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Gender Perceptions and Female Students' Academic Engagement and Success in STEM Fields

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Gender Perceptions and Female Students' Academic Engagement and Success in STEM Fields

In a classroom, engagement, a combination of instructor-student rapport and participation, is a substantial contributor to success (Frisby et al., 2014; Frisby et al., 2016; Frisby & Martin, 2010; Lammers et al., 2017). It enriches the learning experience and promotes information retention among students (van Blankenstein et al., 2011). At the university level, engagement continues to be a predictor of academic success, but some students, specifically female students in science, technology, engineering, and math (STEM), are less engaged than their peers. In university STEM departments, females are not only outnumbered in these male-dominated spaces but also participate less (Aguillon et al., 2020; Bailey et al., 2020; Martinez & Christnacht, 2021; Opie et al., 2019). These disparities between male and female STEM students have led researchers to investigate possible environmental contributors. Given the preexisting gender imbalances in STEM fields, students' gender perceptions of their instructors, faculty, and classmates have been researched as possible environmental factors influencing female STEM students' engagement and success.

This study investigated the relationships between perceived instructor gender, classroom gender composition, gender composition of the departmental faculty, and female students' engagement and success in STEM fields. Study participants were asked to reflect on their STEM department and a previous departmental course and complete a series of single-item assessments and standardized measures related to their level of engagement, classroom success, and perceptions of gender. It was expected that the students' perceptions of gender would create variations in engagement level and final course grades, particularly with female STEM students

engaging more and performing better when enrolled in classrooms or belonging to departments with a female instructor, female faculty majority, and/or female student majority.

Literature Review

The extant research has focused on classroom participation, extracurricular involvement, instructor-student rapport, and final course grades as measures of students' academic engagement and success. Of particular interest is the influence of gender, and how engagement and success differ between male and female students.

Active participation in the classroom involves communication with both students and instructors. However, some students are apprehensive about participating, especially in an environment they view as threatening, judgmental, or unaccepting (Frisby et al., 2014). Although any student can develop participation apprehension, this reluctance to participate can be exasperated by bias. Female university students face additional threats of judgment and unacceptance in classrooms with "chilly climate[s]", which refer to the discrimination and stereotypes directed at females in academia (Hall & Sandler, 1982, 1984; Sandler & Hall, 1986, as cited in Crombie et al., 2003). Females in these chilly climates were found less likely to participate than their male peers (Fassinger, 1995, as cited in Crombie et al., 2003).

Amplifying the influence of the chilly climate is the issue of gender imbalance in university departments. According to the National Science Foundation's science and engineering indicators (2018), the majority of bachelor's degrees in science and engineering fields in 2015 were awarded to men. As a result, courses with male-dominated gender compositions and chilly climates may create an intimidating environment for female students, causing lower participation (Hall & Sandler, 1982, 1984; Sandler & Hall, 1986, as cited in Crombie et al., 2003). One study, conducted by Casad and colleagues (2018), of 579 female STEM students found that viewing the

environment as threatening or negative can eventually lead to student disengagement. Other studies have found that female students in STEM participate less than their male peers (Aguillon et al., 2020; Bailey et al., 2020; Opie et al., 2019). A recent study of introductory biology courses found that male students participated more despite the gender of the instructor, volunteering more responses during class (Aguillon et al., 2020). Supplementing this research, a study of 34 life sciences courses found that male students were more likely than their female counterparts to participate in class (Bailey et al., 2020).

Similar to in-class participation, some studies have looked at extracurricular involvement as an aspect of student engagement and success. A study by King and colleagues (2020) looked at the connection between extracurricular involvement and academic success among historically under-represented university students. The study found that extracurricular involvement was believed by students to be a major contributor to their academic success. Although this study looked at the connection between extracurricular involvement and academic success, it did not specify involvement in STEM-related extracurriculars. One of the few studies of STEM-focused extracurricular involvement found that girls who participated showed a stronger interest in STEM than non-participants (Stringer et al., 2019). Supplementing this research, a study investigating the link between involvement in science and math clubs and high school science and math GPAs found that participation in these clubs resulted in higher GPAs (Gottfried & Williams, 2013). Unfortunately, like many other studies on extracurricular involvement and student success, both studies were conducted on children, in particular middle and high schoolers. Although these studies demonstrate the connection between extracurricular involvement in academic engagement and success, no studies linking involvement in STEM

extracurriculars or clubs and female STEM students' engagement and success at the university level were found in the literature.

Instructor-student rapport has also received attention in the literature as a contributor to classroom engagement and predictor of academic success. In previous research, instructor-student rapport was found to influence the students' views of the classroom (Rosenfeld, 1983 as cited in Frisby et al., 2014). A more recent study indicated that a relationship with the instructor can mitigate the chance of participation apprehension (Frisby et al., 2014). In this study by Frisby and colleagues (2014), instructor-student rapport helped decrease participation anxiety among students. Similarly, a study by Frisby and Martin (2010) found that among the 232 students who reported on their relationships with instructors and students and classroom participation, instructor rapport was associated with greater participation. Instructor-student rapport has also been associated with higher final course grades. A study investigating the connection between instructor-student rapport and final course grades found students had higher final grades when their instructor-student rapport was consistent or increased over the course of the semester (Lammers et al., 2017).

The variability of female students' engagement and success in STEM fields has prompted further studies to discover the possible causes of this phenomenon, one of which is instructor gender. Some studies reported little or mixed results on the relationship between instructor gender and female student engagement and success (Hoffmann & Oreopoulos, 2009; Howard & Henney, 1998; Leraas et al., 2018). Howard and Henney (1998) found that both male and female students indicated that instructor gender had little influence on their participation level. A study by Hoffmann and Oreopoulos (2009) focused on freshman university students and the influence of same-sex instructors on grade performance. The study found that same-sex instructors had

only a small impact on students' grades. Leraas and colleagues' (2018) study of gender and student participation found that although there was a relationship between instructor-student rapport and participation, instructor gender did not have any significant influence on participation. The relationship between instructor gender and instructor-student rapport has received little attention in the extant literature. A recent study of instructor-student rapport and the influence of gender found that, regardless of instructor gender, feminine students had high instructor-student rapport ratings (Lammers & Byrd, 2019). Unfortunately, no literature comparing instructor-student rapport ratings between female students in STEM with a male or female instructor was identified.

Recent research considering fields of study finds that instructor gender plays a more significant role in female engagement and success than previously believed, specifically in STEM courses (Bailey et al., 2020; Solanki & Xu, 2018). In one study, the introduction of a female STEM instructor was shown to increase female students' overall classroom engagement (Solanki & Xu, 2018). In another study, female instructors contributed to higher final course grades for female students (Bailey et al., 2020).

Inequitable classroom gender ratios may also influence participation within STEM courses and contribute to the mixed results documented in past research. In the study by Leraas et al. (2018), participation differences within male- and female-instructed courses were not delineated by STEM and non-STEM courses but rather by the gender of students. However, STEM majors, and therefore courses, have varying student gender compositions, with a general trend towards male dominance. Bailey and colleagues (2020) found that classrooms with a higher percentage of females and female instructors lead to increased participation and grade performance among female students. Unfortunately, no studies relating female students' STEM

extracurricular involvement, instructor gender, faculty gender composition, or classroom gender composition were identified in the literature.

Theoretical Background

According to symbolic interactionalism, repeated interactions establish the norms, beliefs, and acceptable behaviors of society (Carter & Fuller, 2015). Gender norms, for example, are created through recurrent interactions in which specific behaviors or roles are performed by perceived males or females. The performance of these gendered behaviors is equivalent to what West and Zimmerman (1987) refer to as "doing gender" (as cited in Carter & Fuller, 2015). By "doing gender", men and women further establish acceptable forms of masculinity and femininity, and gender becomes a "master status" that is used to interpret and navigate the social environment (West & Zimmerman, 1987 as cited in Carter & Fuller, 2015).

Roles and behaviors become associated with respective genders by how well they fit with societal views of masculinity or femininity (Eagly & Wood, 2011; Martin & Halverson, 1981, as cited in Olsson & Martiny, 2018). In the college environment, STEM majors and fields are considered masculine professions, due to historically low rates of female professionals in these fields (Olsson & Martiny, 2018). Additionally, the idea of a masculine profession is upheld by the high number of professor and instructor positions held by men. In other words, these STEM classrooms are "doing gender" and promoting certain roles as masculine.

Although individuals are socialized through interactions to believe that certain behaviors and roles correspond with a respective gender, there is a belief that gender can be undone. It is theorized that gender stereotypes and gendered performances can be challenged by observing men and women perform "counterstereotypical" roles and behaviors (Olsson & Martiny, 2018). In particular, this theory has been applied to highly gendered fields and careers, such as STEM,

to increase female involvement. Research suggests that females do not explore these fields due to stereotypes and negative ability beliefs, however, counterstereotypical role models in STEM can help female students overcome these barriers (Olsson & Martiny, 2018).

Symbolic interactionalism, counterstereotypical role model theory, and past research prompt explorations into the role of same-gender instructors and same-gender student majority in STEM fields, and how they can influence rapport, participation, and success for students. This study, and those before it, theorized that having a female instructor or female student majority in a stereotypical masculine field would promote better outcomes for female students by contradicting "gender-stereotypical ability beliefs" (Olsson and Martiny, 2018).

Connection to Social Work Practice

As outlined in the NASW Code of Ethics, social workers must challenge social injustice and advocate for equality (National Association of Social Workers, n.d.). One form of social injustice in the United States is the gender pay gap, with women making 83 cents to every dollar earned by men (Wisniewski, 2022). Wages are highly influenced by educational attainment, however, even with equal educational backgrounds, men continue to earn more than women (Fan & Sturman, 2019). Continuing this trend, females are underrepresented in some of the highest-paid fields in the U.S. workforce, such as STEM. Females made up only 27% of STEM workers in 2019 and continue to earn less than their male counterparts (Martinez & Christnacht, 2021). This inequity in STEM representation and employment presents an issue for advocates working to narrow the gender pay gap. Therefore, a push for women in STEM is crucial to promoting social justice and gender equality in the U.S. workforce.

To promote more females in STEM fields and careers, it is imperative that the barriers to these students' engagement and success are investigated and broken down. To do so, an

investigation of the educational environments in which these students are underrepresented is necessary. By investigating the environmental factors influencing female STEM students' academic engagement and success, there is an opportunity to address females' underrepresentation in STEM at its source. In relation to social justice, there is hope that by adjusting the female students' educational environment, such as through extracurricular involvement and gender representation, more females will be drawn into and persist in STEM fields, narrowing the gender pay gap as result.

