Support Networks in Male Dominated STEM Majors and Their Impacts on Female Student's STEM Outcomes

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Abstract

Despite efforts to promote gender diversity in STEM, math-based STEM majors, such as Engineering, Computer science and Physics, remain male dominated. In this research, the effects of peer interactions are examined within students in math-based STEM majors, since peer relationships significantly impact retention and success in STEM. However, underrepresented groups, such as women in STEM, are particularly susceptible to negative stereotypes about their group, through the induction of stereotype threat. This study seeks to investigate how the gender of the support-giver and support-seeker in a peer directed study group affect male dominated STEM majors' personal wellbeing, social perceptions and STEM-related outcomes using video vignettes of an interaction in a study group. The gender of the support-giver, as depicted in the vignette, influenced social perceptions and to a lesser extent, STEM-related outcomes. Likewise, female participants scored lower in personal wellbeing, social perceptions and STEM-related outcomes, which were consistent with literature about stereotype threat. Implications of these findings and future research directions are discussed.

Despite significant advances in gender equity in higher education in the last century, some STEM fields still have markedly fewer females than males. Specifically, this gender gap persists in the most math intensive fields. While women earn undergraduate and graduate degrees in the biological sciences at a comparable rate to men, they are notably underrepresented in math based STEM fields, such as computer sciences, engineering and physics (National Science Foundation, 2023). Though the STEM gender gap is multifactorial, this research focuses on social influences, specifically peer support, which includes academic assistance, emotional support and the ability to relate to other STEM peers' shared goals and struggles. This research serves to investigate how peer support relates to stereotypes and prejudices about women in STEM. Specifically, the purpose of this study is to examine interactions within peer directed STEM study groups, such as how the gender of the support-giver and support-receiver affect students' affect, perceptions of their support system and well-being in STEM.

Self Efficacy

Self efficacy is the extent to which an individual believes they have the power to create a desired outcome for themselves. This is crucial for shaping an individuals' motivations and behaviors because without perceived control of a situation, people would lack a reason to react to their circumstances because it would not make a difference (Bandura & Locke, 2003). This is relevant to STEM because it is an important factor in driving STEM retention and success, especially in minoritized students. A study investigating STEM self efficacy, interest and performance in a longitudinal study of American high school students found that STEM self efficacy beliefs strongly affect women, such that high self efficacy beliefs, along with high STEM performance in early high school, most strongly predicted STEM major enrollment. An
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early development of self confidence in STEM seems to be crucial for promoting female STEM retention (Sakellariou & Fang, 2021).

Peer Value of STEM

Peer interactions play an integral role in shaping STEM interest and retention. During teenage years and young adulthood, having peers that appreciate the importance of STEM promotes STEM retention, likely because they're susceptible to peer influences during this time. For instance, high STEM affiliated girls also showed more interest in STEM careers when they belonged to mixed gender friend groups, likely because they viewed STEM as more co-ed (Robnett & Leaper, 2013). This suggests that the gender composition of STEM students' support groups plays an important role in promoting STEM retention, beyond the general gender composition of STEM students in a given school environment. Gender diverse support systems could protect against the effects of negative stereotypes about women in STEM by decreasing the saliency of these stereotypes.

Strong connections to STEM peers continue to play an important role in STEM retention and performance in college. Students report higher degrees of relatedness in STEM when they feel a stronger connection to their STEM community on campus (Hilts et al., 2018). Furthermore, STEM classmate contact predicts higher levels of perceived competence in minority students, which positively correlates with higher grades. Thus, fostering a strong STEM community could help improve STEM retention, particularly among underrepresented groups, such as women and minorities. Likewise, the racial and gender composition of students' support networks affect how much success students derive from their STEM community. Students in college STEM majors who had close study partners of different racial identities display higher GPAs (Park et al., 2021). This indicates the benefits of a diverse peer support network, as it leads to more positive outcomes among STEM majors.

