HIGH SCHOOL EDITION
Journal of Student Research
Volume 11 Issue 3 (2022)

Analyzing Gender Differences in FIRST® Robotics Challenge by FIRST® Robotics

Ria Rajpal[1], Kate Sample[2#] and Eileen Torraca[1#]

[1]West Broward High School
[2]FIRST Robotics
[#]Advisor

ABSTRACT

Technological innovation has grown over the years, so there has been a greater demand for the STEM workforce. Thus, many initiatives have been taken to meet this demand. One of these many initiatives is robotics. Over the years, many robotics leagues have been created, the most notable being FIRST Robotics and Vex Robotics. While these initiatives are implemented to bring change, marginalized groups like women have been known to be undermined in the activity. This paper aims to address this issue by studying gender differences, specifically in the FIRST Robotics Challenge (FRC) by FIRST robotics. The study was conducted through online surveys taken by participants of FRC that utilized both quantitative and qualitative data. This data was analyzed to discover how males felt about aspects of the activity versus females. This study finds that females have had a net negative experience within FIRST as they faced less encouragement, more discrimination, comments doubting ability, etc., compared to their male counterparts. With this understanding, more effort should be taken to retain and encourage the future involvement of females in robotics. Future research is needed to address this issue in other male-dominated activities to allow society to meet demands in the STEM workforce and provide equal opportunity to those entering the field.

Introduction

Throughout the world, the demand for STEM (Science, Technology, Engineering, and Math) labor is rapidly increasing as our reliance on technology grows. The United States Bureau of Labor Statistics explains that half a million jobs in STEM will open within the next ten years (Ziberman and Ice, 2021).To meet demands, 10,000 engineers must be produced yearly to allow for productivity and innovation (Salzman, 2013). To combat this demand for labor within STEM industries, as many individuals as possible must be encouraged into the industry through different initiatives and programs. However, these trends of encouragement are not displayed as certain marginalized groups, like women, make up a minority in this field.

In the United States, despite the huge demand, women make up 27% of the STEM workforce while men make up 73% of the workforce (Martinez and Christinact, 2021). This is extremely problematic as not only does this prevent the United States from fulfilling its labor shortage but also ethically wrong as women deserve an equal role in contributing to innovations in STEM. As a result, many researchers have looked at different ways to spur STEM involvement within the younger generation and various groups like women.

One of these methods to increase involvement is robotics during their primary education. Of the many robotics competitions and leagues, one of the most notable ones is hosted by FIRST Robotics called the First Robotics Competition (FRC). Their mission serves to “inspire young people to be science and technology leaders and innovators, by engaging them in exciting mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership (FIRST Robotics, 2022).” With over 2.5 million participants since its creation (FIRST Robotics, 2022), female participants are a smaller make-up, or 31% of FIRST robotics (Salem, 2018). This makeup is reflective of the STEM

workforce. Due to the lack of involvement in STEM for women, researchers conclude getting young girls involved in robotics like FIRST Robotics is essential as it increases STEM activity, interest, knowledge, careers, and identity for young girls by factors of 1.4-3.3 times (Hoover et al., 2021). This research hopes to examine differences in the experience of FIRST Robotics to create more effective strategies for involving more women in the activity. This study provides data/findings on the experiences of participants of FIRST Robotics, specifically the First Robotics Challenge (FRC), through 3 sections: differences in experience, mentor satisfaction, and confidence in FIRST-related activities.

Literature Review

Women in the STEM workforce

The STEM workforce, including computer scientists, engineers, chemists, and physicists, is currently disproportionately male as the United States Census Bureau quantifies women as 27% of the workforce (Martinez and Christnacht, 2021). This is specifically concerning as women make up 47% of the entire workforce. Many attribute this to a lack of STEM education for women as they are 30% of STEM degrees, with those with a degree in STEM entering healthcare and education rather than STEM (Ryan, 2017). Pew Research explains that the lack of women in the field is attributed to the lack of encouragement when they were young, lack of mentors, and discrimination creating a negative connotation (Funk and Parker, 2018). Additionally, those that enter the field face entirely different experiences than their male counterparts that are rooted in stereotypes and discrimination. The Pew Research Center furthers women face lower salaries and unequal treatment inhibiting their recruitment, hiring, and promotions. They quantify that 50% of women in the STEM workforce face gender-related discrimination in the sense that they were paid less, were treated as they were incompetent, experienced microaggressions, felt unsupported by seniors, endured isolation, were passed on for important assignments, and denied job and promotions (Funk and Parker, 2018). Many researchers feel the most effective way is to combat these stereotypes from when they begin in their youth through education, programs, and initiatives to prevent discrimination and stereotypes from continuing into their adulthood and within future generations.

Gender Disparities in STEM Education

Since gender discrimination begins in adolescence, much research has been done to look at this difference during one's primary education. One study done by researchers Tessa E.S. Charlesworth and Mahzarin R. Banaji (2019) in the journal of neuroscience concludes that in high school, women are 23% of Advanced Placement computer science students and 29% of Advanced Placement Physics students. These trends continue as more men end up declaring a STEM major in college as they receive more training and education. Similarly, researchers Corbin and Hill (2010) of the American Association of University Women discovered that the girls that take Advanced Placement courses in STEM score lower than their male counterparts. They attribute this to their concept of "stereotype threat," which is when a stereotype cognitively and emotionally creates a burden or the fear that the stereotype will be proved true, which ends up hurting one's performance even when they initially feel confident they will succeed. This "stereotype threat" also inhibits individuals from entering the field in the first place. When the stereotype is removed, the individual ends up succeeding and pursuing the activity. This concept is why many believe young girls underperform or do not enter technical fields to begin with. As a result, many initiatives have been done and studied to remove this stereotype. A case study done by 3 researchers, Peggy Doerschuk, Jiangjiang Liu, and Judith Mann of Lamar University, studied a program that enrolled middle school girls in computing summer camps. They concluded this program encouraged students to pursue computer science by increasing their confidence and knowledge. Similarly, Amanda Sullivan and Marina Umaschi Bers (2012) also performed a study that worked to introduce girls to STEM and remove this disparity. They did so by introducing children (boys and girls) to robotics and computer science, concluding that

introducing both boys and girls to STEM before stereotypes began to level the playing field for both groups. This resulted in success in STEM for both groups, where they equally performed and worked with one another.