Methodology

The purpose of this study was to explore the role of gender perceptions in academic engagement and success for female STEM students. Specifically, we investigated the relationships between instructor gender, classroom gender composition, departmental faculty gender composition, and the participants' academic engagement and success in STEM fields. Engagement in STEM fields was characterized by participants' classroom instructor-student rapport, participation, and involvement in STEM extracurriculars. Success was determined by the participants' reported final letter grades. The current study seeks to answer fifteen research questions regarding female students' gender perceptions, engagement, and success in STEM fields (See Table 1 in Appendix A).

Data Collection

Data for this study was collected via an online survey created using Qualtrics. The survey was voluntary, and participants were made aware of the survey and this study through department faculty, registered student organizations, and social media posts. Individual STEM departments and registered student organizations were contacted and asked to support this study by distributing the survey link and study information via email to all students enrolled in their

respective departments or student organization. Two news articles asking for participants for the study were posted to the University of Arkansas' online newspaper, Newswire, and a Twitter post was shared about the study. Participants had the chance to receive one of ten $50 Amazon gift cards. The study's procedures were waived by the institutional review board at the University of Arkansas (See Appendix B).

Sample

Students were eligible to participate if they: 1) identified as female; 2) were enrolled in at least their second undergraduate year at the University of Arkansas; and 3) belonged to one of sixteen selected STEM majors. After the initial exclusion portion of the survey, eligible participants were provided with an informed consent document describing the study and listing the contact information of the primary investigators. Participants who agreed to participate were then directed to the remainder of the survey.

Two additional exclusion criteria were used after the survey was closed and responses were recorded to ensure the most accurate analysis. Initially, 44 participants completed the survey. However, four of those participants identified as graduate students and one participant failed to pass a validation item within the survey (i.e., "Please select the number 3 for this question"). Thus, these five causes were dropped, and subsequent analyses were conducted with the remaining 39 participants.

Measurements

Participants completed a variety of single-item assessments and standardized measures related to their engagement, academic success, and gender perceptions (See Appendix C).

Participant Characteristics

Additional information was collected from participants, including their major, final letter grade in their selected course, and involvement in STEM extracurriculars and clubs.

Gender Perceptions

Participants were asked to reflect on a course they have completed in their department and provide their perspective on the instructor's gender and the gender composition of the classroom (i.e., “What was the perceived gender of the instructor of your selected course?”, participants chose either male or female; “What was the estimated gender composition of your selected course?”, participants chose either male-dominated, balanced, or female-dominated). Their perspective on the faculty gender composition of their department was also collected.

Instructor-Student Rapport

Participants were asked to rate their agreement to nine statements about their interactions and relationships with their instructors on a 5-point Likert scale, with one being "strongly disagree" and five being "strongly agree". Table 2 depicts the average ranking for each of the nine statements (See Appendix A). The instructor-student rapport 5-point Likert scale was an adaptation of Lammers and Gillaspy’s (2013) Student-Instructor Rapport Scale-9. In this study, the statements were written in first-person, and the scale ranged from one being “strongly disagree” to five being “strongly agree”, as opposed to one being “not at all” and five being “very much so” in the study by Lammers and Gillaspy (2013). This scaling alteration was made because the Qualtrics program did not provide a Likert scaling option of one being “not at all” and five being “very much so”.

Classroom Participation

Participants were asked to estimate their classroom participation and the level of classroom engagement of their perceived male and female classmates. Participants’ estimated

classroom participation was based on the frequency for which they engaged in five classroom behaviors, ranking the performance of each behavior on a 5-point Likert scale, with one being "never" and five being "always". Table 3 depicts the average rank for each of the 5 behavioral statements (See Appendix A). The classroom participation 5-point Likert scale was an adaptation of Frisby and colleagues' (2014) 5-item survey with a 5-point Likert scale, which had internal reliability of .93. In the current study, the scale used to evaluate perceived participation ranged from one being "never" to five being "always", as opposed to one being "never" and five being "often" in the study by Frisby et al. (2014).

Data Analysis

All data analyses were performed using the data analysis tool in the Qualtrics program. The program used a confidence level of 95% to look for relationships between variables. The program ran either a ranked T-test, ranked ANOVA, chi-squared test, or Fisher's exact test given the types of variables in each research question. Participants' average rank of instructor-student rapport statements, classroom participation statements, and estimated classroom engagement of male and female classmates given the instructor gender and classroom gender composition were compared. Participants' final letter grades given the instructor gender and classroom gender composition were compared. Perceptions of departmental faculty gender composition were compared given the participants' perceived instructor gender, classroom gender composition, and identified major. Involvement in STEM extracurriculars and clubs was compared given participants' perceived instructor gender, instructor-student rapport rankings, classroom participation rankings, classroom gender composition, and departmental faculty gender composition. The strength of significant relationships was determined using the effect sizes. For the ranked T-tests performed, a small effect was $d > 0.2$, a medium effect was $d > 0.5$, and a

large effect was $d > 0.8$. For the chi-squared tests performed with three groups, a small effect was $V > 0.07$, a medium effect was $V > 0.21$, and a large effect was $V > 0.35$. For the ranked ANOVA test performed, a small effect was $f > 0.1$, a medium effect was $f > 0.25$, and a large effect was $f > 0.4$. For the Fisher's exact test performed, a small effect was $V > 0.1$, a medium effect was $V > 0.3$, and a large effect was $V > 0.5$.

Results

Table 4 depicts the majors of participants included in the analysis (See Appendix A). Final letter grade distribution ranged from A to D, with 19 participants receiving an A (48.7%), 12 receiving a B (30.8%), 7 receiving a C (17.9%), and 1 receiving a D (2.6%). Of the 39 participants included in the analysis, 28 indicated that they were involved in STEM extracurriculars or clubs. 64.1% of participants estimated their major's faculty gender composition as male-dominated, $n = 25$, 30.8% estimated their major's faculty gender composition as balanced, $n = 12$, and 5.1% estimated their major's faculty gender composition as female-dominated, $n = 2$.

Research Question 1

The first research question was: Is the perceived gender of the instructor related to female STEM students' perceived instructor-student rapport? Table 5 and Figure 1 depict the ranking distribution for each of the nine statements by participants with a male instructor, $n = 26$ (See Appendix A). Table 6 depicts the average rank for each of the nine statements for participants with a male instructor. Table 7 and Figure 2 depict the ranking distribution for each of the nine statements by participants with a female instructor, $n = 13$. Table 8 depicts the average rank for each of the nine statements for participants with a female instructor. For each statement, a ranked T-test was performed. Of the nine statements, the statement "my instructor respected me" had a

statistically significant relationship with the perceived instructor gender. The ranked T-test revealed that participants who had a female instructor had a statistically higher ranking of the statement "my instructor respected me" (M = 4.69, SD = 0.48) than participants with a male instructor (M = 3.88, SD = 1.21), t(37) = 0.81, p = .013, d = 0.81. The statements "my instructor treated me fairly" and "my instructor encouraged me" revealed relationships that were very near significant for participants with a female instructor. The results of the ranked T-tests with p-values and effect sizes for each statement are listed in Table 9.

Research Question 2

The second research question was: Is the perceived gender of the instructor related to female STEM students' perceived classroom participation level? Figure 3 and Table 10 depict the ranking distribution for each of the five behavioral statements by participants with a male instructor, n = 26 (See Appendix A). The average ranking for each behavioral statement given a male instructor is provided in Table 11. Figure 4 and Table 12 depict the ranking distribution for each of the five behavioral statements by participants with a female instructor, n = 13. The average ranking for each behavioral statement given a female instructor is provided in Table 13. For each statement, a ranked T-test was performed. None of the five statements had a statistically significant relationship with instructor gender with a confidence level of 95%. The results of each ranked T-test with p-values and effects sizes are provided in Table 14.

Research Question 3

The third research question was: Is the perceived classroom gender composition related to female STEM students' perceived classroom participation level? Figure 5 and Table 15 depict the ranking distribution of behavioral statements for participants in a perceived male-dominated classroom, n = 18 (See Appendix A). The average ranking for each behavioral statement given a

male-dominated classroom is provided in Table 16. Figure 6 and Table 17 depict the ranking distribution of behavioral statements for participants in a perceived balanced classroom, n = 19. The average ranking for each behavioral statement given a balanced classroom is provided in Table 18. Figure 7 and Table 19 depict the ranking distribution of behavioral statements for participants in a perceived female-dominated classroom, n = 2. The average ranking for each behavioral statement given a female-dominated classroom is provided in Table 20. For each statement, a ranked ANOVA test was performed. None of the statements had a statistically significant relationship with perceived classroom gender composition with a confidence level of 95%. The results of the ranked ANOVA tests, with p-values and effects sizes, Cohen's f, are provided in Table 21.

Research Question 4

The fourth research question was: Is the perceived gender of the instructor related to female STEM students' final letter grades? Table 22 depicts the final letter grade distribution of participants with a female instructor, n = 13 (See Appendix A). Table 23 depicts the final letter grade distribution of participants with a male instructor, n = 26. A chi-squared test was performed, and no statistically significant relationships were found between final letter grades and perceived instructor gender, X^2 (3, N = 39) = 3.76, p = 0.289, v = 0.31.

Research Question 5

The fifth research question was: Is the perceived classroom gender composition related to the final letter grade of female STEM students? Tables 24, 25, and 26 depict the final grade distributions of male-dominated, n = 18, balanced, n = 19, and female-dominated, n = 2, classrooms respectively (See Appendix A). A chi-squared test was performed, and no

statistically significant relationships were found between perceived classroom gender composition and final letter grade, X^2 (6, N = 39) = 4.26, p = 0.641, v = 0.23.

Research Question 6

The sixth research question was: Is the perceived gender of the instructor related to the classroom engagement of both male and female STEM students? Tables 27 and 28 depict the rank distribution for engagement levels of perceived females and perceived males respectively (See Appendix A). The average rank for the perceived females in the classroom was 3.26, and the average rank for the perceived males in the classroom was 3.72. Tables 29 and 30 depict the rank distributions for engagement level of perceived females and perceived males with male or female instructors respectively. The average rank for the perceived females in the classrooms was 3.08 with a male instructor, and 3.62 with a female instructor. The average rank for the perceived males in the classrooms was 3.62 with a male instructor, and 3.92 with a female instructor. The chi-squared test for perceived male engagement revealed no statistically significant relationship, X^2 (3, N = 39) = 2.39, p = 0.405, v = 0.25. The chi-squared test for perceived female engagement revealed no statistically significant relationship, X^2 (4, N = 39) = 3.30, p = 0.509, v = 0.29.