However, diverse peer support networks may not provide the same benefits for minoritized students. For instance, Black students reap less of the benefits of having interracial study partners, despite engaging with professors and organizing study groups more often (Park et al., 2021). This implies that connectedness within campus STEM communities do not adequately mitigate the systemic barriers faced by Black students. Increased connection with STEM peers does not guarantee more positive outcomes for underrepresented students, such as women in STEM.

Stereotype Threat

Stereotype threat causes decreased performance because of negative stereotypes about a person's salient identity (Spencer, Steele & Quinn, 1999). In STEM specifically, women encounter the stereotype that men are better at math than women. This stereotype is made especially salient in male dominated STEM fields, such as computer science and engineering, where women are likely to be greatly outnumbered by men (Van Veelen et al., 2019). They may experience the negative effects of tokenization, which occurs when minoritized individuals are viewed as a representative of their minority group, rather than as an individual (Kanter, 1977). Stereotype threat is often activated by more subtle displays of disrespect, rather than flagrant discrimination. This subtle discriminatory treatment is especially insidious because it can actually be more harmful than bold displays of discrimination. For instance, female engineering students who interacted with sexist men underperformed on a math exam compared with those who interacted with a non sexist man (Logel et al., 2009). Notably, the men's sexist attitudes went unnoticed by the women, who reported more positive feelings towards the men higher in sexism. These results are notable because they indicate that female STEM students may fail to detect and avoid sexist men who activate stereotype threat.

Group Dynamics

Peer interactions, particularly in collaborative environments, may play an important role in mitigating the effects of stereotype threat. Cooperative contexts markedly decrease the effects of stereotype threat-- when participants' minority identity was made evident and they were the minority in the group, they underperformed in the competitive, but not collaborative contexts (Lee & Nass, 2012). More generally, intergroup contact has been shown to reduce the effects of stereotype threat and improve intergroup relationships (Abrams et al., 2006; Pettigrew & Tropp, 2006; Frey & Tropp, 2006; Crisp & Abrams, 2008). Increased intergroup contact minimizes the effects of negative stereotypes in the person who holds the stereotype and the people with the salient stereotyped identity (Crisp & Abrams, 2008). However, cross gender study groups could negatively affect female students by perpetuating, rather than reducing their experience of stereotype threat. This is especially important considering that stereotype threat is often undetected, so female students may not consciously perceive the negative effects they experience (Son Hing, 2012). Among female engineering students in a group problem solving task, first year students display lower anxiety in female majority and gender parity groups, and both first year and higher level students participated more in female majority groups (Dasgupta et al., 2015). Female study groups could benefit female students, particularly in early college, by acting as a "social vaccine" against gender stereotypes (Dasgupta et al., 2015). Female students could benefit from female study groups because they would feel more confident asking and answering questions, thus enhancing their learning and understanding.

Current Study

The current study seeks to investigate how gendered interactions within self directed study groups affects female students' feelings of competence and belongingness in STEM, self efficacy, and STEM persistence. Previous research has established the benefits of having a robust STEM support system for academic success, satisfaction in STEM, and STEM retention (Hilts et al., 2018). Both gender diverse support systems and female majority support systems have been demonstrated to possess unique benefits, along with unique costs. However, there is much less research directly comparing these support systems. This research seeks to directly compare the effects of male and female peer support in order to investigate the contexts in which each support type is more favorable. It uses a vignette depicting a common interaction in study groups, in which the subject imagines asking a question, which is answered by either a male or female member of their study group. By doing so, we can elucidate how gender diverse dynamics in STEM peer support groups may or may not benefit women.

Hypotheses

1. Both men and women will have higher warmth and competence ratings when they view vignettes depicting an interaction with a male group member compared to an interaction with a female group member.

2. Women will report lower feelings of self efficacy and STEM well-being in the male vignette condition compared to the female vignette condition. Men will have no differences between the male and female vignette conditions.

