems than students from majority groups, such as men.

In another study, Suan and Nasurdin (2016) found that gender moderated the relationship between supervisor support and work engagement among hotel employees in Malaysia. Although supervisor support led to higher engagement among customer-contact employees, this relationship was stronger for men than for women. Suan and Nasurdin suggested that this finding might be due to the larger percentage of male supervisors in the Malaysia hotel industry in comparison to women in supervisory positions. Additionally, they reasoned that the relationship between supervisor support and work engagement was weaker for women due to conflicting social gender roles, in which male supervisors may be more achievement-oriented, valuing individualism more strongly in comparison to their female employees, who may find a disconnect in interacting and forming a supportive bond with their supervisor because of this. Although the hospitality industry and field of education differ, it is unclear whether students in STEM may feel similarly such that male students would experience more engagement when receiving support from an authority figure, such as teaching faculty.

Alternatively, Lin et al. (2009) found that the relationship between supervisor-staff social exchanges and job productivity was stronger among female staff than male staff across various engineering departments at a manufacturing company in Taiwan. Specifically, Lin et al. found that women who perceived lower quality leader-member exchange, which involves the "various social exchange relationships between supervisors and subordinates" (p. 193), engaged in lower job productivity. It was proposed in the same study that women may value social relationships more than men, thereby causing female employees to be more critical of their interactions with their supervisor, which may also resemble female STEM students' interactions with others in higher status positions, such as faculty or family. Although Suan and Nasurdin (2016) found that male employees were more likely to be affected by supervisor support in terms of engagement, Lin et al. found that female employees were more affected by supervisor interaction in terms of job productivity. Due to these discrepancies, it would be beneficial to examine the potential moderating effect of gender on support and academic engagement among STEM students.

In a study examining the moderating effect of gender on ethical leadership (e.g., leaders with an emphasis on ethical values, principals who demonstrate social responsibility) and organizational commitment among academic staff and managers, Karakuş (2018) found that female teachers were “more sensitive to the managerial actions” (p. 8) of their principal’s ethical leadership, resulting in higher levels of organizational commitment. Although leadership may not be completely interchangeable with social support, the interaction between teaching staff and their principal may be somewhat similar to students and faculty in an academic setting, as students may perceive faculty as authority figures that facilitate learning. Ethical leadership could be interpreted as receiving support from an authority figure who may feel a sense of social responsibility to support students; thus, perhaps the implications of this study may resemble support from faculty on students’ level of commitment such that female STEM students are likely to be more strongly affected by faculty support.

The present study examined three types of support: peer, faculty, and parental support. Because underrepresented groups, such as women, face negative stereotypes and a chilly climate in STEM fields, it may be the case that women are affected differently than men when receiving support by these various groups. Based on the reviewed literature, the following hypotheses were tested in the present study.

Hypothesis 5: Gender will moderate the relationship between peer (*H5a*), faculty (*H5b*), and parental (*H5c*) support and academic engagement such that the relationship between support type and academic engagement will be stronger for women than for men majoring in STEM.

Hypothesis 6: Gender will moderate the relationship between peer (*H6a*), faculty (*H6b*), and parental (*H6c*) support and commitment to major such that the relationship between support type and commitment to major will be stronger for women than for men in STEM.

The Present Study

Although there appears to be initial interest in pursuing education and careers in STEM, it seems that students are choosing to leave these fields during postsecondary education, contributing to what has been deemed as the STEM leaky pipeline (Alper & Gibbons, 1993; Metcalf, 2010). Due to this phenomenon, there has been a call to study variables that can increase retention within STEM fields, especially among minority groups such as women, who face a chilly climate associated with negative stereotypes and discrimination in these fields (Walton et al., 2015). Because women can often face these negative environments in STEM, it was expected in the present study that gender would act as a moderator of the relationships between the predictor variables (i.e., sense of belonging, grit, and support systems) and the outcome variables (i.e., academic engagement and commitment to major) such that the relationships would be stronger for women than for men. This study was intended to contribute to the existing literature on STEM students in order to provide possible solutions to the leaky pipeline and chilly climate phenomena endured by minority groups within STEM fields.

Method

Participants

The original sample consisted of 473 students attending university in Northern California. Criteria to participate in the study included that participants had to be majoring in STEM and be over the age of 18 at the time of data collection. A large number of participants were removed from the data prior to analysis due to not meeting the criteria or had a large amount of missing data. As a result, the final sample consisted of 254 undergraduate STEM students. Participant demographic information is reported in Table 1.

Table 1

Demographic Characteristics of Participants

Variable	*n*	%
Gender		
Male	154	62.3%
Female	93	37.7%
Ethnicity		
White	47	19.0%
African American	4	1.6%
Asian	113	45.6%
Latino/a	46	18.5%
Native American	2	0.7%
Multiracial	18	7.3%
Other	18	7.3%
STEM Major		
Science	88	34.6%
Technology and Engineering	151	59.5%
Mathematics	15	5.9%

Note. N = 247-254.

The sample consisted of 62.3% male and 37.7% female undergraduates. The age of participants ranged from 19 to 39 (*M* = 22.49, *SD* = 3.04). Regarding ethnicity, most participants identified as Asian (45.6%), followed by White (19.0%) and Latino/a (18.5%). In terms of academic STEM major, 59.5% of students were majoring in technology and engineering fields (e.g., electrical engineering, computer science, industrial technology), 34.6% in science fields (e.g., biology, chemistry, health science), and 5.9% in mathematical fields (e.g., applied mathematics, economics, statistics).

Measures

Academic Engagement

Student engagement in academic work can be defined as the involvement and effort exerted into learning and understanding the knowledge and skills the academic field is intended to promote (Lamborn et al., 1992). Academic engagement was measured by utilizing a university adaptation of the Utrecht School Engagement Scale (UWES) by Schaufeli et al. (2002), which was modified to be applicable to gauge overall interest in one's academic experience. Ten statements were used to assess academic engagement regarding the participant's major. Participants were instructed to indicate the degree to which they agreed or disagreed on each statement regarding their experience within their academic major on a 5-point Likert scale (1 = *Strongly disagree*, 5 = *Strongly agree*). Sample items included "In my major, when I run into a difficult question, I try even harder" and "I feel excited about attending my classes." Responses were averaged to obtain a composite score. Higher scores demonstrated more engagement within one's academic major. Cronbach's alpha was .73, indicating high reliability.

Commitment to Major

Commitment can be defined as the desire to stay involved in order to achieve an interesting and meaningful experience or long-term goal (Sheard & Golby, 2007). The Academic Commitment Scale (Human-Vogel & Rabe, 2015) was used and adapted to assess commitment to major. Commitment to one's major was measured with five items, and participants were asked to indicate the degree to which they agreed or disagreed on each statement using a 5-point Likert scale (1 = *Strongly disagree*, 5 = *Strongly agree*). Sample items included "I am proud to be in my major" and "I am glad that I enrolled in my current major over the other majors I considered." Responses were averaged to obtain a composite score. Higher scores indicated stronger commitment to academic major. Cronbach's alpha was .87, indicating high reliability.