Robotics Leagues

As highlighted above, robotics is a key tool to use to encourage both men and women into STEM in an equal and supportive environment. As a result, many competitive robotics leagues have been created over the years. It started over 20 years ago in colleges like MIT with its "Back to the Future" and Trinity College with its " Firefighting Robot Contest," where students would participate in week-long seasons where they design, build and program robots to compete in designated challenges to develop and enhance skills in engineering, programming, etc. The competitions are often played like many sports in which brackets occur, and spectators watch as teams compete (Mallinson, 2015 Trinity College, 2021). These collegiate robotics competitions paved the way for robotics leagues for young children from grades K-12. Over the years, robotics leagues like FIRST robotics, Vex Robotics, RoboCup, and World Robot Olympiad have been created for various age groups. This activity presents various benefits in both the educational aspect and individual aspects. Educational benefits include improved math, computer science, engineering, and other technical skills. Individual aspects include collaboration and a strong work ethic (Ryan, 2021). Additionally, this provides kids with an experience that allows them to find a passion in STEM and increase innovative thinking to create a brighter future. Robotics leagues have had major successes with having millions of participants globally, becoming televised events and capturing interest in STEM.

Women In Robotics

Despite robotics leagues having numerous successes, gender issues remain prevalent throughout the various leagues. This first issue is the gender imbalance, where there are disproportionately more men than females in robotics. For example, women make up 23% of VEX Robotics and 31% of FIRST Robotics (Girl Powered, 2018 Salem, 2018). Specifically, in a division of FIRST Robotics called FIRST Lego League (FLL), boys outnumber girls by a 5:2 ratio (Melchior, Cutter, & Cohen, 2004). However, this imbalance is extremely problematic as women involved in FIRST are 3.2 times more likely to have stronger outcomes in a STEM activity, 2.2 times more likely to have stronger outcomes in STEM interest, 2.1 times more likely to have stronger outcomes in STEM knowledge, 1.9 times more likely to have stronger outcomes in STEM Careers, and 1.4 times more likely to have stronger outcomes in STEM identity than those who are not involved (Meschede, Warfield, Hoover, Haque, 2021). Due to this large imbalance, research has been done addressing the differences that can result in the small female population. However, very few studies and research has been done on the topic, specifically in FIRST Robotics, leaving a gap that this inquiry hopes to solve. Of the literature available, it mainly concerns VEX Robotics. According to Bers and Sullivan (2019), there were not many differences in experiences as both participant groups had the same mentor satisfaction and had an overall positive experience. Although, in certain areas like building and general technical ability, men had stronger outcomes than women. While this study explores gender differences in VEX Robotics, whose purpose is similar to the area of inquiry of FIRST Robotics, there are significant differences in how it operates like team size, season differences, costs, etc. can result in a different conclusion.

FIRST Robotics

FIRST Robotics is a robotics league that encompasses participants from grades K-12 through 3 different leagues: FIRST Lego League (FLL), FIRST Technical Challenge (FTC), and FIRST Robotics Competition (FRC.). These events combine "the excitement of traditional sports with the rigor of STEM learning, engaging millions of people with programs that have a proven impact on learning, interest, and skill-building inside and outside of the classroom. FIRST builds powerful mentorship relationships between young people and STEM professionals, helping

kids gain confidence to explore the innovation process while they learn valuable science, engineering, technology, teamwork, and problem-solving skills (FIRST Robotics, 2021).” Since its founding in 1989, FIRST Robotics has engaged almost 2.5 million people in over 34 countries. However, females make up 31% of FIRST robotics (Salem, 2018). This study hopes to study the experiences of males and females that result in such a large gender balance to address and create strategies to increase female involvement to provide for the need of individuals in STEM and level the playing field of the STEM workforce. Therefore, the question guiding this work is: What gender differences exist in FIRST Robotics, specifically the FIRST Robotics Competition (FRC)?

Hypothesis

The researcher hypothesizes that gender differences experienced in the FIRST Robotics Competition (FRC) division of FIRST Robotics must be drastic to result in a 30% female/70% male imbalance. However, confidence in most FIRST-related activities and mentor satisfaction will be fairly equal, similarly to a study done by Bers and Sullivan (2019) on VEX Robotics. This is because those who don’t feel confident or satisfied with their mentor would most likely exit the activity, preventing their results from being incorporated and resulting in the low population of females in FIRST Robotics.

Methodology

To effectively answer the research question, online surveys were distributed to participants of the FIRST Robotics Competition. Since this study focuses on gender differences in FRC, online surveys were imperative because they utilized qualitative and quantitative data to reach a conclusion. The methodology used was based on Bers and Sullivan’s study “VEX ROBOTICS COMPETITIONS: GENDER DIFFERENCES IN STUDENT ATTITUDES AND EXPERIENCES,” which studied gender differences in VEX Robotics. However, the methodology used is different in the sense it solely utilizes participants' experiences as mentors are sometimes unaware of situations going on in a team. Additionally, it uses a larger sample size to reflect a larger and deeper understanding of student perception of gender differences. These surveys were reviewed and approved by the Institutional Review Board (IRB). The questions used in the survey are located in appendix B..

Surveys were sent through the researcher’s coach on their FRC team to coaches of other FRC teams, which were then distributed to members of said teams. One hundred and twenty responses, with 85 women, 30 men, and 5 who identified as another gender. Before completing the survey, consent was obtained from the participants, which informed those who took the survey that their responses would be used while their identity was protected. Said consent form was approved and reviewed by the Institutional Review Board (IRB). The consent form is located in appendix A.