3. Women will have lower overall ratings of self efficacy, STEM belongingness and STEM competence than men.

Methods

Participants

Participants consisted of 160 undergraduate students at the University of California, Santa Barbara, who were currently enrolled in a male-dominated STEM major. Eligible majors include Electrical Engineering, Chemical engineering, Mechanical Engineering, Computer Engineering, Computer Science, Chemistry, Physics, Mathematics and Statistics. Subjects were 64% male (n = 101) and 36% female (n = 51). They were 58% white (n = 94), 19% Black or African American (n = 31), 14% Asian (n = 22), 8% Indigenous, 6% Hispanic/Latino (n = 10) and 1.9% other (n = 3). Subjects' ages ranged from 18-29, with a mean age of 20.51 years.

Procedure

Participants completed an online survey, which was administered on Qualtrics. They first completed a brief preliminary survey to ensure they are enrolled in a male dominated STEM major. Qualifying participants were then assigned to watch one of two vignettes depicting an interaction in a self-directed peer study group, in which either a male group member (Josh) or a female group member (Shannon) answers the participants' question (See Appendix A for full vignette script) . After viewing the vignette, participants completed a survey measuring outcomes of interest.

Measures

Social and Momentary Well-being.

Participants were first asked about their social and momentary wellbeing using 4 items adapted from Kroencke et al. (in press). Items were scored on a 4 point scale ranging from "1 = not at all" to "4 = very much". Social wellbeing (M = 3.41, SD =0.548, α = .816) includes 4 items, such as "I felt positively towards my interaction partners" and "my interaction partners supported me emotionally". Momentary well-being (M = 3.37, SD = 0.543, α = .645) includes 7 items including "right now, I feel happy" and "right now, I feel stressed."

Warmth and Competence.

Next, participants' feelings of warmth and competence towards both the question answerer and the group as a whole was assessed, using a scale adapted from Fiske et al. (2002). Participants rated both the question answerer and the study group as a whole on 8 traits, such as "friendly" and "capable," using a 7 point scale ranging from "1 = not at all" to "7 = very much so." Warmth and competence scores for both the question answerer (M = 5.717, SD = 0.933, α = .931) and the study group (M = 5.591, SD = 1.098, α = .964) were highly correlated, so they were combined into one composite warmth and competence score.

Next, participants were prompted to answer a series of survey questions according to their general experience, rather than relating to the vignette specifically.

Generalized self efficacy.

Participants' feelings of self efficacy was measured using Schwarzer and Jerusalem (1995)'s generalized self efficacy scale. This included 10 items (M = 5.642, SD = 0.915, α = .932), which were scored on a 7 point scale ranging from "1 = not at all" to "7 = very much so." For example, there were items such as "I can always manage to solve difficult problems if I try hard enough." and "I can usually handle whatever comes my way."

STEM-related Outcomes.

Various aspects of STEM wellbeing were measured using 11 items adapted from Hilts et al. (2018). STEM relatedness, perceived STEM competence, connectedness within STEM major, and friends/peers value of STEM were grouped together into a composite variable. Specifically, each measure was Z-standardized and then averaged to make a composite score, which broadly represents STEM-related outcomes. This was done because these items had high internal reliability (α = .885) and represent similar constructs, namely participants' overall well-being within their STEM major.

STEM relatedness.

STEM relatedness (M = 3.212, SD = 0.691, α = .805) was assessed using 2 items; "I have a lot in common with individuals who are STEM majors" and "I share
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many similarities with individuals who are STEM majors," which were scored on a 4 point scale ranging from "1 = not at all true" to "4 = completely true."

STEM competence.

Perceived competence in STEM courses (M = 4.912, SD = 0.736, α = .869) was measured with 5 items, such as "I am certain I can master the skills taught in my classes this year." and "Even if the work is hard I can learn it." A 6 point scale was used ranging from "1 = strongly disagree" to "6 = strongly agree."

Peers/Friends value of STEM.

Peer value of STEM (M = 3.420, SD = 0.552, α = .655) and friends' value of STEM (M = 3.352, SD = 0.660, α = 0.669) included the following 2 items each: "My STEM peers/good friends who are not STEM majors are supportive of the major I have chosen." and "My STEM peers/good friends who are not STEM majors think STEM is a worthwhile career for me." These measures were scored on a 4 point scale, ranging from "1 = not at all true" to "4 = completely true."