Sense of Belonging

In an academic context, sense of belonging can be defined as a student's personal belief that their presence and contributions are valued and that they are an accepted member of their academic community (Good et al., 2012). Items from the Sense of Belonging to Math scale developed by Good et al. (2012) were modified to be applicable to a general academic setting. Participants were asked to respond to seven items regarding their perceived sense of belonging in their respective major by indicating the degree to which they agreed or disagreed with each statement through a 5-point Likert scale (1 = *Strongly disagree*, 5 = *Strongly agree*). Sample items included "I feel accepted in my major classes" and "I feel I am part of my major." Responses were averaged to obtain a composite score, and higher scores indicated higher levels of belongingness. Cronbach's alpha was .88, indicating high reliability.

Personality Trait Grit

The personality trait grit refers to the perseverance and passion for long-term goals (Duckworth et al., 2007). In this study, the Short Grit Scale (Grit-S) developed by Duckworth and Quinn (2009) was utilized and modified to reflect an academic setting. Participants rated six statements on a 5-point Likert scale (1 = *Not like me at all*, 5 = *Very much like me*), indicating the degree to which each statement applied to them. Sample items included "I am easily distracted by new projects and ideas" (reverse coded) and "I set goals but later choose to pursue different ones." There were originally six items, however, one item was removed in order to increase reliability. With five items, Cronbach's alpha was .61, indicating moderately low reliability. Responses were averaged to obtain a composite score. Higher scores indicated stronger grit levels.

Support Systems: Peers, Faculty, Parents/Guardians

Support systems can be defined as seeking help through any means of communication in times of distress, providing psychological assistance to the individual by acting as an external coping resource that can reduce stress-related impediments within academic fields (Gottlieb, 1979; Rosenthal et al., 2011). In this study, support systems were examined from three separate sources: peers, faculty, and parents/guardians. For this study, the Student/Peer Measure and Student/Faculty Measure developed by Hoffman et al. (2002) were modified into statements pertaining to the three different support systems.

Participants were instructed to rate statements on a 5-point Likert scale (1 = *Strongly disagree*, 5 = *Strongly agree*), indicating the degree to which each item applied to them. Five items were used to assess perceived support from peers. Sample items included "My peers help me find ways to resolve problems in college (academic, social, etc.)" and "My peers do not care whether I do well in my major or not" (reverse coded). Cronbach's alpha indicated good reliability (α = .72). Perception of support from faculty was assessed by eight items, including sample items such as "I am able to openly discuss my plans about the future (e.g., jobs, graduate school) with my professor" and "My professors are empathetic towards me." Cronbach's alpha was .76, indicating high reliability. Perceived support from parents/guardians was assessed by six items, including "I feel comfortable talking to my parents/guardians about my academic problems" and "My parents/guardians provide emotional support." Cronbach's alpha was .74, indicating good reliability. Three separate composite scores were created by averaging all response items pertaining to each type of support system. The higher the scores, the more support students felt they received from peers, faculty, and parents/guardians, for each variable, respectively.

Demographic Information

Participants were asked to answer questions regarding their demographic information. These questions encompassed gender, age, ethnicity, and current academic major.

Procedure

The survey was distributed in person via paper questionnaires. Professors of targeted STEM majors were contacted in order to collect data from classes of major core curriculums. If professors gave consent to use their students for the study, the research team went to their class to collect data. Potential participants were given a consent form which provided the purpose of the study, potential risks and benefits associated with the study, measures taken to respect confidentiality, as well as contact information if participants had any further questions. The consent form stated that the study would take approximately 15 minutes to complete and that the study would examine the participant's academic experiences. Participants were informed that their participation in the study was entirely voluntary and were given the choice to take part in the study or not. Those who did not consent to participate in the study were thanked and were not given the survey. Those who gave consent to participate in the study were given the questionnaire and instructed to complete the survey.

Consenting participants were first asked to list their current academic major. Next, participants were asked to answer a series of questions regarding their personality in an academic setting followed by statements about their academic engagement, support (i.e., faculty, peers, and parents/guardians), sense of belonging, and commitment to their academic major. The last section consisted of demographic questions. Once finished with the questionnaire, participants were thanked for their time and were allowed to leave. All responses were entered into the Statistical Package for Social Sciences (SPSS) Version 25 and analyzed by utilizing Pearson correlations and hierarchical multiple regressions.

Results

Descriptive Statistics

The means and standard deviations for the measured variables are displayed in Table 2. Participants reported moderately high levels of sense of belonging (*M* = 3.80, *SD* = 0.73). This shows that, in general, participants felt like they belonged in their academic community. Participants reported moderate levels of grit (*M* = 3.47, *SD* = 0.56), indicating that most participants had relatively average levels of grit.

In terms of support systems, participants reported moderately high levels of peer support (*M* = 3.72, *SD* = 0.67) and parental support (*M* = 3.80, *SD* = 0.74) and moderate levels of faculty support (*M* = 3.59, *SD* = 0.59). Participants appeared to experience the most support from parents/guardians, followed by peers, and then faculty. Overall, it seemed that participants felt supported by their peers, faculty, and parents/guardians.

Participants reported moderate levels of academic engagement (*M* = 3.54, *SD* = 0.51), suggesting that most participants felt engaged in their academics. Ratings of participants' commitment to their major was relatively high (*M* = 4.20, *SD* = 0.70), indicating a relatively strong perception of commitment to one's STEM major.

Pearson Correlations

Pearson correlations were calculated to examine the strength of the relationships among the measured variables. The Pearson correlations are displayed in Table 2. There was a strong and positive relationship between sense of belonging and academic engagement, $r(236) = .54$, $p < .01$, and commitment to major, $r(237) = .67$, $p < .01$, such that students who

Table 2

Means, Standard Deviations, Pearson Correlations, and Cronbach's Alphas Among the Measured Variables (N = 254)

	M	*SD*	1	2	3	4	5	6	7	8
1. Sense of belonging	3.80	0.73	(.88)							
2. Grit	3.47	0.56	.29 **	(.61)						
3. Peer support	3.72	0.67	.27 **	.09	(.72)					
4. Faculty support	3.59	0.59	.42 **	.07	.06	(.76)				
5. Parental support	3.80	0.74	.19 **	.15 *	.28 **	.05	(.74)			
6. Gender	--	--	.01	.09	.01	.07	.03	--		
7. Academic engagement	3.54	0.51	.54 **	.40 **	.09	.41 **	.15 **	.04	(.73)	
8. Commitment to major	4.20	0.70	.67 **	.26 **	.20 **	.35 **	.17 **	.10	.54 **	(.87)

Note. Reliability Coefficients (Cronbach's alpha) are in the parentheses along the diagonal.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

experienced higher levels of sense of belonging were more likely to also experience higher levels of academic engagement and commitment to their STEM major.