The survey utilized 3 sections: Experience Evaluation, Mentor Satisfaction, and Confidence in FIRST-related skills. The Experience Evaluation section is composed of multiple-choice questions, mainly yes, no, or no impact/not sure questions with the ability to elaborate, excluding the question on Gender. Additionally, one open-ended question was used. In the Mentor Satisfaction section, Multiple Choice questions were used to determine the genders of their mentors, and a scaled question from 1 to 10 was used to determine satisfaction with those mentors. The 1 meant not satisfied at all, and the 10 meant very satisfied. In the confidence in FIRST-related skills section, scaled questions from 1-10 were used to determine confidence in certain skills like building, programming, driving, etc. A one correlated to not being confident at all, and a 10 signified very confidently.

Results

Experience Evaluation

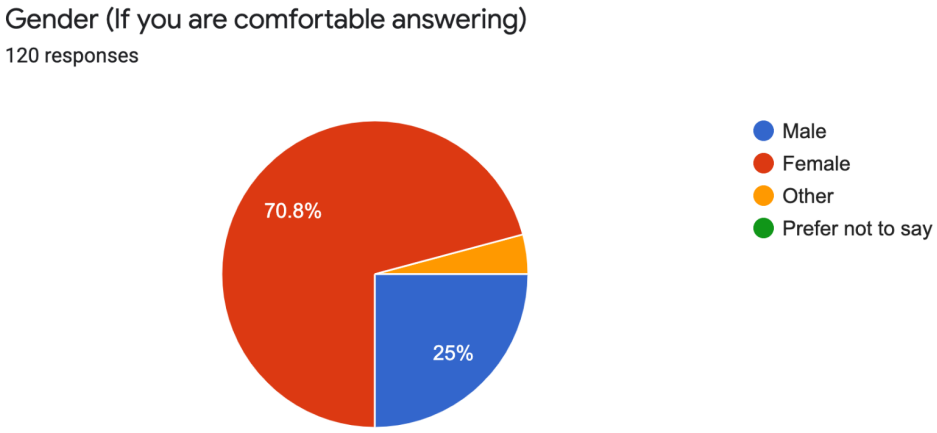

Figure 1. Demographics of Participants

According to the demographic data collected, female students outnumbered male students, with there being 71% or 88 females, while 25% or 30 males and the rest of the 4 percent or 5 participants identified as another gender (see Figure 1). This demographic came as a shock, as an imbalance has been statistically proven with a seventy percent male and thirty percent female population. However, an important factor to consider is the motivations when taking this survey. It has been experimentally proven that women desire to change on a higher level than men do when it comes to resolving inequalities based on gender and gender experiences (Heymen, Hunt, Malik, and Slep, 2009). Due to this, we can see more women wanting to contribute to change in robotics, especially as they are the ones being affected, unlike men.

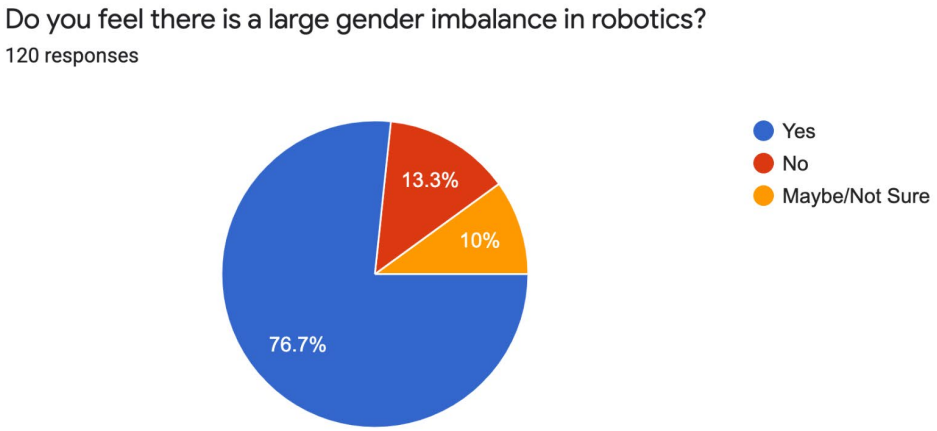

Figure 2. Gender Imbalance

When asked if there was a large imbalance in robotics, 92 (76.7%) individuals, both male, and female, responded "Yes" that there is an imbalance in robotics, and 16 (13.3%) individuals, both women and men felt there was not and 12 (10%) said not sure or maybe (see figure 2).

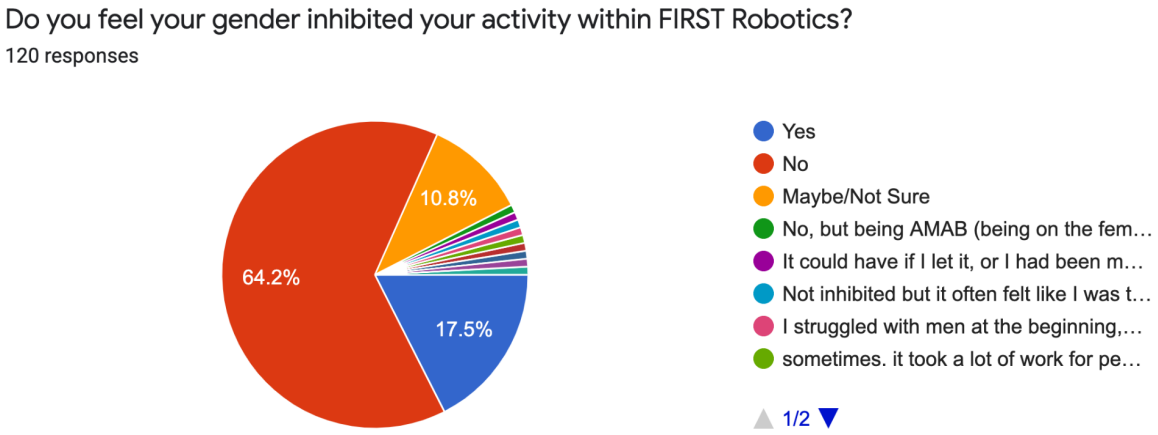

Figure 3. Gender Inhibiting Activity

Table 1. Notable quotes on gender inhibiting activity

Notable Quotes
"Not inhibited but it often felt like I was the "token female." I've noticed this with other females on our team. Most recently the female on programming." -female respondent
"It could have if I let it, or I would have been more uncomfortable standing up for myself."--female respondent