Research Question 7

The seventh research question was: Is the perceived classroom gender composition related to the classroom engagement of both male and female STEM students? The average rank of engagement for perceived females in the classrooms was 3.11 when in male-dominated classrooms, 3.32 when in balanced classrooms, and 4.00 when in female-dominated classrooms. The average rank of engagement for perceived males in the classrooms was 3.61 when in male-dominated classrooms, 3.74 when in balanced classrooms, and 4.50 when in female-dominated

classrooms. Tables 31 and 32 depict the rank distribution for engagement levels of perceived females and perceived males in classrooms with different gender compositions respectively (See Appendix A). Two chi-squared tests were performed. The chi-squared test for perceived male engagement in different gender composition classrooms was very near significant, X^2 (6, N = 39) = 11.6, p = 0.071, v = 0.39. The chi-square test for perceived female engagement in different classroom gender compositions revealed no statistically significant relationship, X^2 (8, N = 39) = 8.29, p = 0.405, v = 0.33.

Research Question 8

The eighth research question was: Is the perceived gender of the instructor related to female STEM students' perception of their department's faculty gender composition? Table 33 depicts female STEM students' perceptions of their department's faculty gender composition when they have either a male or female instructor (See Appendix A). A chi-square test was performed. The chi-square test revealed no statistically significant relationship, X^2 (2, N = 39) = 0.270, p = 0.874, v = 0.08.

Research Question 9

The ninth research question was: Is the perceived gender composition of the classroom related to female STEM students' perception of their department's faculty gender composition? Table 34 depicts the perceived gender composition of faculty (male-dominated, balanced, or female-dominated) when given the perceived gender composition of the classroom (male-dominated, balanced, or female-dominated) (See Appendix A). A chi-squared test was performed and revealed a statistically strong relationship between perceived gender composition of the classroom and perceived gender composition of faculty, X^2 (4, N = 39) = 16.6, p = 0.002, v = 0.46. In particular, there was a strong relationship between perceiving the classroom gender

composition as balanced and perceiving the faculty gender composition as balanced. Perceiving the classroom as male-dominated also had a significant relationship with perceiving the faculty as male-dominated.

Research Question 10

The tenth research question was: Is the female STEM students' department related to the perceived gender composition of its faculty? A chi-squared test was performed, and no statistically significant relationship was found, X^2 (26, N = 39) = 24.8, p = 0.531, v = 0.56.

Research Question 11

The eleventh research question was: Is the perceived gender of the instructor related to female STEM students' involvement in STEM extracurriculars and clubs? Table 35 depicts the percentage of participants who indicated involvement in STEM extracurriculars or clubs given the perceived instructor gender (See Appendix A). A Fisher's exact test was performed, and no statistically significant relationship was found between instructor gender and involvement in STEM extracurriculars or clubs, p = 0.719, v = 0.08.

Research Question 12

The twelfth research question was: Is the female STEM students' involvement in STEM extracurriculars and clubs related to perceived classroom participation level? Five ranked T-tests were performed, and one statistically significant relationship was found. The ranked T-test revealed that participants involved in STEM extracurriculars or clubs had statistically higher rankings for the statement "I contributed without hesitation" (M = 2.64, SD =1.10) than participants who were not involved in STEM extracurriculars or clubs (M = 1.73, SD = 0.79), t(37) = -0.916, p = 0.013, d = 0.924. The statements "I expressed personal opinions" and "I volunteered in class" had very near significant relationships. Table 36 depicts the results of the

five ranked T-tests comparing involvement in extracurricular activities and estimated classroom participation (See Appendix A).

Research Question 13

The thirteenth research question was: Is the female STEM students' involvement in STEM extracurriculars and clubs related to estimated instructor-student rapport? A ranked T-test was performed for each of the statements and one statistically significant relationship was found. The ranked T-test revealed that participants involved in STEM extracurriculars or clubs had statistically higher rankings for the statement "my instructor encouraged me" (M = 4.07, SD = 1.02) than participants who were not involved in STEM extracurriculars or clubs (M = 3.18, SD = 1.33), t(37) = , p = 0.036, d = 0.80. No other statements revealed a statistically significant relationship between involvement in STEM extracurriculars and instructor-student rapport. Table 37 depicts the results of the ranked T-test for the nine statements given involvement in STEM extracurriculars (See Appendix A).

Research Question 14

The fourteenth research question was: Is the perceived gender composition of the classroom related to female STEM students' involvement in STEM extracurriculars and clubs? Table 38 depicts the percentage of participants who were or were not involved in STEM extracurriculars or clubs given the estimated gender compositions of their classrooms (See Appendix A). A chi-squared test was performed, and no statistically significant relationships were found, X^2 (2, N = 39) = 0.894, p = 0.639, v = 0.15.

Research Question 15

The fifteenth research question was: Is the perceived faculty gender composition of the female STEM students' department related to involvement in STEM extracurriculars and clubs?

Table 39 depicts the percentages of participants involved or not involved in extracurriculars and clubs given estimated faculty gender composition (See Appendix A). A chi-squared test was performed, and no statistically significant relationships were found, X^2 (2, N = 39) = 1.02, p = 0.599, v = 0.16.

Discussion

This study examined how gender perceptions impact the ways female STEM students navigate and interact with their university environment. STEM fields are highly gendered spaces, with males outnumbering females in the classroom and the workforce (Martinez & Christnacht, 2021). Educators and institutions have tried to close the gap between males and females in STEM fields with little success (Martinez & Christnacht, 2021; National Science Board, 2018). Therefore, the overarching question of this study and those like it, is what environmental factors are preventing female students from engaging and succeeding in STEM, and what students, educators, and policymakers can do about it. This study chose to focus on instructor gender, classroom gender composition, and faculty gender composition as possible environmental factors that impact female STEM students' engagement and success by influencing instructor-student rapport, classroom participation levels, final letter grades, and involvement in STEM extracurriculars or clubs.

Based on past research and theoretical background, it was hypothesized that significant connections would be found between these environmental factors and levels of engagement and success among female STEM students (Bailey et al., 2020; Olsson & Martiny, 2008; Solanki & Xu, 2018). However, this study had some unexpected results. For research question one, instructor-student rapport, a contributing factor to classroom engagement and success, showed some connections to the perceived gender of the instructor, but not as many significant

connections as was theorized (See Table 1 in Appendix A). Only one of the nine statements showed a statistically significant difference between female and male instructors. The female STEM participants with a female instructor more strongly agreed with the statement "my instructor respected me" than those with a male instructor. Two other statements, "my instructor treated me fairly" and "my instructor encouraged me", had near statistically significant results. Although none of the extant literature compared instructor-student rapport between female students in STEM, the study's results were partially consistent with Lammers and Byrd's 2019 study, in which female students had high rapport ratings with both feminine and masculine instructors. Given some statistically significant relationships were revealed, it seems that instructor gender could impact how the female STEM student interacts with their instructor and the feelings they have about those interactions, but more research will be needed on this topic.

Unexpectedly, the female participants' perceived classroom participation levels and final letter grades did not have any statistically significant relationship with the gender of the instructor as explored in research questions two and four (See Table 1 in Appendix A). These findings were inconsistent with the research of Bailey and colleagues (2020) and Solanki and Xu (2018), in which female students' classroom engagement and course grades increased with the introduction of a female STEM instructor. The findings of the study were more consistent with those of Leraas et al. (2018), Hoffmann and Oreopoulos (2009), and Howard and Henney (1998), in which instructor gender did not have any significant impact on classroom participation or grade performance. A possible explanation is that instructor-student rapport and participation in conjunction contribute to academic success (Frisby et al., 2014; Frisby et al., 2016; Frisby & Martin, 2010; Leraas et al., 2018). Leraas and colleagues (2018), Frisby and colleagues (2014), and Frisby and Martin (2010) found that instructor-student rapport was associated with

participation. In this study, instructor-student rapport had few statistically significant relationships instructor gender. If instructor-student rapport was not strongly correlated with instructor gender but is correlated with participation, then it follows, that participation would not have a strong correlation with instructor gender.

Based on past research findings that more females in the classroom resulted in increased participation and final letter grades of female students, it was theorized that similar outcomes would be found in this study (Bailey et al., 2020). However, no such outcomes were observed, and no statistically significant relationships were found between classroom gender composition and perceived levels of participation or final letter grades. A contributor to this incongruent result is perhaps this study's limited sample size and the low number of participants who perceived their classrooms as female-dominated, n = 2.

Although this study focused on female students' engagement and success in STEM fields, participants were asked to estimate the level of engagement for both males and females in their classrooms. This estimation had two functions. First, the estimations were used as comparisons to past studies about the experience of female university students in STEM. Past studies found that females in STEM have poorer levels of engagement and participation than their male peers. In this study, the female students, on average, ranked their male peers as having better levels of classroom engagement and participation (See Tables 27 and 28 in Appendix A). Therefore, the university environment of this study is similar to those in others, in which males are outperforming females in terms of participation. Second, a lack of significant differences in these levels of engagement for both groups given instructor gender or classroom gender composition would suggest that perhaps other factors are impacting engagement, such as variables specific to the instructor including teaching style or teacher bias (Solanki & Xu, 2018).

This study found no significant relationships between male and female group engagement and instructor gender or classroom gender composition which is consistent with past research conducted by Howard and Henney (1998), Leraas and colleagues (2018), and Aguillon and colleagues (2020).

The perceived gender composition of the faculty was also analyzed for its relationship to the participants' perceived gender of their instructor and classroom gender composition. Interestingly, the instructor's gender did not have any significant relationship with the perceived gender composition of the faculty, but the gender composition of the classroom did. The data analysis showed a strong statistically significant relationship between perceived classroom gender composition and faculty gender composition. It seems that perceptions of one aspect of the environment influence the perceptions of another, in this case, gender composition. Even if these perceptions are not congruent with the actual gender compositions of classrooms or faculty, they still demonstrate how gender is a master status that individuals use to understand and interpret their environment (Carter & Fuller, 2015). These results are consistent with the study by Olsson and Martiny (2019), which found gender representation to be important both within classrooms and in faculty to ensure that female STEM students feel connected to and represented in their university environment. Connectedness, a result of instructor-student rapport and representation, can help decrease feelings of participation anxiety and counteract the effects of the chilly climates found in STEM classrooms (Fassinger, 1995; Hall & Sandler, 1982, 1984; Sandler & Hall, 1986, as cited in Crombie et al, 2003; Frisby et al., 2014). In support of this theory, the studies by Bailey and colleagues (2020) and Solanki and Xu (2018) found that gender representation in faculty and student composition contributed to classroom engagement and success for female students.