Results showed that the personality trait grit had a moderate and positive relationship with academic engagement, $r(241) = .40$, $p < .01$. Grit also had a moderate and positive relationship with commitment to major $r(241) = .26$, $p < .01$. These relationships suggest that STEM undergraduates who displayed more grit were more likely to show higher levels of academic engagement and commitment to their major.

There was no significant correlation between perceived support from peers and academic engagement $r(240) = .09$, $p > .05$, suggesting that regardless of support received from peers, it was not related to one's level of academic engagement. However, there was a weak and positive relationship between perceived support from peers and commitment to one's major, $r(240) = .20$, $p < .01$, indicating that those who reported greater support from peers reported higher levels of commitment to their STEM major.

Results showed that perceived support from faculty had a moderately strong and positive correlation with academic engagement, $r(237) = .41$, $p < .01$, and a moderate and positive correlation with commitment to one's major $r(237) = .35$, $p < .01$, which suggests that those who received more support from faculty were more likely to experience higher levels of academic engagement and commitment to their STEM major.

There was a weak and positive relationship between perceived support from parents/guardians with academic engagement, $r(241) = .15$, $p < .01$, and commitment to one's major, $r(241) = .17$, $p < .01$, indicating that STEM students who received more parental support were more likely to report higher levels of academic engagement and commitment to their major. Among the types of support, support from faculty had the strongest relationship with academic engagement and commitment to one's major.

There were no significant correlations between gender and sense of belonging, $r(242) = .01$, $p > .05$, grit, $r(247) = .09$, $p > .05$, peer support, $r(246) = .01$, $p > .05$, faculty support, $r(243) = .07$, $p > .05$, or parental support, $r(247) = .03$, $p > .05$. Similarly, there were no significant correlations between gender and academic engagement, $r(246) = .04$, $p > .05$, or commitment to major, $r(246) = .10$, $p > .05$.

Overall, these results indicate that STEM students who experienced higher levels of sense of belonging, grit, and support (i.e., faculty and parental) were more likely to be academically engaged. Similarly, those who experienced higher levels of sense of belonging, grit, and support (i.e., peer, faculty, and parental) were more likely to be committed to their STEM major. Gender as a moderator was not related to any of the predictor variables (i.e., sense of belonging, grit, and support systems) or the outcome variables (i.e., academic engagement and commitment to major).

Tests of Hypotheses

The present study tested hypotheses regarding whether gender would act as a moderator of the relationship between the predictor variables (i.e., sense of belonging, grit, and support systems) and academic engagement and commitment to major among STEM students. To test these hypotheses, 10 hierarchical multiple regression (MRC) analyses were conducted, with five MRC analyses predicting academic engagement and another five MRC analyses predicting commitment to a STEM major. Each MRC analysis used two steps. In each MRC analysis, one predictor variable (i.e., sense of belonging, grit, or type of support) and the moderator variable of gender were entered as the first step to examine if there were direct effects with one of the outcome variables (i.e., academic engagement and commitment to major). In the second step, the cross product of the predictor variable and gender was entered to test the moderating role of gender on the outcome variable.

Hypothesis 1 stated that gender would moderate the relationship between sense of belonging and academic engagement such that the relationship between sense of belonging and academic engagement would be stronger for women than for men majoring in STEM. Table 3 depicts the results from this analysis. The first step of the MRC analysis showed that the combined main effects of sense of belonging and gender significantly predicted academic engagement, $R^2 = .30$, $R^2_{adj} = .30$, $F(2, 238) = 50.63$, $p < .01$, accounting for 30% of the variance in academic engagement. It appeared that only sense of belonging had a significant, unique relationship with academic engagement, $\beta = .55$, $t = 10.05$, $p < .01$, such that experiencing greater belongingness was related to higher levels of academic engagement.

Table 3

Hierarchical Multiple Regression Analysis for Sense of Belonging and Gender Predicting Academic Engagement and Commitment to Major

		Engagement			Commitment		
	Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1	Belonging	.30***	.30	0.55***	.46***	.46	0.67***
	Gender			0.03			0.10*
Step 2	Belonging x Gender	.30***	.00	0.23	.46***	.00	-0.08

Note. N = 238 for Academic Engagement. N = 239 for Commitment to Major.
*p < .05, **p < .01, ***p < .001

In the second step, it was shown that there was no significant interaction between sense of belonging and gender, $\Delta R^2 = .00$, $F(1, 237) = .47$, $p = .49$. This meant that the interaction effect did not significantly account for any additional variance in academic engagement above and beyond the combined main effects of sense of belonging and gender. Overall, the results did not show that gender moderated the relationship between sense of belonging and academic engagement, thus Hypothesis 1 was not supported.

Hypothesis 2 stated that gender would moderate the relationship between sense of belonging and commitment to major such that the relationship between sense of belonging and commitment to major would be stronger for women than for men in STEM. As depicted in Table 3, results showed that the combined main effects of sense of belonging and gender significantly contributed to the prediction of commitment to one's STEM major, $R^2 = .46$, $R^2_{adj} = .46$, $F(2, 239) = 101.80$, $p < .01$, accounting for 46% of the variance in commitment to major. Both sense of belonging, $\beta = .67$, $t = 14.11$, $p < .01$, and gender, $\beta = .10$, $t = 2.04$, $p = .04$, had a significant and unique relationship with commitment to major. It appeared that higher levels of sense of belonging was related to higher levels of commitment to major. Results also showed that women had higher levels of commitment to their STEM major than did men.

The second step did not show a significant interaction between the variables, $\Delta R^2 = .00$, $F(1, 238) = .07$, $p = .80$. This result indicated that the added effect of the interaction between sense of belonging and gender was not significant and did not account for any additional variance in commitment to major above and beyond the combined main effects of sense of belonging and gender. Gender did not moderate the relationship between sense of belonging and commitment to one's STEM major. Therefore, Hypothesis 2 was not supported.

Hypothesis 3 predicted that gender would moderate the relationship between grit and academic engagement such that the relationship between grit and academic engagement would be stronger for women than for men majoring in STEM fields. The results are displayed in Table 4. In the first step of the analysis, results showed that the combined main effects of grit and gender significantly predicted academic engagement, $R^2 = .16$, $R^2_{adj} = .16$, $F(2, 243) = 23.62$, $p < .01$, accounting for 16% of the variance in academic engagement. Only grit significantly contributed to the prediction of academic engagement among STEM undergraduates, $\beta = .40$, $t = 6.83$, $p < .01$, such that grittier students were more likely to be engaged in their academics. Results of the second step did not show a significant interaction effect between the variables, $\Delta R^2 = .01$, $F(1, 242) = 2.16$, $p = .14$. This indicated that the interaction effect between grit and gender did not significantly account for any variance in academic engagement above and beyond the combined main effects of grit and gender. Gender did not moderate the relationship between grit and academic engagement. Thus, Hypothesis 3 was not supported.