When asked if their gender inhibited their activity in FIRST Robotics, 77 (64.2%) individuals said no, 21 (17.5%) said yes, and 13(10.8%) said maybe/not sure (see figure 3), and 9 chose to respond with notable quotes (see table 1). These quotes all highlight that their gender negatively affected their experience but did not inhibit them. Of the individuals saying their gender hurt their activity in FIRST robotics, 19/21 (90.5%) were women.

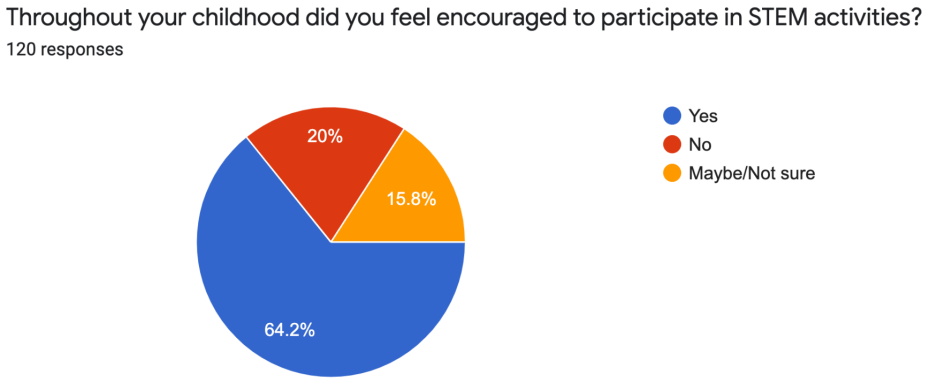

Figure 4. STEM encouragement as a Child

When asked if they felt encouraged to participate in STEM activities, 77 (64.2%) participants said yes, with mixed responses from men and women, and 24 (20%) said no, with 100% of these responses being female, and 19 (15.8%) participants said maybe or not sure with mixed responses from men and women (see figure 4).

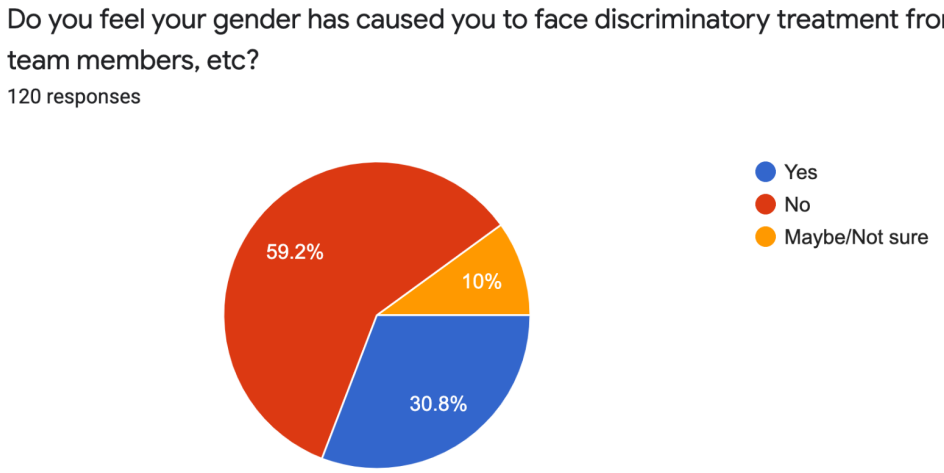

Figure 5. Discriminatory treatment

When asked if they felt their gender has caused them to face discriminatory treatment, 71 (59.2%) participants, a mix of males and females, said no. Meanwhile, 37 (30.8%) participants said yes, of whom 36 (97.3%) were female and 1 (2.7%) was male, and 12 (10%) participants who were all female said maybe/not sure (see figure 5).

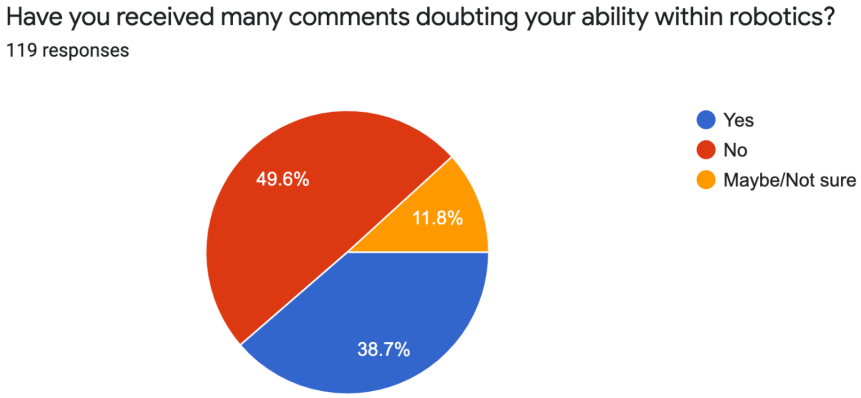

Figure 6. Comments doubting ability

When asked if they received comments doubting their ability, 59 (49.6%) participants of mixed genders said no, 46 (38.7%) participants, of which 42 (91.3%) were females and 4 (8.7%) were males said yes, and 14 (11.8%) participants of mixed genders said maybe/not sure.