Connection to STEM Peers.

This measure (M = 2.571, SD = 0.950, α = .793) includes 3 questions such as "I talk to competent, relatable individuals majoring in STEM," which ranged from "1 = never" to 4 = daily" and "I do not know anyone majoring in STEM who both has similar qualities to me and is doing well in STEM classes this semester," which used a scale ranging from "1 = not at all true" to 4 = completely true"

Intent to leave STEM.

These 2 items were measured on a 6 point scale ranging from "1 = strongly disagree" to "6 = strongly agree." Intent to leave STEM (M = 5.174, SD = 0.989, α = .451) included the following items: "I am likely to remain in my STEM major through to graduation or completion of my program of study" (reverse scored) and "I intend to switch to a major in the social sciences, arts, or humanities and/or leave my STEM-related track before I graduate or complete my program of study"

Academic major satisfaction scale.

Academic major satisfaction (M = 3.862, SD = 0.670, α = .687) was assessed using a scale adapted from Nauta (2007). The 6 items were scored on a 5 point scale. Subjects were told to indicate the extent to which the statements apply to them, with "1 = not well at all" to "5 = extremely well." Items included were "I am strongly considering changing to another major." and "I often wish I hadn't gotten into this major."

Short form career inventory.

The short form career inventory (M = 4.163, SD = 0.670, α = .894) assessed participants' feelings of confidence about their future STEM careers, and was adapted from McIlveen et al. (2013). Questions include 6 items such as "Thinking about my career inspires me" and "I will adjust easily to shifting demands at work," and were scored on a 5 point scale, with "1 = strongly disagree" and "5 = strongly agree."

Demographics.

Subjects provided demographic information, including age, race/ethnicity, gender identity, year in school, GPA, first generation status, international student status, participation in STEM organizations, and transfer student status.

Results

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA was conducted to test the effects of gender and experimental condition on the measures described above. The measures were conceptually grouped into three main categories: personal well-being, social evaluations and STEM-related outcomes. Personal well-being includes momentary well-being and self efficacy measures, as these measures indicate subjects' general affect when the subjects completed the survey. Warmth and competence, and social well-being measures comprises the social evaluation category, as these measures relate to subjects' evaluations of the social interaction, including their interaction partner and their study group. The STEM-related outcomes category consists of items that measure participants' feelings of wellbeing in STEM, including STEM competence, STEM relatedness and academic major satisfaction. (see Appendix B).

Personal well-being

Momentary Well-Being

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA revealed no significant main effect of gender, $F(1,152) = 0.842$, $p = .360$, but a significant main effect of condition, $F(1,152) = 6.133$, $p = .014$, such that participants in the Josh condition ($M = 3.474$, $SD = 0.063$) reported significantly higher well being scores than participants in the Shannon condition, $M = 3.248$, $SD = 0.066$ (see Appendix B). The interaction between gender and vignette condition on momentary well-being was not significant ($F(1,152) = 0.058$, $p = .811$).

Self Efficacy

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA showed a significant main effect of gender ($F(1,152) = 16.850$, $p < .001$), such that men ($M = 5.850$, $SD = 0.088$) had significantly higher self efficacy scores than women ($M = 5.223$, $SD = 0.125$). There was no significant main effect of vignette condition ($F(1,152) = 0.022$, $p = .882$), and the interaction between participant gender and vignette condition was not significant, $F(1,152) = 0.004$, $p = .952$ (see Appendix B). Social evaluations

Warmth and Competence

The warmth and competence ratings of the interaction partner and the warmth and competence ratings of the study group had strong internal reliability, so they were grouped into a singular composite rating ($\alpha = .925$). Moreover, they measure similar outcomes, since only one study group member speaks during the vignette interaction, so participants probably conflated the question-answerer as representative of the group as a whole. A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA showed a significant main effect of participant gender, $F(1,152) = 5.56$, $p = .020$, on warmth and competence ratings, in that men ($M = 5.63$, $SD = 0.094$) reported higher warmth and competence ratings than women ($M = 5.409$, $SD = 0.133$). There was no significant main effect of vignette condition, $F(1,152) = 0.129$, $p = .720$, on warmth and competence ratings, and the interaction between participant gender and vignette condition on warmth and competence ratings was not significant, $F(1,152) = 0.006$, $p = .939$, (see Appendix B).