Involvement in STEM extracurriculars and clubs was also analyzed in connection to instructor gender, classroom gender composition, faculty gender composition, instructor-student rapport, and classroom participation. One statistically significant relationship was found between involvement in STEM extracurriculars or clubs and classroom participation. Participants who were involved in STEM extracurriculars or clubs agreed more strongly with the statement "I contributed without hesitation" than those who were not. Similarly, one statistically significant relationship was found for the instructor-student rapport statement "my instructor encouraged me", with participants involved in STEM extracurriculars agreeing more strongly than those who were not. These results could be explained by variables unique to the participants, such as lower participation apprehension and more willingness to share or interact in class (Frisby et al., 2014). Involvement in extracurriculars demonstrates the participants' innate lack of participation apprehension, which could explain why they ranked themselves with more classroom participation and better instructor-student rapport than participants who were not involved. Nevertheless, this significant finding suggests that engagement in the classroom is related to involvement outside of the classroom. For the purpose of encouraging more females to enter into and persist in STEM fields, educational institutions may benefit from the creation of STEM-related extracurricular activities and clubs aimed at female students.

Similar to the results of research questions two and three, involvement in extracurricular activities was not related to instructor gender or classroom gender composition (See Table 1 in Appendix A). These results were not entirely unexpected due to the lack of significant relationships between classroom participation, instructor gender, and classroom gender composition. As evidence by this study, classroom participation and involvement in extracurriculars are slightly related. However, classroom participation was not correlated with

classroom gender composition or instructor gender, which was consistent with past research (Howard & Henney, 1998; Leraas et al., 2018). Therefore, it is not entirely unexpected that involvement in extracurriculars would not be correlated with instructor gender or classroom gender composition. Given the connections between grade performance, motivation, and involvement in extracurricular activities, more research should be conducted to see if gender perceptions within STEM classrooms and departments influence female students' involvement (Gottfried & Williams, 2013; King et al., 2020; Stringer et al., 2019).

Limitations

Although this study attempted to answer the question of what environmental factors may influence the engagement and success of female students in STEM, few significant answers were found, and more robust research is needed on this topic. This study had multiple limitations which should be improved on in future research. First, the sample size was very small, and some relationships were perhaps overlooked or perceived as nonexistent. For example, a significant finding in research on gender in STEM, is that female students perform better with a female teacher and/or a female majority. However, as stated previously, only two participants identified their classrooms as female-dominated. Second, casual relationships are unable to be investigated with the current study's design. Participants were asked for their perceptions and beliefs related to a course they completed in the past. Not only are the results subject to the inaccuracies and biases of memory and perception, but the variables are also unable to be manipulated to analyze certain relationships.

Third, participants were from various majors and the courses used for reflection were not identified. This poses a risk of confounding variables, such as instructor or participant specifics. Instructors may vary in teaching style, participation expectations, communication styles, and

general demeanor resulting in erroneous comparisons between instructors, even those of the same perceived gender. Similarly, participants vary in general levels of classroom engagement due to social confidence and willingness to share in the educational setting. Fourth, members of STEM-related extracurriculars and clubs were invited to participate, which could contribute to a sample of participants with levels of classroom participation and instructor relationships that are not representative of the population. Furthermore, the sampling method used was voluntary response. Finally, due to the sample size constraints, the instructor-student rapport and classroom participation statements were analyzed individually rather than as a whole scale. Therefore, the scales are no longer standardized.

To address these limitations, an experimental design would be needed. An experimental design would ensure an adequate sample size, including enough female-dominated classrooms to conduct a proper comparison. A larger sample size would also allow for an analysis of the instructor-student rapport and classroom participation scales as a whole as opposed to individual statements. A random sampling method would also be favorable to eliminate the chance of sampling bias. The same participants should be used throughout the study to ensure each rating of instructor-student rapport, participation, and final letter grade were subject to the same internal variations. Similarly, the instructors selected for the study should have similar teaching styles, professional demeanors, and expectations of their students. Data for the experimental study should be both self-report and observational to collect data on perceptions and actual occurrences within the classroom.

Conclusion

Female university students are facing the adverse consequences of gendered spaces in STEM fields. Men currently outnumber women in engineering, physics, mathematics, and

statistics; and educators and policymakers have tried with little success to increase the number of females in STEM (National Science Board, 2018). Beyond the enrollment disparities, male STEM students are outperforming their female peers by participating more in the classroom (Aguillon et al., 2020; Bailey et al., 2020). With educational success closely linked to classroom participation and instructor-student rapport, researchers have begun looking at factors influencing the engagement and success of female STEM students with the hope of improving university environments to fit their needs. In this study, gender perceptions were investigated as a possible contributor to female students' low performance in STEM fields. Instructor gender, classroom gender composition, and faculty gender composition were analyzed for connections to instructor-student rapport, classroom participation, final letter grade, and extracurricular involvement. Theoretically, the appearance of more female role models - instructors, faculty, and classmates - in the university STEM environment would promote counter-stereotypical ability beliefs for female students, resulting in higher levels of engagement and success.

The findings of this study were limited, but the results indicate that instructor gender may be one factor influencing instructor-student rapport. Furthermore, the perceived gender composition of the classroom was connected to the perceived faculty gender composition. Therefore, perceptions of gender were shown to have some influence over female STEM students' navigation and interpretation of the university environment. Other findings, such as the connections between STEM extracurricular involvement, instructor-student rapport, and classroom participation, illustrate the importance of further research on the contributors to student engagement and involvement in the classroom and beyond. Perhaps with more research, the factors influencing females' low involvement and poor performance in STEM fields will be uncovered, and the gender gaps closed.

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Appendix A

Research Questions

1. Is the perceived gender of the instructor related to female STEM students' perceived instructor-student rapport?
2. Is the perceived gender of the instructor related to female STEM students' perceived classroom participation level?
3. Is the perceived classroom gender composition related to female STEM students' perceived classroom participation level?
4. Is the perceived gender of the instructor related to female STEM students' final letter grades?
5. Is the perceived classroom gender composition related to the final letter grade of female STEM students?
6. Is the perceived gender of the instructor related to the classroom engagement of both male and female STEM students?
7. Is the perceived classroom gender composition related to the classroom engagement of both male and female STEM students?
8. Is the perceived gender of the instructor related to the female STEM students' perception of their department's faculty gender composition?
9. Is the perceived gender composition of the classroom related to female STEM students' perception of their major's faculty gender composition?
10. Is the female STEM students' department related to the perceived gender composition of its faculty?
11. Is the perceived gender of the instructor related to the female STEM students' involvement in STEM extracurriculars and clubs?
12. Is the female STEM students' involvement in STEM extracurriculars and clubs related to perceived classroom participation level?
13. Is the female STEM students' involvement in STEM extracurriculars related to estimated instructor-student rapport?
14. Is the perceived gender composition of the classroom related to the female STEM students' involvement in STEM extracurriculars and clubs?
15. Is the perceived faculty gender composition of the female STEM students' department related to involvement in STEM extracurriculars and clubs?

Table 1

Instructor-Student Rapport: Overall Average Statement Rank

Statement	Average rank
My instructor cared about me.	3.46
My instructor communicated effectively.	3.67
My instructor was approachable when I had questions or comments.	3.72
In general, I was satisfied with my relationship with my instructor.	3.79
My instructor encouraged me.	3.82
My instructor had earned my respect.	3.85
My instructor understood me.	3.87
My instructor treated me fairly.	3.92
My instructor respected me.	4.15

Table 2

Participation: Overall Average Statement Rank

Statements	Average Rank
I contributed to class	3.05
I volunteered when I knew the answers	3.05
I volunteered in class	2.51
I contributed without hesitation	2.38
I expressed personal opinions	1.74

Table 3

Participant Majors

Major	Count	Percent of Sample	Major	Count	Percent of Sample
Biological Engineering	3	7.7%	Computer Science	3	7.7%
Biology	7	17.9%	Data Science	1	2.6%
Biomedical Engineering	6	15.4%	Earth Science	3	7.7%
Chemical Engineering	2	5.1%	Industrial Engineering	2	5.1%
Chemistry	3	7.7%	Mathematics	2	5.1%
Civil Engineering	2	5.1%	Mechanical Engineering	2	5.1%
Computer Engineering	2	5.1%	Physics	1	2.6%

Table 4

Instructor-Student Rapport: Male Instructor

	My instructor understood me.	My instructor encouraged me.	My instructor cared about me.	My instructor treated me fairly.	My instructor communicated effectively.	My instructor respected me.	My instructor had earned my respect.	My instructor was approachable when I had questions or comments.	In general, I was satisfied with my relationship with my instructor.
Strongly disagree	7.7%	11.5%	11.5%	7.7%	7.7%	7.7%	7.7%	11.5%	11.5%
Somewhat disagree	11.5%	7.7%	7.7%	15.4%	11.5%	3.8%	11.5%	11.5%	7.7%
Neither agree nor disagree	19.2%	15.4%	30.8%	11.5%	11.5%	19.2%	15.4%	7.7%	15.4%
Somewhat agree	26.9%	42.3%	38.5%	30.8%	38.5%	30.8%	30.8%	42.3%	34.6%
Strongly agree	34.6%	23.1%	11.5%	34.6%	30.8%	38.5%	34.6%	26.9%	30.8%