Table 2. Gender's Role in Robotics

Male Participants	"My gender has played a small to insignificant role in my involvement in robotics. I felt that I was welcomed in the team regardless of gender." "I don't know if my gender has affected anything, but i've had a lot of experience with FIRST and during FTC there was almost an equal ratio of boys to girls, now in FRC there seems to be less involvement" "Honestly, not much, it's a very inclusive program where anyone can join and start doing anything." "As a man, I haven't really had any issues. That being said, there are not enough women in robotics. Like everywhere else, men make women feel uncomfortable. "
Female Participants	"I feel like on my team women are figure headshot . While there are many women in positions of leadership on my team, I feel as if we are just there so that we can be used as a percentage, so our team can say that they have all these women in positions of leadership, and as a sub team leader myself I feel I did not get the education that my male subteam members did. My mentors may chalk it up to that I was not putting in enough time but I was there everyday that we had to meet. Furthermore, when it came to competition week, and even though I am the design and fab sub team captain, I was never put in the pit on the agenda, a male member of my team was. Granted my education is my own and I am responsible to take it into my own hands when my expectations for my education are not met, in the future I hope I can find it in me to speak up about this issue on my team." "by being a girl, many of the "heavy" jobs have always been passed off to the guys on the team" "I feel I was pushed not to do design because I felt that's a girly thing to do, and I wanted to be different. I chose programming which was all guys (15), 2 girls (at the training, not on the team). I was a novice and knew nothing other than the word Java, but was very interested, despite my efforts to learn it seemed our make programming mentor had some inherent bias to women considering there has been only one female programmer in the past 3 years. Women have less of a push from society to program, which was evident by how many women knew any programming (0) versus how many were interested in it 4-5)" "My gender has allowed me to face biases that caused me to have to work harder in order to be there. My abilities were doubted for much longer than my male counterparts And my loud personality has thrown some of my team members off. I would say that being a female on stem has caused me to want to continue to help younger women grow in stem And be presented with mentors And positive environments I wasn't."

When asked how their gender plays a role in their experience in robotics, there were a few themes that appeared among the responses made based on gender. In most responses provided by males, they often said their gender does not play a role in their experience within the activity using phrases like “not much” or “small to the insignificant role.” Additionally, some often acknowledged the lack of inclusivity, mentioning: “less involvement” of girls and” not enough women in robotics”, while some claimed it was a “very inclusive program.” Meanwhile, in responses that were done by females, themes of biases, being passed off on jobs, and different educational experiences that men were common.

Mentor Satisfaction

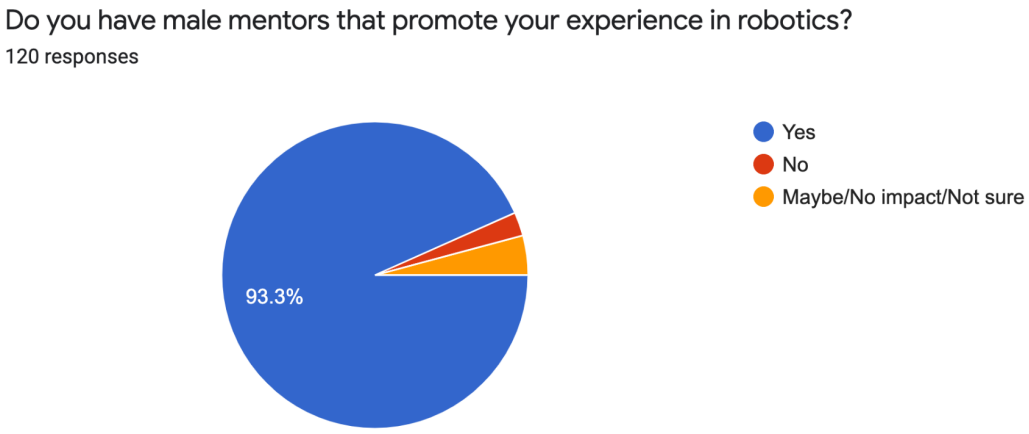

Figure 7. Male Mentor Satisfaction

When asked if they had male mentors that promoted their experience in robotics, 112 (93.3%) participants of mixed genders said yes, 3 (2.5%) participants of which 2 (67%) were women and 1 (33%) was a man said no, and 5 (4.2%) participants of who were all women said maybe/no impact/no sure.

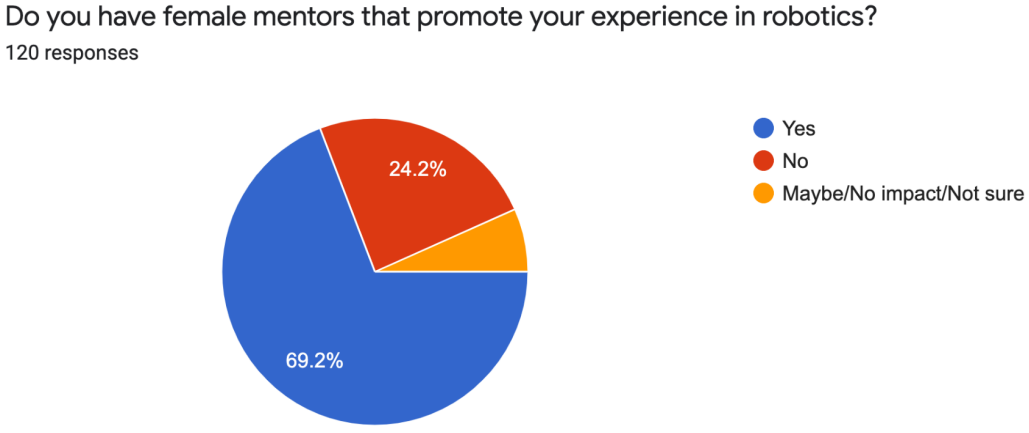

Figure 8. Female Mentor Satisfaction

When asked if they had female mentors that promoted their experience in robotics, 83 (69.2%) participants of mixed genders said yes, 29 (24.2%) participants of both men and women said no, and 8 (6.7%) participants of mixed genders said maybe/no impact/no sure (see Figure 8).