Hypothesis 4 stated that gender would moderate the relationship between grit and commitment to major such that the relationship between grit and commitment to major would be stronger for women than for men in STEM. The results from this analysis are depicted in Table 4. The first step of the analysis revealed that the combined main effects of grit and gender significantly predicted commitment to major among STEM undergraduates, $R^2 = .08$, $R^2_{adj} = .08$, $F(2, 243) = 10.16$, $p < .01$, accounting for 8% of the variance in commitment to major. Only grit had a significant, unique relationship with commitment to major, β = .26, t = 4.20, p < .01, such that grittier students were more likely to be committed to their STEM major. The results of the second step showed that there was no significant interaction effect between grit and gender on commitment to major, $\Delta R^2 = .00$, $F(1, 242) = .03$, $p = .30$, indicating that the interaction effect did not significantly account for any additional variance in commitment to major above and beyond the combined main effects of grit and gender. Gender did not moderate the relationship between grit and commitment to major. Therefore, these results did not show support for Hypothesis 4.

Table 4

Hierarchical Multiple Regression Analysis for Grit and Gender Predicting Academic Engagement and Commitment to Major

		Engagement			Commitment		
	Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1	Grit	.16***	.16	0.40***	.08***	.08	0.26***
	Gender			0.01			0.08
Step 2	Grit x Gender	.17***	.01	0.63	.08***	.00	0.47

Note. N = 243, *p < .05, **p < .01, ***p < .001

It was predicted in H5a that gender would moderate the relationship between support received by peers and academic engagement such that the relationship between peer support and academic engagement would be stronger for women than for men in STEM. The results of this MRC analysis are shown in Table 5. Results from the first step of analysis showed that the main effects of peer support and gender did not significantly contribute to the prediction of academic engagement among STEM students, $R^2 = .01$, $R^2_{adj} = .00$, $F(2, 242) =$

1.33, $p = .27$. These results showed that neither peer support nor gender contributed to the prediction of academic engagement. It was also found that there was no significant interaction between these variables, $\Delta R^2 = .01$, $F(1, 241) = 1.24$, $p = .27$, indicating that gender did not moderate the relationship between peer support and academic engagement. Thus, H5a was not supported.

Table 5

Hierarchical Multiple Regression Analysis for Peer Support and Gender Predicting Academic Engagement and Commitment to Major

		Engagement			Commitment		
	Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1	Peer support	.01	.00	0.09	.05**	.04	0.20**
	Gender			0.05			0.10
Step 2	Peer support x Gender	.02	.01	-0.45	.05**	.00	0.07

Note. $N = 242$, $*p < .05$, $**p < .01$, $***p < .001$

In H6a, it was predicted that the relationship between peer support and commitment to one's major would be moderated by gender such that the relationship between peer support and commitment to major would be stronger for women than for men in STEM. The results of this analysis are shown in Table 5. Results from the first step indicated that the main effects of peer support and gender significantly contributed to the prediction of one's commitment to their STEM major, $R^2 = .05$, $R^2_{adj} = .05$, $F(2, 242) = 6.58$, $p < .01$, accounting for 5% of the variance in commitment to major. Only peer support had a significant, unique relationship with commitment to major, $\beta = .20$, $t = 3.23$, $p < .01$, such that experiencing greater perceived peer support increased the likelihood that students were committed to their STEM major. The results of the second step revealed that there was no significant interaction between peer support and gender, $\Delta R^2 = .00$, $F(1, 241) = .03$, $p = .87$. The interaction effect explained no additional variance in commitment to major above and beyond the combined main effects of peer support and gender. Gender did not moderate the relationship between peer support and commitment to major. Therefore, H6a was not supported.

It was predicted in H5b that gender would moderate the relationship between support received by faculty and academic engagement such that the relationship between faculty support and academic engagement would be stronger for women than for men majoring in STEM. The results of this analysis are shown in Table 6. Results from the first step showed that the main effects of faculty support and gender significantly contributed to the prediction of academic engagement, $R^2 = .18$, $R^2_{adj} = .18$, $F(2, 239) = 26.13$, $p < .01$, accounting for 18% of the variance. Only faculty support had a significant, unique relationship with engagement, $\beta = .42$, $t = 7.20$, $p < .01$, such that greater perceived levels of faculty support were related to higher levels of academic engagement. The second step of the analysis did not show a significant interaction between faculty support and gender, $\Delta R^2 = .00$, $F(1, 238) = .00$, $p = .94$. This result indicated that the interaction effect did not significantly account for any additional variance in academic engagement above and beyond the combined effects of faculty support and gender. Overall, H5b was not supported as gender did not moderate the relationship between support received by faculty and academic engagement among STEM undergraduates.

Table 6

Hierarchical Multiple Regression Analysis for Faculty Support and Gender Predicting Academic Engagement and Commitment to Major

		Engagement			Commitment		
	Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1	Faculty support	.18***	.18	0.42***	.13***	.12	0.35***
	Gender			0.01			0.08
Step 2	Faculty support x Gender	.18***	.00	-0.08	.13***	.00	-0.30

Note. N = 239, *p < .05, **p < .01, ***p < .001

It was expected in H6b that gender would moderate the relationship between support received by faculty and commitment to one's major such that the relationship between faculty support and commitment to major would be stronger for women than for men in STEM. The results are displayed in Table 6. The first step of the analysis showed that the main effects of faculty support and gender significantly contributed to the prediction of commitment to major, R^2 = .13, R^2_{adj} = .12, $F(2, 239) = 17.79$, $p < .01$, accounting for 13% of the variance in commitment to major. Only support received from faculty had a significant, unique relationship with commitment to major, β = .35, t = 5.72, $p < .01$, such that students who experienced greater levels of support from faculty were more likely to be committed to their STEM major. The results of the second step did not show a significant interaction between faculty support and gender, indicating that the interaction effect explained no additional variance in commitment to major above and beyond the combined effects of faculty support and gender, ΔR^2 = .00, $F(1, 238) = .50$, p = .48. Gender did not moderate the relationship between faculty support and commitment to major, thus H6b was not supported.

It was predicted in H5c that the relationship between parental support and academic engagement would be moderated by gender such that the relationship between parental support and academic engagement would be stronger for women than for men majoring in STEM. The results of this analysis are illustrated in Table 7. The results of first step showed that the main effects of parental support and gender significantly contributed to the prediction of academic engagement, $R^2 = .03$, $R^2_{adj} = .01$, $F(2, 243) = 3.45$, $p = .03$, accounting for 3% of the variance in academic engagement. Only parental support had a significant, unique relationship with academic engagement such that students who experienced more support from parents/guardians were more likely to be engaged in their academics, $\beta = .16$, $t = 2.54$, $p = .01$.