Table 5

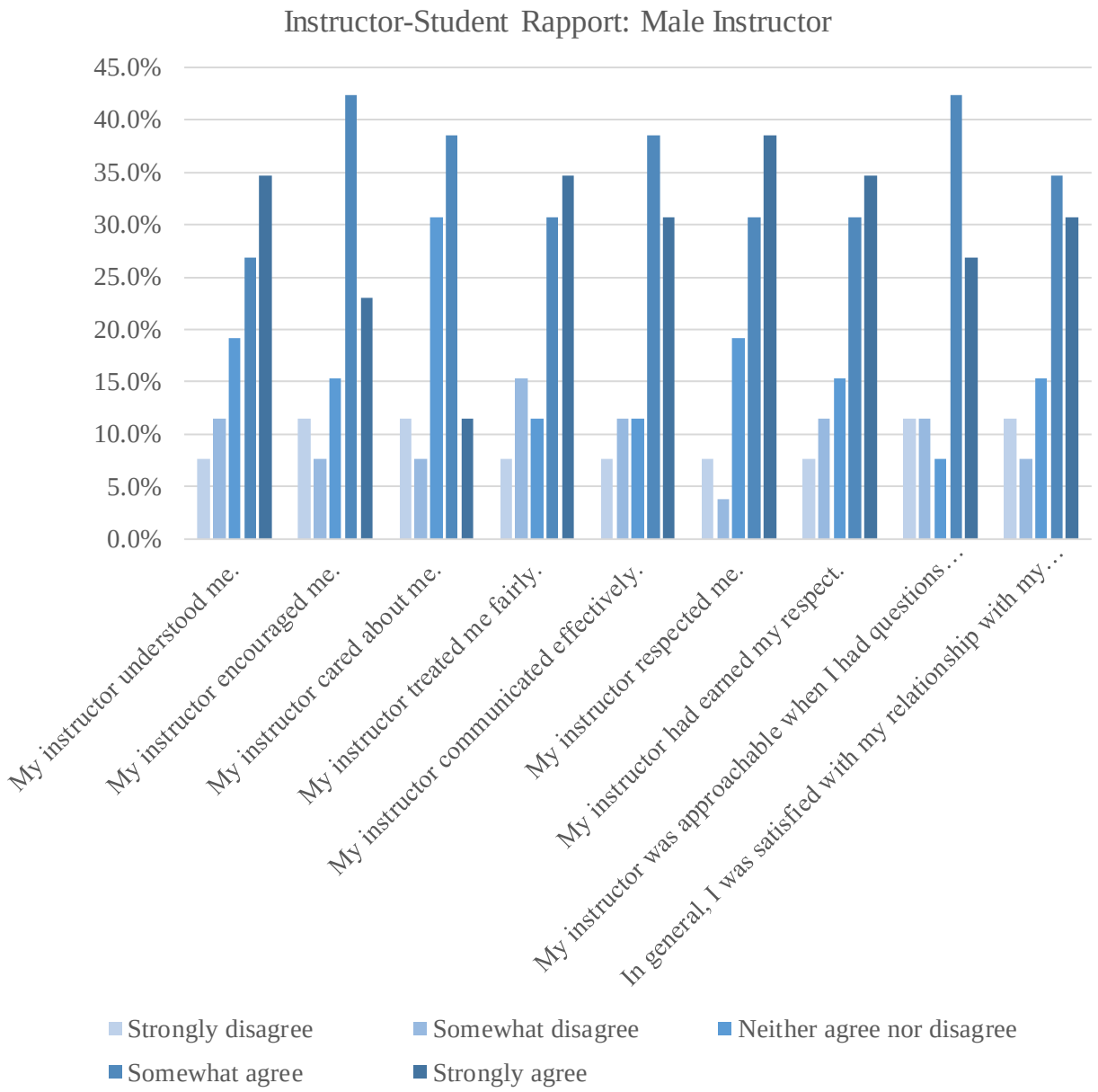
Instructor-Student Rapport: Male Instructor
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
My instructor understood me.
My instructor encouraged me.
My instructor cared about me.
My instructor treated me fairly.
My instructor communicated effectively.
My instructor respected me.
My instructor had earned my respect.
My instructor was approachable when I had questions…
In general, I was satisfied with my relationship with my…
Strongly disagree
Somewhat disagree
Neither agree nor disagree
Somewhat agree
Strongly agree

Figure 1

Instructor-Student Rapport: Male Instructor

Statements	Average Rank	Standard Deviation
My instructor cared about me.	3.31	1.16
My instructor encouraged me.	3.58	1.27
My instructor was approachable when I had questions or comments.	3.62	1.33
In general, I was satisfied with my relationship with my instructor.	3.65	1.32
My instructor understood me.	3.69	1.29
My instructor treated me fairly.	3.69	1.32
My instructor communicated effectively.	3.73	1.25
My instructor had earned my respect.	3.73	1.28
My instructor respected me.	3.88	1.21

Table 6

Instructor-Student Rapport: Female Instructor

	My instructor understood me.	My instructor encouraged me.	My instructor cared about me.	My instructor treated me fairly.	My instructor communicated effectively.	My instructor respected me.	My instructor had earned my respect.	My instructor was approachable when I had questions or comments.	In general, I was satisfied with my relationship with my instructor.
Strongly disagree	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Somewhat disagree	0.0%	0.0%	15.4%	7.7%	30.8%	0.0%	15.4%	15.4%	15.4%
Neither agree nor disagree	15.4%	15.4%	30.8%	7.7%	7.7%	0.0%	7.7%	15.4%	7.7%
Somewhat agree	46.2%	38.5%	15.4%	23.1%	38.5%	30.8%	30.8%	30.8%	30.8%
Strongly agree	38.5%	46.2%	38.5%	61.5%	23.1%	69.2%	46.2%	38.5%	46.2%

Table 7

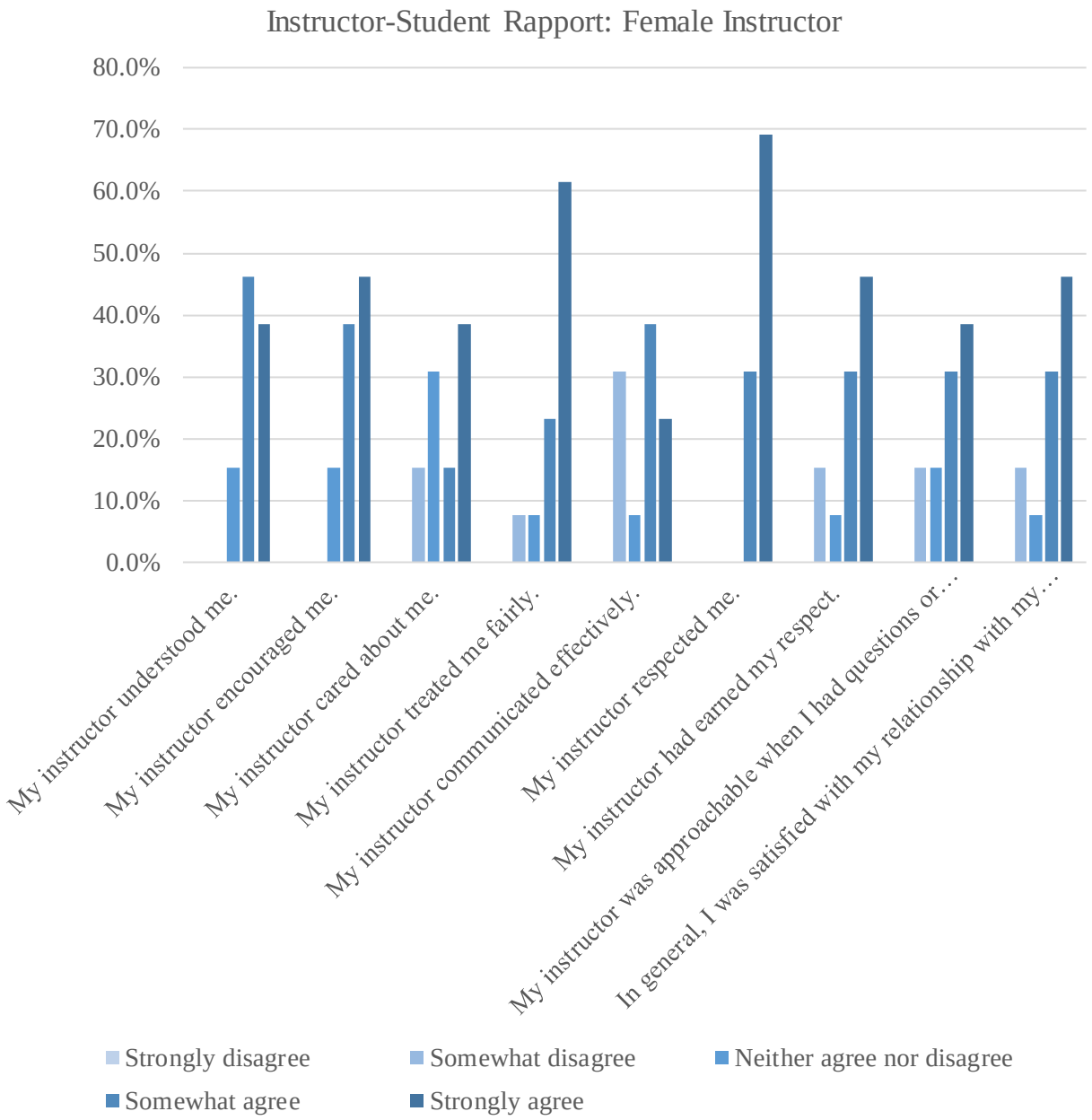
Instructor-Student Rapport: Female Instructor
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
My instructor understood me.
My instructor encouraged me.
My instructor cared about me.
My instructor treated me fairly.
My instructor communicated effectively.
My instructor respected me.
My instructor had earned my respect.
My instructor was approachable when I had questions or…
In general, I was satisfied with my relationship with my…
Strongly disagree
Somewhat disagree
Neither agree nor disagree
Somewhat agree
Strongly agree

Figure 2

Instructor-Student Rapport: Female Instructor

Statements	Average Rank	Standard Deviation
My instructor communicated effectively.	3.54	1.20
My instructor cared about me.	3.77	1.17
My instructor was approachable when I had questions or comments.	3.92	1.12
My instructor had earned my respect.	4.08	1.12
In general, I was satisfied with my relationship with my instructor.	4.08	1.12
My instructor understood me.	4.23	0.73
My instructor encouraged me.	4.31	0.75
My instructor treated me fairly.	4.38	0.96
My instructor respected me.	4.69	0.48

Table 8

Instructor-Student Rapport with Instructor Gender Ranked T-test Results

Statement	P-value	Cohen's d
In general, I was satisfied with my relationship with my instructor.	0.325	0.348
My instructor was approachable when I had questions or comments.	0.532	0.221
My instructor had earned my respect.	0.422	0.282
My instructor respected me.	0.0129	0.807
My instructor communicated effectively.	0.592	0.188
My instructor treated me fairly.	0.0820	0.604
My instructor cared about me.	0.337	0.361
My instructor encouraged me.	0.0727	0.626
My instructor understood me.	0.245	0.376