Social Well-being

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA revealed a significant main effect of participant gender, $F(1,152) = 2.55$, $p = .004$, on social well-being ratings, but no significant main effect of vignette condition, $F(1,152) = 0.832$, $p = .363$. The interaction between participant gender and vignette condition on social well-being ratings is not significant, $F(1,152) = 2.152$, $p = .144$. STEM-related outcomes

STEM-related outcomes

The measures of STEM competence, STEM relatedness and connection to STEM peers were grouped together into one variable titled "STEM-related outcomes" because they had good internal reliability ($\alpha = .885$). Likewise, they measure similar things, namely subjects' general confidence in STEM and their well-being in their STEM major. The measures used different scales, so they were Z standardized for analysis. A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA yielded no significant main effect of participant gender ($F(1,149) = 2.146$, $p = 0.145$) or vignette condition ($F(1,149) = 0.049$, $p = 0.825$) on STEM-related outcomes. The interaction between participant gender and vignette condition was not significant, $F(1,149) = 1.296$, $p = 0.257$ (see Fig. 1d). In subsequent analyses, a pairwise comparison revealed a marginal gender difference ($p = .067$) within the male interaction vignette condition, such that within the male interaction vignette condition, men ($M = 0.17$, $SD = 0.118$) reported marginally higher STEM-related outcomes than women ($M = -0.19$, $SD = 0.154$). There were no significant gender differences in the female interaction vignette condition ($p = .820$). The other STEM outcomes were not grouped with the "STEM-related outcomes" variable because they were not strongly correlated with those outcomes. Specifically, including these variables would reduce the reliability of the composite variable of STEM-related outcomes ($\alpha = .885$). These variables include connection to STEM peers, intent to stay in STEM, major preparedness, and future career preparedness. With the inclusion of these variables the reliability would be $\alpha = .562$.

Connection to STEM peers

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA revealed a significant main effect of participant gender, $F(1,151) = 8.882$, $p = 0.003$, with men ($M = 2.699$, $SD = 0.092$) reporting a significantly higher connection to STEM peers than women ($M = 2.220$, $SD = 0.132$). There was no significant main effect of vignette condition, $F(1,151) = 0.484$, $p = 0.488$ on connection to STEM peers. The interaction between participant gender and vignette condition on connection to STEM peers was not significant, $F(1,151) = 0.035$, $p = 0.852$.

Intent to stay in STEM

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA produced no significant main effect of participant gender, $F(1,151) = 0.941$, $p = 0.334$, or vignette condition, $F(1,151) = 1.352$, $p = 0.247$. The interaction between participant gender and experimental condition was not significant, $F(1,151) = 0.980$, $p = 0.324$.

Academic Major Satisfaction

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA revealed no significant main effect of participant gender, $F(1,152) = 1.233$, $p = 0.269$, or vignette condition $F(1,152) = 0.173$, p =
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0.678. The interaction between participant gender and vignette condition was not significant ($F(1,152) = 2.703$, $p = 0.102$.

Future STEM Career Preparedness

A 2 (participant gender: male, female) x 2 (vignette condition: male, female) between subjects ANOVA was conducted and revealed a significant main effect of participant gender, $F(1,151) = 3.987$, $p = 0.048$, such that men ($M = 4.233$, $SD = 0.067$) reported significantly higher career preparedness than women ($M = 4.003$, $SD = 0.094$). There was no significant main effect of experimental condition, $F(1,151) = 1.347$, $p = 0.248$. Likewise, the interaction between participant gender and experimental condition was not significant, $F(1,151) = 0.076$, $p = 0.783$.