Table 7

Hierarchical Multiple Regression Analysis for Parental Support and Gender Predicting Academic Engagement and Commitment to Major

		Engagement			Commitment		
	Predictor	R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1	Parental support	.03*	.02	0.16*	.04**	.03	0.17**
	Gender			0.04			0.10
Step 2	Parental support x Gender	.04*	.01	-0.73	.04**	.00	-0.14

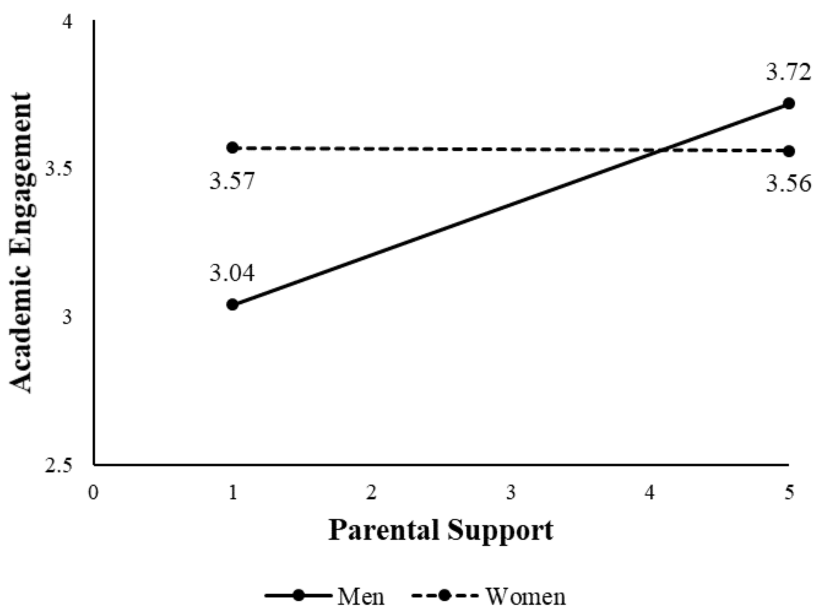
Note. $N = 243$, $*p < .05$, $**p < .01$, $***p < .001$

The results of the second step did not show a significant interaction effect between the variables, indicating that the interaction effect explained no additional variance in academic engagement above and beyond the combined effects of parental support and gender, ΔR^2 =

.01, $F(1, 242) = 3.56$, $p = .06$. Thus, H5c was not supported. However, these results showed that gender tended to moderate the relationship between parental support and engagement. Further analysis was conducted utilizing linear regression analysis for men and women. Figure 1 shows that there was no relationship between parental support and academic engagement for women, but parental support was positively related to academic engagement for men in STEM such that the more parental support men received, the more likely they were to experience academic engagement.

Figure 1

Regression Lines Depicting the Relationship Between Parental Support and Academic Engagement for Men and Women in STEM



It was expected in H6c that gender would moderate the relationship between parental support and commitment to major such that the relationship between parental support and commitment to major would be stronger for women than for men in STEM. The results of this analysis are displayed in Table 7. The results of the first step showed that the main effects of parental support and gender significantly contributed to the prediction of commitment to major among STEM students, R^2 = .04, R^2_{adj} = .03, $F(2, 243) = 4.81$, $p < .01$, accounting for 4% of the variance in commitment to major. Only parental support had a significant, unique relationship with commitment to major, $\beta = .17$, $t = 2.67$, $p < .01$, such that greater perceived parental support was related to higher levels of commitment to one's STEM major. Results from the second step did not show a significant interaction effect between the variables, indicating that the interaction effect explained no additional variance in commitment to major above and beyond the combined effects of parental support and gender, $\Delta R^2 = .00$, $F(1, 242) = .13$, $p = .72$. Gender did not moderate the relationship between parental support and commitment to one's STEM major. Thus, H6c was not supported.

Overall, the results showed that gender was not a moderator of the relationships between the predictors (i.e., sense of belonging, grit, and support systems) and outcome variables of academic engagement and commitment to major among undergraduate STEM students. Despite not yielding significant results, it appeared that gender tended to moderate the relationship between parental support and academic engagement such that men who received more parental support were more likely to experience academic engagement. However, there was no relationship between parental support and academic engagement for women. Additionally, sense of belonging, grit, and support from faculty and parents/guardians were found to be important variables in predicting academic engagement. Similarly, sense of belonging, grit, and support from peers, faculty, and parents/guardians were found to be important variables in predicting students' commitment to their STEM major.

Discussion

In recent years, the United States has seen an increase in STEM enrollment across college campuses due to the growing demand for skilled workers in STEM (Noonan, 2017). Despite the increase in enrollment to pursue degrees in STEM, students have been leaving these fields during postsecondary education in what has been coined as the STEM leaky pipeline phenomenon (Alper & Gibbons, 1993). Minority groups such as women tend to face a chilly climate associated with negative stereotypes and discrimination, causing them to leave STEM fields at a higher rate than their male peers (Metcalf, 2010; Walton et al., 2015). Past studies have examined factors such as academic engagement and commitment in an effort to increase retention and graduation rates in STEM fields in order to combat the leaky pipeline.

In the present study, the relationships between sense of belonging, personality trait grit, and support systems (i.e., peers, faculty, and parents/guardians) and academic engagement and commitment to major were examined. Due to the discrimination and chilly climate women often face in STEM, the strengths of these relationships were thought to differ as a function of gender. Although past studies have examined the relationships among these variables, very few studies have looked at gender as a moderator, especially in educational STEM environments. Thus, this study examined if gender would act as a moderator of the relationships between the predictor variables (i.e., sense of belonging, grit, and support systems) and the outcome variables (i.e., academic engagement and commitment to major).

Summary of Findings

Hypothesis 1 stated that gender would moderate the relationship between sense of belonging and academic engagement such that the relationship between sense of belonging and academic engagement would be stronger for women than for men majoring in STEM. Results did not show an interaction between sense of belonging and gender on academic engagement. Thus, Hypothesis 1 was not supported. However, it was found that experiencing higher levels of belongingness was related to higher levels of academic engagement.

Hypothesis 2 proposed that gender would moderate the relationship between sense of belonging and commitment to major such that the relationship between sense of belonging and commitment to major would be stronger for women than for men in STEM. Although results showed that higher levels of sense of belonging was related to higher levels of commitment to major, there was no significant interaction effect between sense of belonging and gender on commitment to major. Thus, Hypothesis 2 was not supported.

Hypothesis 3 stated that gender would moderate the relationship between personality trait grit and academic engagement such that the relationship between grit and academic engagement would be stronger for women than for men majoring in STEM fields. Although it was found that grittier students were more likely to be engaged in their academics, results did not show an interaction between grit and gender on academic engagement. Thus, Hypothesis 3 was not supported.

Hypothesis 4 proposed that gender would moderate the relationship between grit and commitment to major such that the relationship between grit and commitment to major would be stronger for women than for men in STEM. Results showed that grittier students were more likely to be committed to their STEM major, but there was no interaction between grit and gender on commitment to major. Hence, Hypothesis 4 was not supported.

Hypothesis 5 stated that gender would moderate the relationship between peer (H5a), faculty (H5b), and parental (5Hc) support and academic engagement such that the relationship between support systems and academic engagement would be stronger for women than for men majoring in STEM. Results did not show an interaction between peer support and gender on academic engagement. Thus, H5a was not supported. Although results revealed that experiencing greater perceived support from faculty and parents/guardians increased the likelihood that students would be more academically engaged, there was no significant interaction between faculty support nor parental support and gender on academic engagement. Therefore, H5b and H5c were not supported.