Table 9

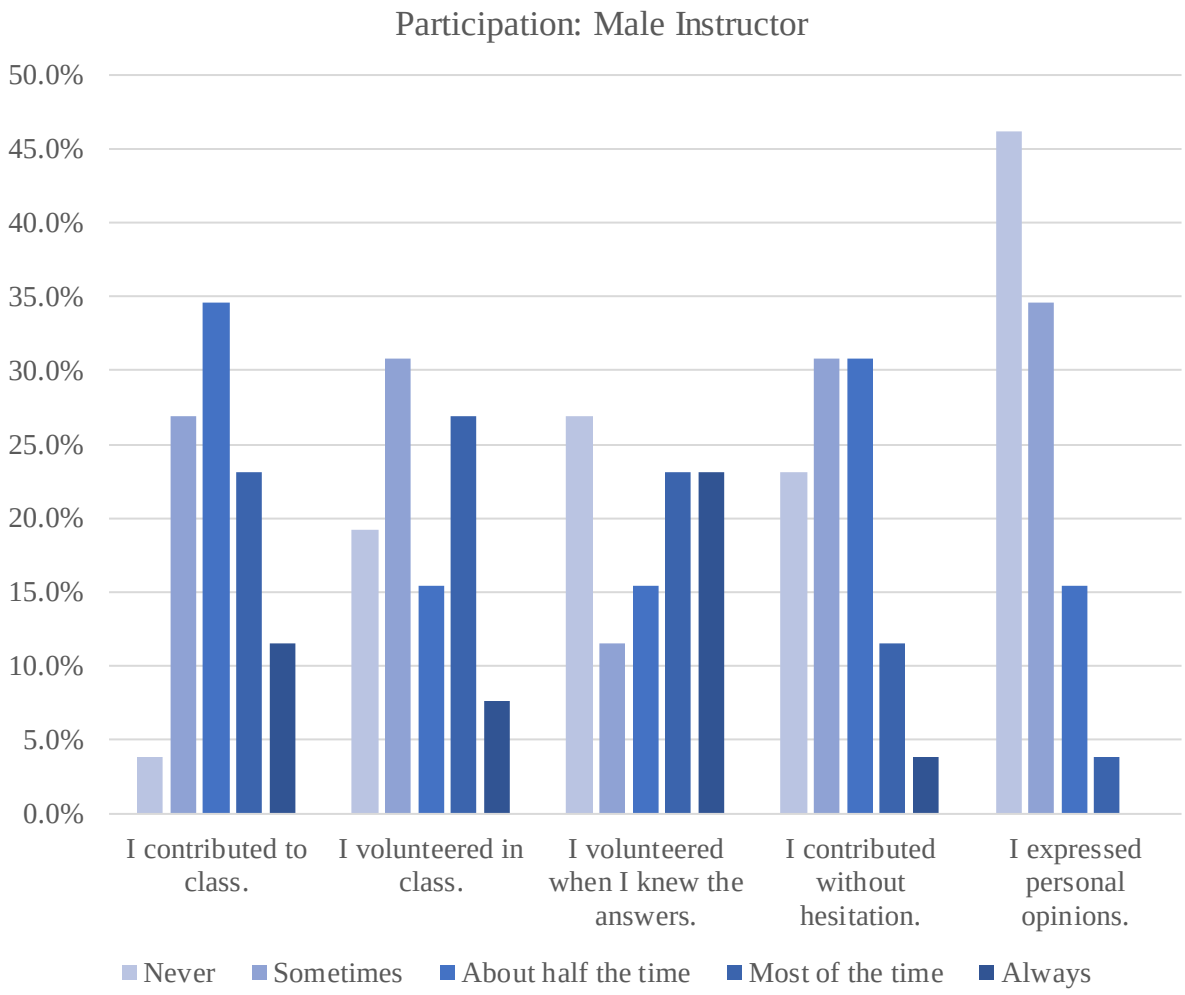
Participation: Male Instructor
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
I contributed to class.
I volunteered in class.
I volunteered when I knew the answers.
I contributed without hesitation.
I expressed personal opinions.
Never
Sometimes
About half the time
Most of the time
Always

Figure 3

Participation: Male Instructor

	I contributed to class.	I volunteered in class.	I volunteered when I knew the answers.	I contributed without hesitation.	I expressed personal opinions.
Never	3.8%	19.2%	26.9%	23.1%	46.2%
Sometimes	26.9%	30.8%	11.5%	30.8%	34.6%
About half the time	34.6%	15.4%	15.4%	30.8%	15.4%
Most of the time	23.1%	26.9%	23.1%	11.5%	3.8%
Always	11.5%	7.7%	23.1%	3.8%	0.0%

Table 10

Participation: Male Instructor

Statements	Average Rank	Standard Deviation
I expressed personal opinions.	1.77	0.86
I contributed without hesitation.	2.42	1.10
I volunteered in class.	2.73	1.28
I volunteered when I knew the answers.	3.04	1.56
I contributed to class.	3.12	1.07

Table 11

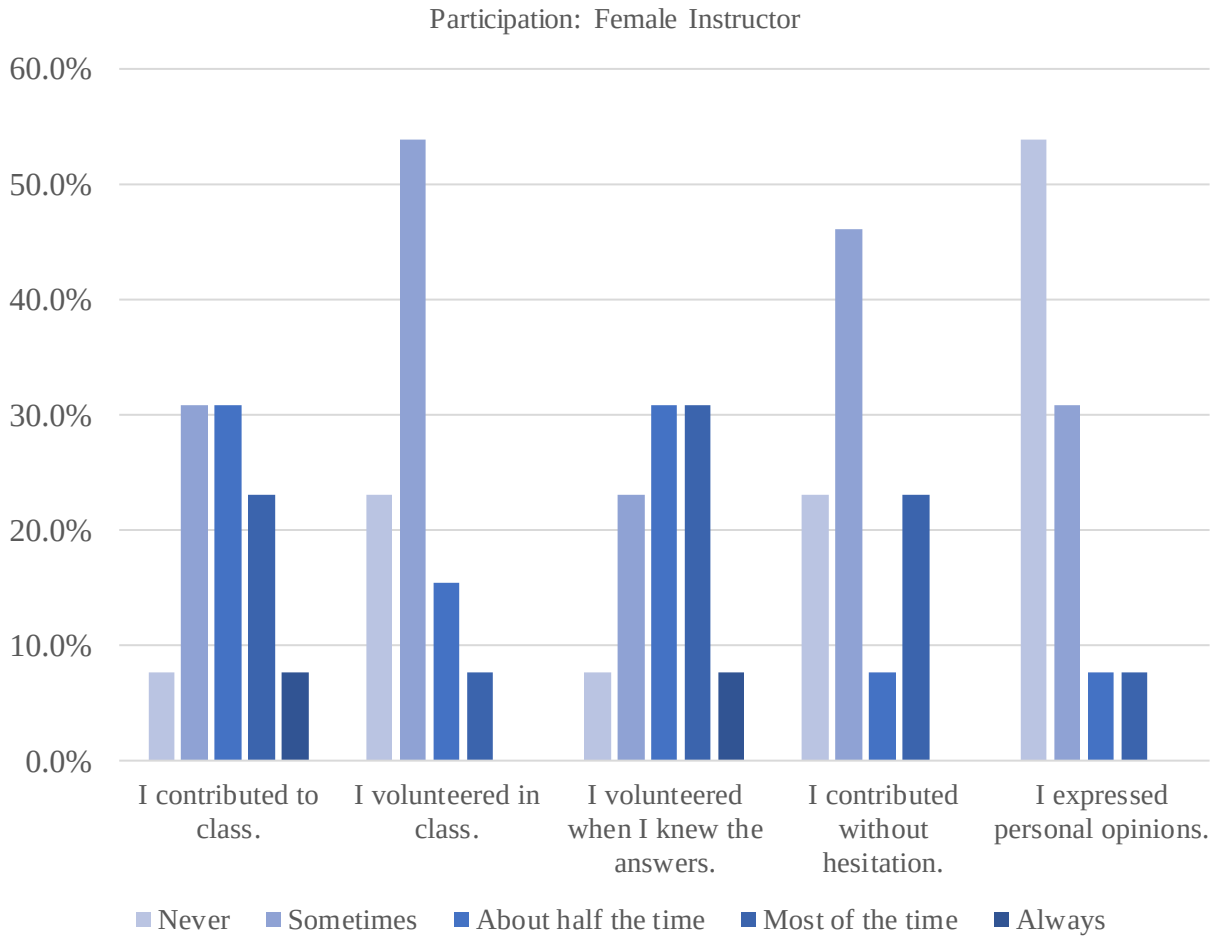
Participation: Female Instructor
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
I contributed to class.
I volunteered in class.
I volunteered when I knew the answers.
I contributed without hesitation.
I expressed personal opinions.
Never
Sometimes
About half the time
Most of the time
Always

Figure 4

Participation: Female Instructor

	I contributed to class.	I volunteered in class.	I volunteered when I knew the answers.	I contributed without hesitation.	I expressed personal opinions.
Never	7.7%	23.1%	7.7%	23.1%	53.8%
Sometimes	30.8%	53.8%	23.1%	46.2%	30.8%
About half the time	30.8%	15.4%	30.8%	7.7%	7.7%
Most of the time	23.1%	7.7%	30.8%	23.1%	7.7%
Always	7.7%	0.0%	7.7%	0.0%	0.0%

Table 12

Participation: Female Instructor

Statements	Average Rank	Standard Deviation
I expressed personal opinions.	1.69	0.95
I volunteered in class.	2.08	0.86
I contributed without hesitation.	2.31	1.11
I contributed to class.	2.92	1.12
I volunteered when I knew the answers.	3.08	1.12

Table 13

Participation with Instructor Gender Ranked T-test Results

Statements	P-value	Cohen's d
I volunteered in class.	0.107	0.528
I contributed to class.	0.634	0.171
I expressed personal opinions.	0.695	0.140
I contributed without hesitation.	0.730	0.123
I volunteered when I knew the answers.	0.974	0.0105