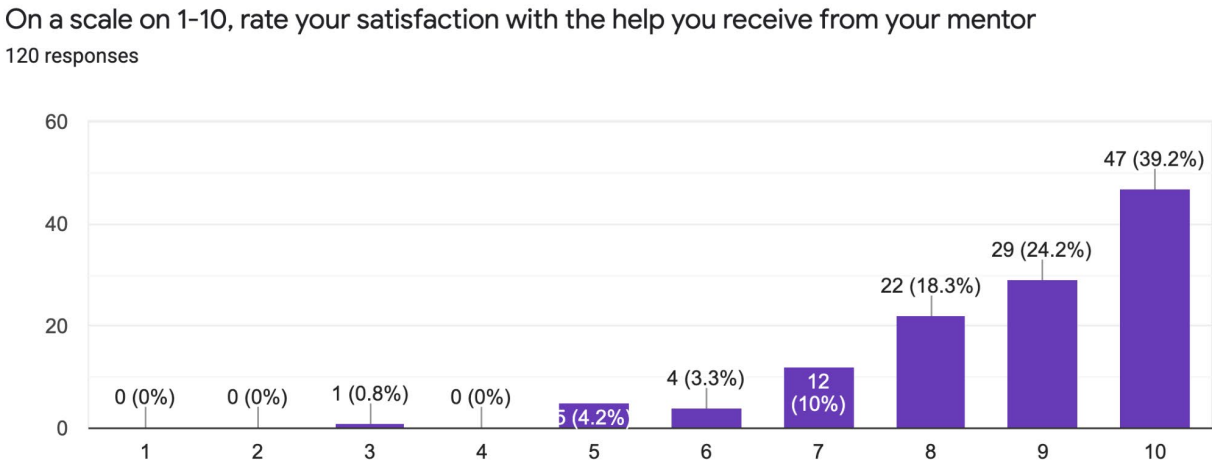

Figure 9. Overall Mentor Satisfaction

Of the 120 responses totaled from the survey when asked about their satisfaction overall with their mentor(s), the lowest response overall from a female was her rating of 3 for mentor satisfaction, and the lowest response from a male was his rating of a 6 for mentor satisfaction. The highest response was a 10 from both males and females. Men averaged an overall rating of 8.7. Meanwhile, females averaged an overall rating of 9.45. (see Figure 9)

Confidence in FIRST Related activities

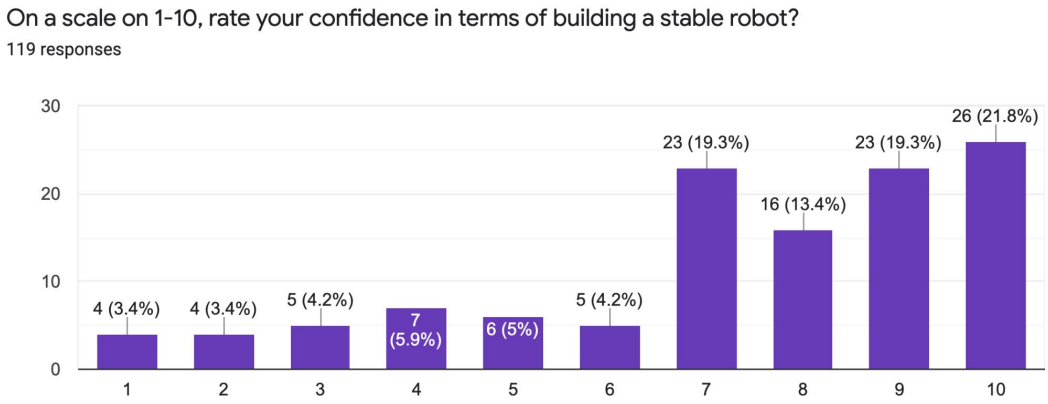

Figure 10. Confidence in Building a Robot

When asked about their confidence in building a robot, the answers varied from 1-to 10, with the overall lowest being from a female with a rating of one. Meanwhile, the lowest rating for males was a 5. On average, females' confidence in building a robot was 8.6, while males' confidence in building a robot was 8. (See Figure 10).

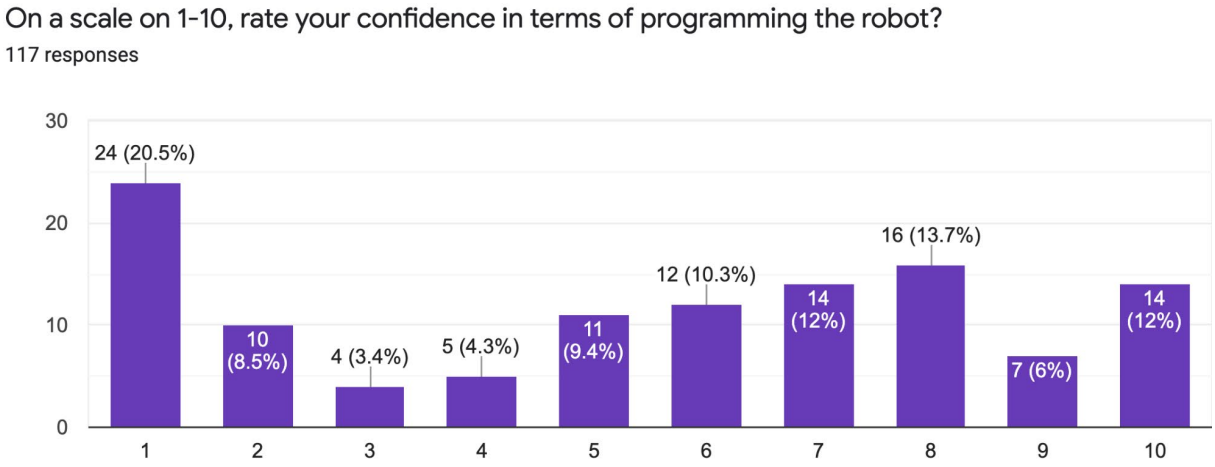

Figure 11. Confidence in Building a Robot

When asked about their confidence in programming a robot, the answers varied from 1-to 10, with the overall lowest being from a female with a rating of one. Similarly, the lowest rating for males was 1. On average, females' confidence in programming a robot was 6.1, while males' confidence in programming a robot was 6.7. (see Figure 11)