Discussion

This study sought to examine the effects of a gendered interaction within a peer directed study group in a male dominated STEM major. Previous research suggests that minoritized STEM students benefit from receiving peer support from other STEM students that belong to their minoritized group, as they can relate to their shared struggles (Dasgupta et al., 2015). It also suggests that minoritized STEM students benefit from peer support from non-minoritized STEM students because it increases their feelings of in-group acceptance (Park et al., 2021). This study aimed to directly compare these types of support. To do this, we created a video vignette depicting a peer directed study group, in which the subjects imagined asking their group for help with a math problem and receiving help from either a male or female presenting group member. Overall, we found mixed support for our hypotheses.

Hypotheses 1: Both men and women will have higher warmth and competence ratings in the Josh condition

This hypothesis was not supported by the data in that there was no significant effect of condition on warmth and competence ratings of the interaction partner. However, there were other results that aligned with this hypothesis. For instance, male participants reported higher interaction well-being scores and warmth/competence ratings of the study group than female participants. This suggests that men have a generally higher comfort level within peer directed STEM study groups. It is possible that women viewed the study group as less favorable because of negative past experiences (Brown, 2000). Furthermore, subjects in the Josh condition had significantly higher momentary well-being scores than those in the Shannon condition. This could reflect that participants felt more comfortable in an imagined interaction with a man in a STEM peer study group. Momentary well-being could actually be a more accurate measure of subjects' perceptions of the interaction. Participants may have not felt strongly about the interaction partner, such that their perceptions of Shannon/Josh did not differ significantly. However, implicit biases towards women in STEM likely produced significant differences that revealed themselves more subtly, namely in the momentary well-being measure.

Hypothesis 2: Women will report lower feelings of self efficacy and STEM well-being in the male vignette condition. Men will have no differences between the male and female vignette

This hypothesis was partially supported by the data. Men had marginally higher STEM-related outcome scores than women in the male interaction condition. However, there was no significant interaction effect, which does not support the hypothesis that the experimental manipulation of gender of the interaction partner would produce lower STEM-related outcomes in female participants. It is likely that these conflicting results are because the experimental manipulation was not strong enough to elicit statistically significant gender differences, not because the gender of a help-seeker and help-giver in a STEM peer group interaction does not matter. Rather, the online video vignette format likely was not sufficiently realistic to elicit a significant interaction effect on STEM-related outcomes. Perhaps a similar study in a laboratory environment could provide realism that the online format could not capture. The experimental manipulation did not significantly affect self efficacy ratings. This could indicate stereotype threat induction given that both experimental conditions invoke a STEM context, leading female participants to perceive themselves as less capable.

Hypothesis 3: Women will have lower overall ratings of self efficacy, STEM belongingness and STEM competence than men

This hypothesis is supported by the experimental data. Men had significantly higher self efficacy ratings than women. Men also showed more feelings of STEM belongingness, as they reported a significantly higher connection to STEM peers than women did. These findings somewhat align with the previous literature, which establishes the detrimental effects of negative stereotypes and minoritization in STEM (Murphy et al., 2007; Spencer et al., 1999; Van Veelen et al., 2019), though the findings surrounding gender differences in self efficacy are mixed (Lennings, 1994; Sachitra & Bandara, 2017; Vantieghem et al., 2014).
The results of this study align with gender differences in STEM outcomes that have been observed in previous literature. This includes male participants having a significantly stronger connection to their STEM peers (Leaper, 2015). The composition of this study's subject pool reflects the general lack of diversity in STEM majors, as the participants were predominantly white (58%) and male (64%). Notably, first generation college students were extremely underrepresented in this subject pool, comprising 9% of the subject pool. This is especially remarkable, given that in the 2022-2023 school year, 33% of the UCSB student body is first generation (University of California, Santa Barbara, 2023), and first generation students are more likely to come from underrepresented groups, such as racial minorities or low income

backgrounds. This highlights that the lack of diversity within these math-based STEM majors extends beyond gender, and reflects a general inaccessibility to minoritized groups.