Table 14

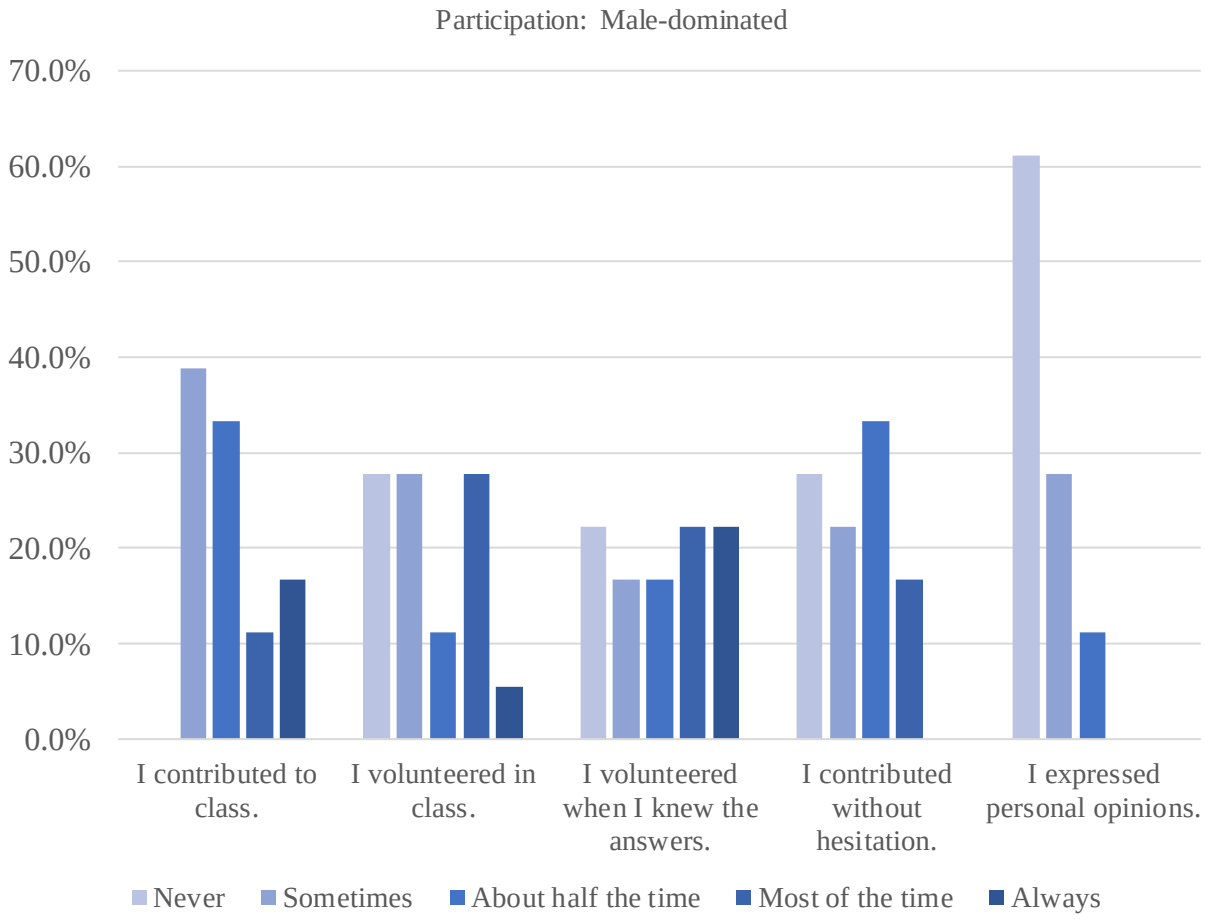
Participation: Male-dominated
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
I contributed to class.
I volunteered in class.
I volunteered when I knew the answers.
I contributed without hesitation.
I expressed personal opinions.
Never
Sometimes
About half the time
Most of the time
Always

Figure 5

Participation: Male-Dominated

	I contributed to class.	I volunteered in class.	I volunteered when I knew the answers.	I contributed without hesitation.	I expressed personal opinions.
Never	0.0%	27.8%	22.2%	27.8%	61.1%
Sometimes	38.9%	27.8%	16.7%	22.2%	27.8%
About half the time	33.3%	11.1%	16.7%	33.3%	11.1%
Most of the time	11.1%	27.8%	22.2%	16.7%	0.0%
Always	16.7%	5.6%	22.2%	0.0%	0.0%

Table 15

Participation: Male-Dominated

Statements	Average Rank	Standard Deviation
I expressed personal opinions.	1.50	0.71
I contributed without hesitation.	2.39	1.09
I volunteered in class.	2.56	1.34
I contributed to class.	3.06	1.11
I volunteered when I knew the answers.	3.06	1.51

Table 16

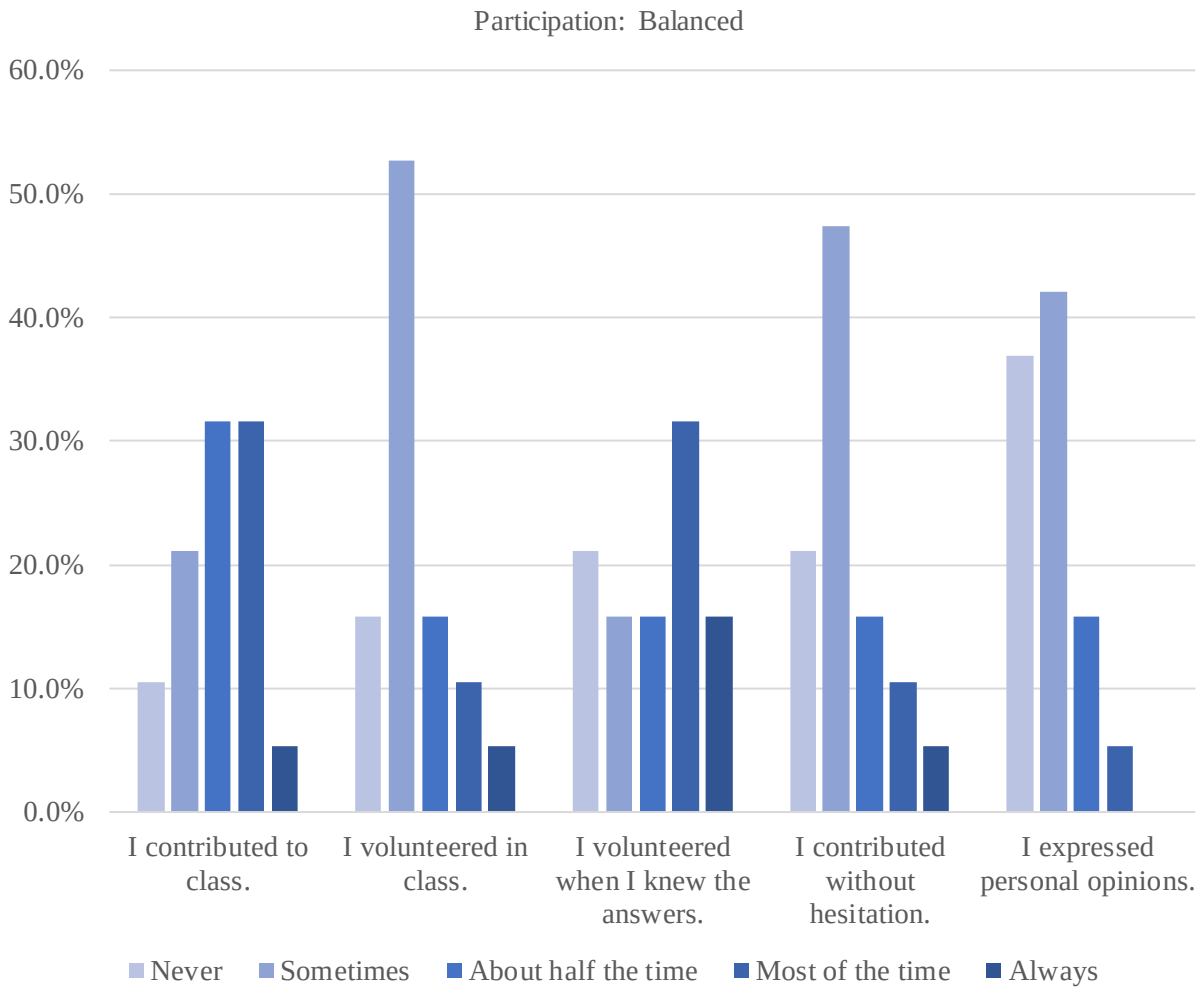
Participation: Balanced
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
I contributed to class.
I volunteered in class.
I volunteered when I knew the answers.
I contributed without hesitation.
I expressed personal opinions.
Never
Sometimes
About half the time
Most of the time
Always

Figure 6

Participation: Balanced

	I contributed to class.	I volunteered in class.	I volunteered when I knew the answers.	I contributed without hesitation.	I expressed personal opinions.
Never	10.5%	15.8%	21.1%	21.1%	36.8%
Sometimes	21.1%	52.6%	15.8%	47.4%	42.1%
About half the time	31.6%	15.8%	15.8%	15.8%	15.8%
Most of the time	31.6%	10.5%	31.6%	10.5%	5.3%
Always	5.3%	5.3%	15.8%	5.3%	0.0%

Table 17

Participation: Balanced

Statements	Average Rank	Standard Deviation
I expressed personal opinions.	1.89	0.88
I contributed without hesitation.	2.32	1.11
I volunteered in class.	2.37	1.07
I contributed to class.	3.00	1.11
I volunteered when I knew the answers.	3.05	1.43

Table 18

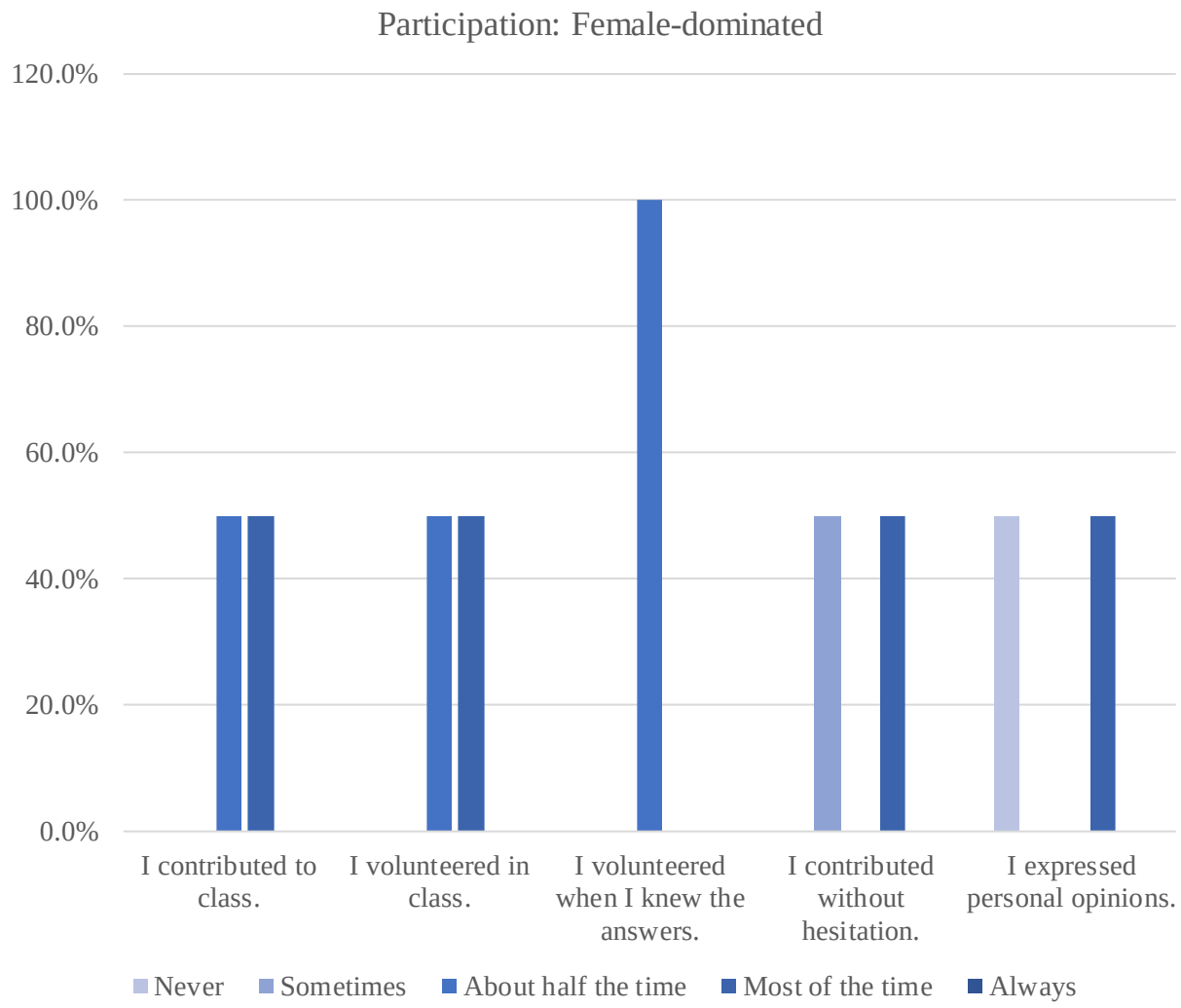
Participation: Female-dominated
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
I contributed to class.
I volunteered in class.
I volunteered when I knew the answers.
I contributed without hesitation.
I expressed personal opinions.
Never
Sometimes
About half the time
Most of the time
Always