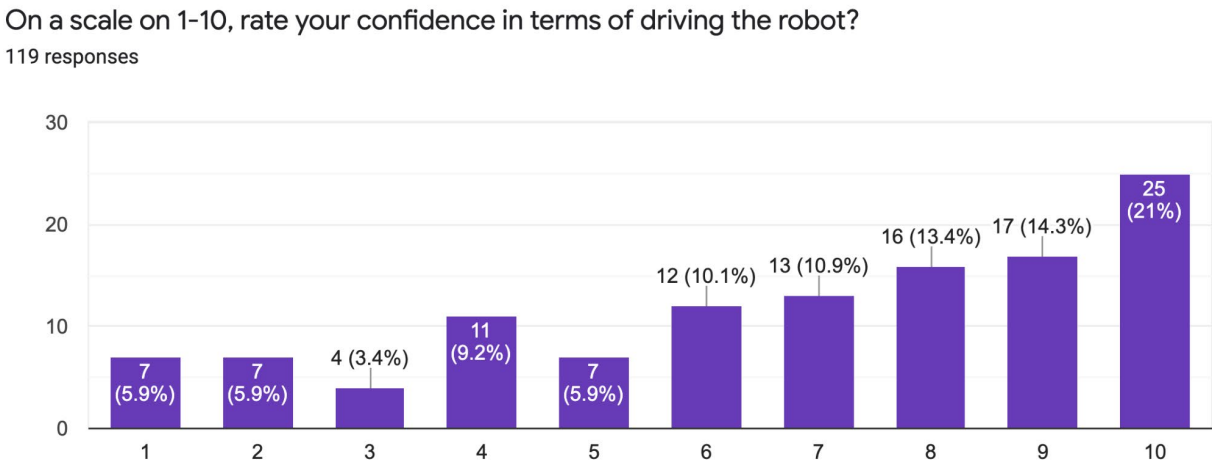

Figure 12. Confidence in Driving a Robot

When asked about their confidence in driving a robot, the answers varied from 1-to 10, with the overall lowest being from a female with a rating of one. Similarly, the lowest rating for males was 1. On average, females' confidence in programming a robot was 8, while males' confidence in programming a robot was 6.9. (see Figure 12)

Discussion

The findings from this study demonstrate that females have had a net negative experience in the FIRST Robotics Competition event of FIRST robotics as more women than men reported facing less encouragement, more discrimination, and many comments doubting their ability. Although females did have successes in driving and building a robot reporting greater average confidence in these skills, they were less confident in the programming section as they had lower average confidence in said skill. Overall, both men and women rated their mentor satisfaction highly but lacked female mentors that promoted their experience. These stark gender differences should be considered to develop initiatives to create a more positive experience that works with a strong education.

In the experience evaluation section, the following questions were asked: "Throughout your childhood, did you feel encouraged to participate in STEM activities?", "Do you feel there is a large gender imbalance in robotics?", "Do you have a large number of female members on your robotics team?", "Do you feel your gender inhibited your activity within FIRST Robotics?", "Do you feel your gender has caused you to face discriminatory treatment from judges, mentors, team members, etc.?" and "Have you received many comments doubting your ability within robotics?" The following open-ended question was also asked, "How has your gender played a role in your involvement in your activity in robotics?" In these questions, many women answered with positive experiences in which they did not feel inhibited, did not face discrimination, and felt supported, like most of the male responses. However, those that did respond with facing negative experiences in which they were inhibited, faced discrimination, and felt unsupported were majority female, accounting for around 90%-100% of the negative experiences per response. Additionally, in the open-ended question, women included details that highlighted their negative experiences like: "used as a percentage," "did not get the education that my male subteam members did," and "heavy jobs have been passed off to the guys on the team," and "pushed not to do design." On the other hand, men mainly responded by not being affected by their gender. This shows that comparatively, women face more differences that hurt their activity in robotics resulting in a net negative, while men face a net positive experience. These findings show that there should be more programs, initiatives, and measures put in place to "level the playing field" to result in a net positive experience that is equal to their male counterparts.

In the mentor satisfaction section, the following questions were asked: "Do you have male mentors that promote your experience in robotics?", "Do you have female mentors that promote your experience in robotics?" and "On a scale of 1-10, rate your satisfaction with the help you receive from your mentor." The responses showed that male mentors were present and overall satisfaction with their mentors was high, but it did show a lack of female mentors that positively contributed to the activity. This suggests that a larger presence of female mentors should be considered as they could have an influence in promoting the female experience in robotics.

In the confidence in FIRST-related activities section, the results were the opposite of the researcher's hypothesis in some ways. This is because women had a higher confidence rating in building a robot and driving the robot than men, as hypothesized by the researcher, but had a lower confidence rating than men in programming. This suggests that measures should be taken to equalize the educational differences in various skills/activities.

Limitations

While aspects of the initial hypotheses have been proved; there are a few limitations in the results. Firstly, there was a larger female population than the male population taking this survey because of the motivations of taking the survey. This resulted in the data not representing a representative example of the population involved in the FIRST Robotics Competition (FRC). However, it reflected the gender differences between the male and female populations. Thus, the results of the survey supported the findings drawn. Secondly, another limitation is that the scaled questions are subjective. For example, one participant's rating of 10 could be equivalent to one's rating of 7. However, parameters were set in the hopes of minizine this effect, and survey results would not have been compromised.