Limitations

A major limitation of this study is the online format, which likely lacked the realism to elicit strong effects. Future studies could explore the effect of this peer group interaction in a laboratory setting to increase the study's realism. Furthermore, this study was limited in its scope, such that it focused on one type of interaction within one study group. Further research could investigate how different types of interactions impact outcomes. Likewise, this study used strangers in a stock image to depict the study group, whereas students generally have previously met the people in their study groups. Thus, tracking how students' naturalistic study group habits affect them could provide more insight into the effects of STEM peer support in students' daily lives.

Conclusion

This research sought to examine group interactions within male dominated STEM majors. Specifically, it tested how the gender of the support-giver and support-receiver affect students' affect, perceptions of their support system and well-being in STEM. The results partially supported the hypotheses, and were consistent with previous literature about stereotype threat, STEM outcomes, and the persistent gender gap in STEM. Specifically, this research and previous literature indicate that men seem to feel more comfortable in and connected to the STEM community. This research highlights the lack of diversity in STEM. This underscores the importance of investigating the factors that affect minoritized groups' STEM participation, so we can develop effective interventions against inequality in STEM.

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Appendix A

Vignette Script

Imagine you are in a study group for MATH 184, which is a vector calculus class required for your major, and you need to do well in the class in order to take upper division courses in your major.

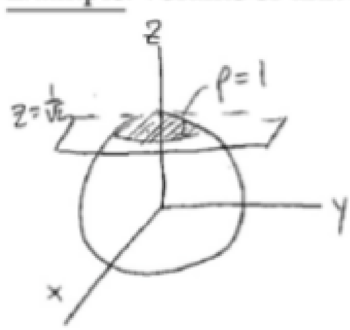
Your group is with four of your classmates, Shannon, Josh, Alexis, and Ethan (See image 1). You have studied with these classmates before, so you know them fairly well. You have an exam in two days, and are reviewing a set of practice problems assigned by the professor.

Image 1: This image depicts the study group that subjects were told to imagine in the vignette.

You are confused about how to solve the following question from the problem set (*see image 2*).

10

Example: volume of unit sphere above $z = \frac{1}{\sqrt{2}}$



$$\int_0^{2\pi} \int_0^{\frac{\pi}{4}} \int_{\frac{1}{\sqrt{2}}\sec\phi}^{1} 1\,\rho^2 \sin\phi \, d\rho \, d\phi \, d\theta$$

Image 2: This image depicts the practice problem that participants were instructed to imagine asking for help solving in the vignette.

You ask the group, "Does anyone know how to solve practice problem number 10?" [Shannon/Josh] tells you, "I can help you. I know how to solve that problem because I feel pretty confident about solving problems involving spherical coordinates."

[He/she] pulls out [his/her] notebook to show you [his/her] notes and how [he/she] solved the problem.

[Shannon/Josh] explains "You first need to take the partial integral of rho squared sin phi [1ρ^2sinΦ(phi)] with respect to rho [ρ]." [He/she] clarifies "you take the integral from 1 over root 2 secant phi to 1 [1/2^(½)secΦ to 1]."

[He/she] explains, "Next you would use the new function from the first part of the problem, and take the partial integral from zero to pi over 4 with regards to phi [0 to π/4 with regards to Φ]." [Shannon/Josh] tells you, "After you do that, you would take the integral of the resulting function from zero to 2 pi [0 to 2π] with respect to theta [Θ] . This will give you your answer"

[Shannon/Josh] ask "Does that make sense to you?"

This makes sense, but you are still somewhat confused.

You say "Yes that makes sense, but I'm still unsure about how you know to integrate with respect to rho first."

[He/she] answers "You first integrate with respect to rho because the bounds for rho are the first set of boundaries that are given in the problem, so you have to integrate with respect to rho so you can find the volume within those boundaries"

[Shannon's/Josh's] explanation makes sense to you, and you feel fairly confident you can solve the problem without [his/her] help.

You nod to [Shannon/Josh] and say "Yes, thank you"

[Shannon/Josh] responds "You're welcome. Let me know if you need any more help."