Although H5c was not supported, results showed that gender tended to moderate the relationship between parental support and academic engagement. Further analysis showed that support from parents/guardians did not have an impact on academic engagement for female students, however, parental support was positively related to male students such that the more parental support male STEM students received, the more likely they were to experience academic engagement. This finding was the opposite of what was hypothesized in H5c. Perhaps male students received support from a male parental figure also in a STEM field, which may have caused male undergraduates to be more affected by parental support, unlike female undergraduates. However, this interpretation is speculative, and participants were not asked to indicate if support was given to them by a male or female parental figure.

Hypothesis 6 proposed that gender would moderate the relationship between peer (H6a), faculty (H6b), and parental (H6c) support and commitment to major such that the relationship between support systems and commitment to major would be stronger for women than for men in STEM. Although results showed that greater levels of support received by peers, faculty, and parents/guardians increased the likelihood that students would be more committed to their STEM major, there was no interaction among support systems and gender on commitment to major. Thus, H6a, H6b, and H6c were not supported.

Overall, none of the proposed hypotheses were supported. The lack of support for these hypotheses may be due to the nature of the participant pool. The participant pool was sampled from a public college in the California Bay Area, which has a multitude of technology-based employers and potential STEM opportunities for students. Participants had reported relatively high levels of commitment to major, indicating that they had a relatively strong perception of commitment to their STEM major. In fact, women had reported higher levels of commitment to their STEM major than men. In addition, participants were from a university that emphasized diversity, equity, and inclusion, which was reflected in the present sample consisting of 38% female participants and 81% ethnic minority students. It may have been the case that both male and female students felt that they had adequate representation and a supportive environment while pursuing a STEM degree; thus, gender did not affect the relationships between the predictor variables and academic engagement or commitment to major within the sample pool.

Additionally, Hypotheses 3 and 4 may not have been supported due to the relatively low reliability of the personality trait grit scale. Future studies may want to ensure higher Cronbach's alpha for grit. Regarding H5c, because women had higher levels of commitment to their major than men, perhaps support received from parents/guardians did not play a major role in their academic engagement. That is, regardless of parental support, women may have been more engaged in their academic work because they were more committed to their major. It may be the case that women did not need parental support to become academically engaged, unlike men.

Theoretical Implications

Based on Hundera (2014) who found that gender moderated the relationship between situational factors and turnover intention among academic staff such that the relationship between situational factors (i.e., role stress and job satisfaction) and turnover intention was stronger for women than for men, this study hypothesized that gender would also moderate the relationships between sense of belonging and academic engagement and commitment to major. However, the findings of the current study were inconsistent with Hundera. Although experiencing a lack of engagement or commitment can cause students to leave their major (Gasiewski et al., 2012; Wessel et al., 2008), it may be the case that intention to leave a career in academia is not comparable to being engaged or committed to a STEM major.

Hundera (2014) had reasoned that because female academic staff experienced an unfavorable working environment, in which they were paid less and held lower status jobs as compared to their male counterparts, women would experience lower job satisfaction and stronger intention to leave their job. In the present study, participants were receiving an education from an institution that embraced diversity, equity, and inclusion, and resided in an area where there was an abundance of STEM opportunities. Perhaps this setting created a more favorable, diverse academic environment, unlike in Hundera's study. Because of this positive environment, female students may not have experienced a chilly climate in their STEM field, which is perhaps why gender did not act as a moderator. However, because student perception of school climate was not measured, this interpretation is speculative. Additionally, due to this study examining undergraduates, Hundera's reasoning that gender acted as a moderator as a result of unequal pay and lower status among academic staff may not have been relevant factors among students.

Because there had not been any prior literature that examined gender as a moderator of the relationships between personality trait grit and academic engagement and commitment to major among STEM students, the present study sought to examine these relationships. In a study that examined gender as moderator of the relationships between personality traits and facets of job satisfaction, Knežević et al. (2021) found that women high in conscientiousness were less likely to experience job satisfaction regarding material (e.g., gifts, bonuses, incentive travel) and non-material (e.g., recognition, flexible working hours) work benefits than men. Knežević et al. found that women generally tended to score higher on the personality dimension of conscientiousness and reasoned that there was a discrepancy in women's expected and realized rewards in the workplace, which led female employees to feel dissatisfied if they believed they were not being adequately rewarded for their work, especially when they were high on conscientiousness.

Given that conscientiousness has been shown to overlap with grit (Credé et al., 2017), it was reasoned that if female STEM students high on grit believed that they were not receiving adequate achievements and academic rewards in equal return for their efforts, their academic engagement and commitment to major would be more affected than that of their male peers who may not experience the same negative stereotypes and chilly climate that women face in STEM. Thus, it was hypothesized in this study that gender would also moderate the relationship between grit and academic engagement and commitment to major. However, this was not the case, and the findings from this study were inconsistent with Knežević et al. (2021).

Knežević et al. (2021) utilized a specific sample, surveying employees from a monopolistic, highly bureaucratic organization in a small town in Serbia, thus, their findings may not be generalizable to the present study. Although they sampled those in the energy sector, the monopolistic workplace setting may not be comparable to an academic environment, especially regarding a broad range of STEM students in comparison to adults working in an energy complex. In addition, though job satisfaction involves a positive perception regarding one's work experience, which may be comparable to the active involvement associated with engagement or the meaningful experience associated with commitment, it may not be comparable to academic engagement or commitment to one's major. Similarly, it may also be the case that even though grit and conscientiousness share the same facet of perseverance (MacCann et al., 2009), they are not interchangeable personality traits.

The findings that gender did not moderate the relationship between support systems (i.e., peers, faculty, and parents/guardians) and academic engagement and commitment to major are not consistent with past research. Bystydzienski et al. (2015) found that female engineering students were more at risk to leave their major if they experienced a lack of support from peers and faculty. Findings from Clark et al. (2016) also suggested that faculty support led to higher levels of engagement among women in STEM, proposing that support through faculty advising could provide reassurance and acceptance. They reasoned that faculty support was critical for women because it helped to create greater compatibility between students' gender and STEM field, protecting them against negative stereotypes and expectations minorities may face in STEM. Because men may not experience the same chilly climate that women face, their own gender-STEM compatibility may not be affected by perceived faculty support, unlike women. Clark et al.'s participants were graduate students in the life sciences; thus, their findings may not apply to undergraduate students. It may be the case that because graduate students have more opportunities to work with and spend more time with faculty, faculty support had more of an impact on graduate student engagement in comparison to undergraduate STEM students.