Figure 7

Participation: Female-Dominated

	I contributed to class.	I volunteered in class.	I volunteered when I knew the answers.	I contributed without hesitation.	I expressed personal opinions.
Never	0.0%	0.0%	0.0%	0.0%	50.0%
Sometimes	0.0%	0.0%	0.0%	50.0%	0.0%
About half the time	50.0%	50.0%	100.0%	0.0%	0.0%
Most of the time	50.0%	50.0%	0.0%	50.0%	50.0%
Always	0.0%	0.0%	0.0%	0.0%	0.0%

Table 19

Participation: Female-Dominated

Statements	Average Rank	Standard Deviation
I expressed personal opinions.	2.50	2.12
I volunteered when I knew the answers.	3.00	0.00
I contributed without hesitation.	3.00	1.41
I contributed to class.	3.50	0.71
I volunteered in class.	3.50	0.71

Table 20

Participation with Classroom Gender Composition Ranked ANOVA Results

Statements	P-value	Cohen's f
I expressed personal opinions.	0.487	0.261
I volunteered in class.	0.148	0.228
I contributed without hesitation.	0.815	0.141
I contributed to class.	0.690	0.121
I volunteered when I knew the answers.	0.988	0.0318

Table 21

Final Letter Grade: Female Instructor

Letter Grade	Count	Percentage
A	9	69.2%
B	2	15.4%
C	2	15.4%

Table 22

Final Letter Grade: Male Instructor

Letter Grade	Count	Percentage
A	10	38.5%
B	10	38.5%
C	5	19.2%
D	1	3.8%

Table 23

Final Letter Grade: Male-Dominated

Letter Grade	Count	Percentage
A	7	38.9%
B	7	38.9%
C	3	16.7%
D	1	5.6%

Table 24

Final Letter Grade: Balanced

Letter Grade	Count	Percentage
A	10	52.6%
B	5	26.3%
C	4	21.1%

Table 25

Final Letter Grade: Female-Dominated

Letter Grade	Count	Percentage
A	2	100.0%

Table 26

Engagement Level: Perceived Females

Rank	Count	Percentage
Terrible	1	2.6%
Poor	7	17.9%
Average	15	38.5%
Good	13	33.3%
Excellent	3	7.7%
Average Rank		3.26

Table 27

Engagement Level: Perceived Males

Rank	Count	Percentage
Terrible	0	0.0%
Poor	1	2.6%
Average	11	28.2%
Good	25	64.1%
Excellent	2	5.1%
Average Rank		3.72

Table 28

Engagement Level with Male and Female Instructor: Perceived Females

Instructor Gender	Terrible	Poor	Average	Good	Excellent	Average Rank
Male	3.8%	23.1%	38.5%	30.8%	3.8%	3.08
Female	0.0%	7.7%	38.5%	38.5%	15.4%	3.62

Table 29

Engagement Level with Male and Female Instructor: Perceived Males

Instructor Gender	Terrible	Poor	Average	Good	Excellent	Average Rank
Male	0.0%	3.8%	34.6%	57.7%	3.8%	3.62
Female	0.0%	0.0%	15.4%	76.9%	7.7%	3.92

Table 30

Engagement Level with Different Classroom Gender Compositions: Perceived Females

Gender Composition	Terrible	Poor	Average	Good	Excellent	Average Rank
Male-Dominated	5.6%	16.7%	44.4%	27.8%	5.6%	3.11
Balanced	0.0%	21.1%	31.6%	42.1%	5.3%	3.32
Female-Dominated	0.0%	0.0%	50.0%	0.0%	50.0%	4.00

Table 31

Engagement Level with Different Classroom Gender Compositions: Perceived Males

Gender Composition	Terrible	Poor	Average	Good	Excellent	Average Rank
Male-dominated	0.0%	0.0%	38.9%	61.1%	0.0%	3.61
Balanced	0.0%	5.3%	21.1%	68.4%	5.3%	3.74
Female-dominated	00%	0.0%	0.0%	50.0%	50.0%	4.50

Table 32

Faculty Gender Composition with Male or Female Instructor

Faculty Gender Composition	Male Instructor		Female Instructor	
	Percentage	Count	Percentage	Count
Male-dominated	65.4%	17	61.5%	8
Balanced	30.8%	8	30.8%	4
Female-dominated	3.8%	1	7.7%	1

Table 33

Faculty Gender Composition with Classroom Gender Composition

Faculty Gender Composition	Classroom Gender Composition		
	Male-dominated	Balanced	Female-dominated
Male-dominated	83.3%	47.4%	50.0%
Balanced	11.1%	52.6%	0.0%
Female-dominated	5.6%	0.0%	50.0%
Total	100%	100%	100%
Count	18	19	2

Table 34

Involvement in STEM Extracurriculars with Male and Female Instructor

Involvement	Male Instructor		Female Instructor	
	Percentage	Count	Percentage	Count
Yes	69.2%	18	76.9%	10
No	30.8%	8	23.1%	3

Table 35

Involvement in STEM Extracurriculars with Classroom Participation Ranked T-test Results

Statements	P-value	Cohen's d
I contributed without hesitation.	0.0125	0.924
I expressed personal opinions.	0.0807	0.582
I volunteered in class.	0.0674	0.555
I contributed to class.	0.416	0.319
I volunteered when I knew the answers.	0.487	0.237

Table 36

Involvement in STEM Extracurriculars with Instructor-Student Rapport Ranked T-test Results

Statements	P-value	Cohen's d
My instructor encouraged me.	0.0359	0.801
My instructor understood me.	0.167	0.533
My instructor respected me.	0.211	0.519
My instructor earned my respect.	0.225	0.489
In general, I was satisfied with my relationship with my instructor.	0.281	0.432
My instructor communicated effectively.	0.576	0.249
My instructor cared about me.	0.578	0.240
My instructor treated me fairly.	0.628	0.185
My instructor was approachable when I had questions or comments.	0.772	0.112

Table 37

Involvement in STEM Extracurriculars with Classroom Gender Composition

Involvement	Male-Dominated		Balanced		Female-Dominated	
	Percentage	Count	Percentage	Count	Percentage	Count
Yes	72.2%	13	68.4%	13	100%	2
No	27.8%	5	31.6%	6	0.0%	0

Table 38

Involvement in STEM Extracurriculars with Faculty Gender Composition

Involvement	Male-Dominated		Balanced		Female-Dominated	
	Percentage	Count	Percentage	Count	Percentage	Count
Yes	68.0%	17	75.0%	9	100%	2
No	32.0%	8	25.0%	3	0.0%	0

Table 39

Appendix B

Institutional Review Board Exemption Letter

UNIVERSITY OF ARKANSAS

To:	Rheanna Kaylee Morgan
From:	Justin R Chimka, Chair IRB Expedited Review
Date:	11/01/2021
Action:	**Exemption Granted**
Action Date:	11/01/2021
Protocol #:	2110361964
Study Title:	A Retrospective Study of the Relationships Between Course Instructor Gender, Classroom Gender Composition and Female Students' Academic Achievement and Engagement in STEM Fields.

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Jacob Goffnett, Investigator

Appendix C

Questionnaire

1. Please think of a course that you have completed within your departmental major. Reflect upon your personal interactions and observations. Read through the statements below and select the response that best represents how much you agree or disagree with each statement. (Participants were asked to select a response from strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, or strongly agree)
    a. My instructor understood me.
    b. My instructor encouraged me.
    c. My instructor cared about me.
    d. My instructor treated me fairly.
    e. My instructor communicated effectively.
    f. My instructor respected me.
    g. My instructor earned my respect.
    h. My instructor was approachable when I had questions or comments.
    i. In general, I was satisfied with my relationship with my instructor.
2. Reflecting on the same course selected for the previous question, read through the statements below and select the response that best represents the frequency you performed each activity. (Participants were asked to select a response from never, sometimes, about half of the time, most of the time, or always)
    a. I contributed to class.
    b. I volunteered in class.
    c. I volunteered when I knew the answers.
    d. I contributed without hesitation.

    e. I expressed personal opinions.

3. Please select the number 3 for this question. (Participants were asked to select a response from 1, 2, 3, or 4)
4. What is your level of study at the University of Arkansas? (Participants were asked to select a response from undergraduate or graduate)
5. Please select the department of the course you reflected on to answer the previous surveys. (Participants were asked to select a response from biological engineering, biology, biomedical engineering, chemical engineering, chemistry, civil engineering, computer engineering, computer science, data science, earth science, electrical engineering, geology, industrial engineering, mathematics, mechanical engineering, or physics)
6. What was the perceived gender of the instructor of your selected course? (Participants were asked to select a response from male or female)
7. What was the estimated gender composition of your selected course? (Participants were asked to select a response from male-dominated, balanced, or female-dominated)
8. For your selected course, estimate the overall student engagement by gender group. (Participants were asked to select a response from: terrible, poor, average, good, or excellent)
    a. Perceived female students
    b. Perceived male students
9. What final letter grade did you receive in your selected course? (Participants were asked to select a response from A, B, C, D, or F)

10. Thinking of your major, what do you perceive to be the gender composition of the faculty? (Participants were asked to select a response from male-dominated, balanced, or female-dominated)
11. Do you participate in any STEM-related extracurricular clubs or activities? (Participants were asked to select a response from yes or no)
12. Would you like to enter the raffle to win 1 or 10 $50 Amazon gift cards? Your response will still remain anonymous. (Participants were asked to select a response from yes or no)