Appendix B

Table 1

Mean/SDs of Outcome Variables by Participant Gender

Measures	Male Participants		Female Participants		
	M	*SD*	*M*	*SD*	*F*
Momentary wellbeing	3.40	0.053	3.32	0.074	0.842
Social Wellbeing	3.50	0.054	3.22	0.076	2.55**
Warmth & Competence	5.79	0.094	5.41	0.133	5.56*
Self efficacy	5.85	0.088	5.22	0.125	16.850***
STEM-related outcomes (z-scores)	0.076	0.080	-0.128	0.074	2.146
Connection to STEM peers	2.70	0.092	2.22	0.132	8.882**
Intent to Stay in STEM	5.20	0.100	5.04	0.142	0.941
Academic Major Satisfaction	3.86	0.083	3.80	0.117	1.233
Future Career Preparedness	4.23	0.067	4.00	0.094	3.987*

*p < .05, **p < .01, ***p < .001

Note. This table shows the *M* and *SD*s for the variables of interest, grouped by participant gender. Statistical significance is denoted with an * ($p < .05$*, $p <$ .01**,
$p < .001$***)

Table 2

Mean/SDs of Outcome Variables by Experimental Condition

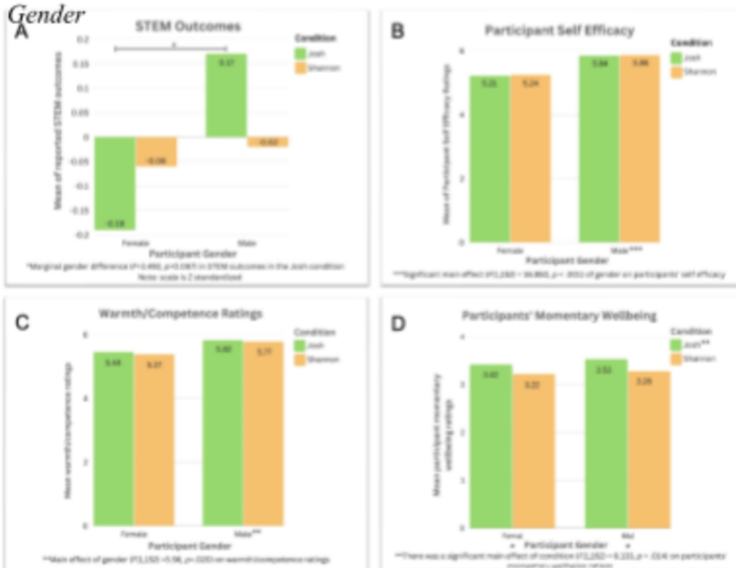
Measures	Male Vignette *M*	Male Vignette *SD*	Female Vignette *M*	Female Vignette *SD*	*F*
Momentary wellbeing	3.47	0.063	3.25	0.066	6.133*
Social Wellbeing	3.40	0.064	3.32	0.067	0.832
Warmth & Competence	5.63	0.112	5.57	0.118	0.129
Self efficacy	5.53	0.105	5.55	0.111	0.022
STEM-related outcomes (z-scores)	-0.011	0.105	-0.142	0.100	0.049
Connection to STEM peers	2.40	0.112	2.52	0.116	0.484
Intent to Stay in STEM	5.22	0.112	5.02	0.125	1.352
Academic Major Satisfaction	3.91	0.099	3.75	0.104	0.173
Future Career Preparedness	4.19	0.080	4.05	0.083	1.347

*p < .05

Note. This table shows the *M* and *SD*s of the variables of interests, grouped by experimental condition. Statistical significance ($p < .05$) is denoted with an *

Figure 1

Means of Some Outcome Variables by Condition and Participant Gender



Note. **a)** A pairwise comparison revealed a marginal gender difference in STEM-related outcomes within the Josh vignette condition, $p = .067$. **b)** There was a significant main effect of participant gender on self efficacy ratings, $F(1,152) = 16.85$, $p < .001$, **c)** There was a significant main effect of participant gender on warmth/competence ratings, $F(1,152) = 5.56$, $p = .020$. **d)** There was a significant main effect of experimental condition on momentary well-being ratings, $F(1,152) = 6.133$, $p = .014$.