Results from the present study indicated that gender tended to moderate the relationship between parental support and academic engagement such that greater support received from parents/guardians was associated with more engagement in academics for men, but not for women. These findings were congruent with Suan and Nasurdin (2016), who found that gender moderated the relationship between supervisor support and work engagement such that the relationship was stronger for men than for women among hotel staff in Malaysia. It may be the case that support received from supervisors was similar to receiving support from an authority figure, such as a parent/guardian. Suan and Nasurdin reasoned that this relationship was stronger for men due to the larger percentage of male supervisors in the Malaysian hotel industry. Perhaps because men make up a majority of the STEM industry, male students received parental support from a male parent/guardian also involved in a STEM field. Thus, it may be the case that parental support had more of an impact on male students. However, this interpretation is speculative, and future studies should further examine if having a parent/guardian of the same gender who is also involved in STEM contributes to the potential moderating role of gender on the relationship between parental support and academic engagement.

Although gender was not found to act as a moderator, the results of present study showed additional evidence supporting that sense of belonging, grit, and certain types of support (i.e., faculty and parental) were related to higher levels of academic engagement. These findings are consistent with previous research that found that sense of belonging contributed to the academic engagement of STEM students (Wilson et al., 2015) and evidence that grittier students experienced higher levels of engagement (Hodge et al., 2018). Although the current study did find that faculty and parental support were related to academic engagement, it did not find that peer support was related to academic engagement, which was not consistent with J. J. L. Chen (2005) who found that receiving support from peers, teachers, and family increased academic engagement among students. However, J. J. L. Chen conducted the study on adolescents in Hong Kong, and many of the participants were identified as poor achievers from low socioeconomic backgrounds, in contrast to the present study on undergraduate STEM students.

It may be the case that college students are not comparable to adolescents in school, as primary school children spend the entire school day with their peers, potentially causing them to be more affected by peer support in comparison to university students who may have only a few classes together. Perhaps because college students may not spend as much time around their peers as adolescent students, their academic engagement was not affected by perceived peer support. The findings that support received from faculty and parents/guardians were related to academic engagement were also consistent with findings from Bryson and Hand (2007) who found that university students who experienced higher levels of support from faculty were more likely to be academically engaged.

Similarly, the present study further established that sense of belonging, grit, and support systems (i.e., peers, faculty, and parents/guardians) were related to higher levels of commitment to major among STEM students. This is in line with previous research, as Hausmann et al. (2009) found that sense of belonging led to higher levels of commitment among college students. There were gaps in the literature regarding the relationship between grit and commitment to major, however, the present study's findings that higher levels of grit were related to higher levels of commitment to major are consistent with Tang et al. (2019) who found that grit was positively associated with academic engagement among primary school students. In terms of support, the finding that peer, faculty, and parental support was related to higher levels of commitment among students is also consistent with past studies. For instance, Klem and Connell (2004) found that teacher support contributed to higher levels of commitment among primary school students and Hackman and Dysinger (1970) demonstrated evidence suggesting that the more parental support received, the more likely first-year college students were committed to their education. Thus, sense of belonging, personality trait grit, and support from various sources are important predictors of academic engagement and commitment to major among STEM students.

Practical Implications

Although the results of this study did not show support for the hypotheses stating that gender would act as a moderator of the predictor variables (i.e., sense of belonging, grit, and support systems) and academic engagement and commitment to major, the results of the study have several practical implications. First, the present study showed that sense of belonging, grit, and certain types of support were positively related to academic engagement and commitment to major, which are important factors in combating the STEM leaky pipeline. Due to these findings, academic institutions can increase STEM students' sense of belonging and perceived support, as these can increase the likelihood that students will experience higher levels of academic engagement and commitment to their major.

Having STEM departments engage in practices to increase student sense of belonging and create a supportive community might involve employing mentoring programs or creating groups that foster a positive learning environment rather than a competitive one as well as ensuring that all students have equal access to these resources. Academic institutions can offer more collaborative spaces or events focused on providing support and opportunities for students to interact and connect with other peers and faculty, which could increase perceptions of peer and faculty support and sense of belonging among STEM students. Colleges could promote and encourage peer mentoring programs, study groups, and other collaborative opportunities that can help students bond with their peers both in and outside of classes. Additionally, educational institutions can make an effort to have a diverse faculty to increase representation and provide students with STEM role models who share similar social identity groups, such as gender, which can facilitate a more inclusive environment (Maranto & Griffin, 2011).

Good et al. (2012) proposed that sense of belonging in learning environments protects against stereotype threat, recommending that faculty can engage in teaching practices that emphasize improvement through hard work and avoid using language that could imply bias, such as telling students that "some people are math people and some people are not" (p. 715), which may reinforce stereotypes. Perhaps academic institutions can educate and employ bias training for faculty to be aware of any implicit biases they might have and reduce any type of stereotyping or biased judgements when interacting with students. Furthermore, professors can make an effort to learn students' names and encourage class participation, which have been found to increase sense of belonging in students (Wilson et al., 2015). Creating a more personalized educational environment can also increase perception of faculty support, resulting in higher levels of academic engagement and commitment (Klem & Connell, 2004).

Colleges may also consider assessing students' opinions to better provide the necessary resources to strengthen belongingness and perceived support. Wilson et al. (2015) recommend holding interventions to address the negative feelings students may experience regarding acceptance in their academic community, as interventions that increased awareness about the importance of belonging and connecting to the community that also shifted the "struggles with fit, acceptance, and belonging from a unique struggle for the individual student to a normal experience for all students" (p. 19) were able to stabilize sense of belonging among students. Similarly, academic institutions can provide resources in case students feel isolated. Perhaps colleges can offer trainings for faculty and student leaders to be able to identify and address students who may be struggling with lack of belongingness or support in order to proactively manage their concerns.

Additionally, perhaps colleges can encourage parents/guardians to become more involved, providing them with resources on how to effectively offer support at or from home.

Although not all parents/guardians may be able to provide financial or physical support, they can provide intangible support, such as emotional support (e.g., listening, giving advice) (Fingerman et al., 2009). Universities may consider holding orientations to educate parents/guardians on the importance of parental support and how to provide emotional assistance to their children. Perhaps parents/guardians can be encouraged to show interest in their child's major and academic pursuits and listen to any additional problems a student might face while attending college. Ensuring that parent-student interactions involve positive support and communication in addition to promoting participation in both school and non-school activities can help empower and motivate students (Mata et al., 2018).

Strengths, Limitations, and Future Directions

One strength of this study is that it is one of few studies that examined gender as a moderator of the relationships between the predictor variables (i.e., sense of belonging, grit, and support systems) and academic engagement and commitment to major among STEM students. Although none of the hypotheses of this study were supported, the present study added to STEM education research by addressing a gap in the literature and providing preliminary insight into how gender might act as a moderator among these variables. Additionally, the present study contributed to the literature on antecedents of academic engagement and commitment to STEM major.

Despite the strengths of this study, there were several limitations. As previously mentioned, the participant pool was composed of students receiving an education from the California Bay Area, which contains many technology-based companies that provide many opportunities for those in STEM. Therefore, the environment for participants may have been more progressive and inclusive than other areas, and thus these results may not be generalizable to other undergraduates receiving a STEM education from different areas. Perhaps female undergraduates did not experience a chilly climate in their STEM field, which affected how gender might act as a moderator. Future research should consider examining student perception of academic climate to assess whether students experienced a positive and inclusive environment. Additionally, 62.3% of the sample were male students. Perhaps if this study included more women in the participant pool, gender may have acted as a moderator. Future studies may want to ensure a more equal representation of men and women. Similarly, this study had a low number of participants majoring in mathematical fields, as compared with science or technology and engineering. Due to these limitations, this study's findings may apply to only this particular sample and may not be generalizable to other populations. Future research may want to utilize a more diverse pool of participants regarding geographical location, campus climate, gender, and type of STEM major.

Due to the non-experimental nature of the study, self-report measures were utilized to measure the studied variables in the present study. Self-reported measures are beneficial for gaining insight into how participants perceived their own feelings and experiences in their major, however, using them may have also served as a limitation. In the study, data were collected from core STEM courses. Although there was no benefit (e.g., extra credit) for completing the survey, participants may have felt pressured to respond with favorable answers in order to seem more engaged or committed in their major than in actuality because surveys were distributed during class time. Future studies may want to obtain a more randomized STEM participant pool, rather than targeting a few select STEM courses.

Additionally, future studies should focus on obtaining participants from a wide array of STEM majors. Due to the present study obtaining participants from core STEM courses, there was a disproportionate amount of certain STEM majors (e.g., electrical engineering) as compared to others. Future research should also consider including fields that have been ambiguously included within the STEM definition, such as psychology (Bray, 2010; Carmichael, 2017), which were not included in the present study. Similarly, gender disparities within certain STEM fields, such as why science fields (e.g., biology) are more balanced in terms of gender representation as compared to other STEM fields (e.g., computer science, physics), should be examined to fully understand the nuances in gender differences within STEM (Cheryan et al., 2017).

Another limitation was the moderately low reliability of the grit measure. As previously mentioned, future studies may want to ensure higher Cronbach's alpha for the personality trait grit. In this study, the Short Grit Scale (Grit-S) developed by Duckworth and Quinn (2009) was utilized, and only six items were selected and modified to fit the academic setting of the present study. Perhaps the modification of items may have resulted in a moderately low reliability score. Future studies may want to consider using the full 8-item Grit-S, the original 12-item self-report measure of which the Grit-S was adapted from (i.e., Grit-O), or a grit scale that has already been adapted for an educational setting.

Additional studies may also consider employing more specificity in the survey questionnaire. The present study did not include indications on whether participants received support from peers, faculty, or parents/guardians with the same gender identity as the student, or whether their parent/guardian was also involved in STEM. More research should be conducted regarding the specificities of parental support, such as the potential STEM status of parents/guardians, and whether there are potential gender differences in peer, faculty, or parent/guardian-student interactions. It may be the case that these factors affect how gender moderates the relationships among the researched variables. Future studies may also want to consider examining other moderators such as race, as racial minorities have also been found to endure a chilly climate and are at risk to leak out of STEM at higher rates than their White male peers (Wilson et al., 2015).

Conclusion

The goal of this study was to examine if gender would act as a moderator of the relationships between the predictor variables (i.e., sense of belonging, grit, and support systems) and academic engagement and commitment to major among STEM students. The study did not find that gender acted as a moderator of the relationships between these variables. However, it was found that there was a tendency for gender to act as a moderator of the relationship between parental support and academic engagement, indicating that the greater support men received from parents/guardians, the more likely men would feel more academically engaged, but there was no relationship between these variables for women. Results of the present study indicate that academic institutions can still encourage sense of belonging and support in order to increase academic engagement and commitment among students in STEM fields. This study contributes to the gap in literature by examining the role of gender as a moderator among factors influencing engagement and commitment in STEM education. Future research should be conducted in order to fully understand the role of gender among these relationships. Because careers in STEM appear to be growing in demand, it would be beneficial to look for ways to combat the leaky pipeline and chilly climate, especially for minorities such as women in STEM.

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Appendix

STEM Survey

Demographic Items

1. Please list your current major or write "undeclared."

2. What is your biological sex?
   - Male
   - Female
   - Other

3. What is your race/ethnicity? Choose all that apply.
   - White
   - African American
   - Asian (e.g., Pacific Islander)
   - Latino/a
   - Native American
   - Other

4. What is your age?

Scale Items

Grit

1. I am easily distracted by new projects and ideas. *

2. Setbacks do not discourage me.

3. I am a hard worker.

4. I set goals but later choose to pursue different ones. *

5. I have difficulty maintaining my focus on projects that take more than a few weeks to complete. *

6. I finish whatever I begin.

Academic Engagement

7. I try hard in my major.

8. When I am in my major classes, I engage in behaviors that make it seem like I am working. *

9. When I get stuck on a concept in my major, I know I will master it in the end.

10. I pay attention when a new subject in my major is presented.

11. I participate in class discussions in my major.

12. When I am in my classes, time goes by slowly. *

13. In my major, when I run into a difficult question, I try even harder.

14. When I am doing my work in my classes, I feel interested.

15. When in my classes, I feel engaged.

16. I feel excited about attending my classes.

Support: Faculty

17. My professors in my classes do not care about my learning progress. *

18. I am able to openly discuss my plans about the future (e.g., jobs, graduate school) with my professors.

19. When other students or I do not understand the concepts and materials from class, our professors are available outside of class to explain and provide help.

20. When I do not understand my coursework, I feel uncomfortable asking my professors for help. *

21. My professors acknowledge my participation in class discussions.

22. My professors ignore students' opinions. *

23. My professors are empathetic towards me.

24. Overall, the majority of my professors provide support to help me do well in college.

Support: Peers

25. My peers help me find ways to resolve problems in college (academic, social, etc.).

26. If I do not understand my coursework, I feel comfortable asking my peers for help.

27. My peers and I spend most of our time together studying.

28. My peers do not care whether I do well in my major or not. *

29. Overall, the peers who have the most influence on me provide support to help me do well in my college coursework.

Support: Parents/Guardians

30. I feel comfortable talking to my parents/guardians about my academic problems.

31. My parents/guardians show interest on how well I am doing in my classes.

32. I feel pressure from my parents/guardians to do well in college.

33. My parents/guardians have discussed with me about career plans related to my major.

34. My parents/guardians encourage me to do well in college.

35. My parents/guardians provide emotional support.

Sense of Belonging

36. I feel I am part of my major classes.

37. I feel comfortable in my major classes.

38. I do not feel connected to classmates in my major. *

39. I feel accepted in my major classes.

40. I feel comfortable in my major.

41. I feel I am part of my major.

Commitment to Major

42. I am committed to my major.

43. My major has a great deal of personal meaning for me.

44. I am proud to be in my major.

45. I enjoy discussing what I learned in my major with others.

46. I am glad that I enrolled in my current major over the other majors I considered.

Note. * indicates that an item was reverse-coded.