Implications

One implication of this study is that it opens a larger conversation in which effective solutions can be created to address the differences in experiences in FIRST robotics events like the FIRST Robotics Competition. These findings can also be applied to other male-dominated activities like other robotics leagues, speech & debate, Mu Alpha Theta, etc. Another implication of this study is working to provide more literature on gender differences in FIRST Robotics and the overarching program of robotics which is the first step toward solving the gender differences in the activity.

Conclusion

Overall, the differences in gender experiences were dramatic in some areas resulting in a net negative experience for women in FIRST Robotics, specifically the FIRST Robotics Challenge. The original hypothesis was partially proven true and partially proven false. The results showed that comparatively, women had a more negative experience in robotics as they faced discrimination, less encouragement, discouraging comments, biases, etc. Additionally, women faced less confidence in programming a robot. However, it did show equal mentor satisfaction and greater confidence in building and driving a robot. These results show that more action should be taken to address the differences to promote equality in robotics, remove the "stereotype threat" from continuing in the future and encourage more women into the STEM field. This will help create positive outcomes in the future as it will satisfy STEM demands, boost innovation, and level the playing field. In summary, the gender differences in robotics must be discussed to a larger extent to ultimately lead to positive outcomes by removing stereotypes and discrimination in STEM.

Areas for Future Research

Areas for future research can study their experiences in robotics in correlation to their experiences in the STEM workforce. Additionally, as a growing presence of those who identify as genders beyond male and female grow, research should be considered as those who identify as other genders are often subject to discrimination as well. Lastly, further research on skill confidence could be done by using tasks to determine one skill level to create an even more accurate conclusion.

Acknowledgments

I would like to thank everyone that played a role in helping my research paper be what it is. Firstly, I would like to thank Kate Sample for her assistance in distributing the online survey. I would not have been able to reach my findings without her help. Secondly, thank you to Eileen Torraca for guiding me through the Advanced Placement Capstone Program. Additionally, I would like to thank West Broward High School for providing me with the Capstone Program and providing me with opportunities like this. I would also like to especially thank all the participants as their input is what made this paper what it is. Lastly, I would like to thank my family and peers who have pushed me to pursue endeavors like this.

References

Charlesworth, T., & Banaji, M. R. (2019). Gender in Science, Technology, Engineering, and Mathematics: Issues, Causes, Solutions. *The Journal of neuroscience: the official journal of the Society for Neuroscience*, *39*(37), 7228–7243.

Corbett, C., & Hill, C. (2015). Solving the equation: The variables for women's success in engineering and computing. Washington, DC: American Association of University Women. Retrieved from https://files.eric.ed.gov/fulltext/ED580805.pdfhttps://doi.org/10.1523/JNEUROSCI.0475-18.2019

Dale, L. (2016, August 9). *Granite city Gearheads » blog archive » a comparison of FIRST and VEX (or VRC)*. Granite City Gearheads. https://www.granitecitygearheads.com/a-comparison-of-first-and-vex-or-vrc/

Doerschuk, P., Liu, J., & Mann, J. (2007). Pilot summer camps in computing for middle school girls. ACM SIGCSE Bulletin, 39(3), 4-8. https://doi.org/10.1145/1269900.1268789

FIRST ®. (n.d.). *FIRST ® Frequently Asked Questions*. FIRST | For Inspiration and Recognition of Science and Technology. https://www.firstinspires.org/sites/default/files/uploads/resource_library/first-faq.pdf

FIRST®. (2021, August 4). *Vision and mission*. FIRST. https://www.firstinspires.org/about/vision-and-mission

Girl Powered, (2018). Why girl powered? Retrieved from: https://www.girlpowered.com/why-girl-powered/

Heyman, R. E., Hunt-Martorano, A. N., Malik, J., & Slep, A. M. (2009). Desired change in couples: gender differences and effects on communication. *Journal of family psychology: JFP: journal of the Division of Family Psychology of the American Psychological Association (Division 43)*, *23*(4), 474–484. https://doi.org/10.1037/a0015980

Melchior A, Cutter T, & Cohen, F. (2004) Evaluation of FIRST LEGO league. Center for Youth and Communities, Heller Graduate School, Brandeis University.

Meschede, T., Warfield, M. E., Hoover, M., & Haque, Z. (2021, March). *FIRST® Longitudinal study: 2020 Survey Results (84-Month Follow Up)*. Graduate School for Social Policy and Management | The Heller School at Brandeis University. https://heller.brandeis.edu/cyc/reports/cyc-first-longitudinalstudy-impactsummaryreport-2020.pdf

Parker, K., & Funk, C. (2020, August 21). *Women and men in STEM often at odds over workplace equity*. Pew Research Center's Social & Demographic Trends Project. https://www.pewresearch.org/social-trends/2018/01/09/women-and-men-in-stem-often-at-odds-over-workplace-equity/

Ryan. (2021, April 6). *Robotics in education: Advantages, benefits & importance for kids*. iD Tech. https://www.idtech.com/blog/educational-benefits-robotics

Salem, T. (2018, May 9). *FIRST Robotics Championship Boosts Diversity*. https://www.usnews.com/news/stem-solutions/articles/2018-05-09/first-robotics-championship-makes-strides-in-diversity

Salzman, H. (2013). What Shortages? The Real Evidence About the STEM Workforce. *Issues in Science and Technology*, *29*(4), 58–67. http://www.jstor.org/stable/43315795

Sullivan, A., & Bers, M. U. (2019). VEX robotics competitions: Gender differences in student attitudes and experiences. *Journal of Information Technology Education: Research*, *18*, 097-112. https://doi.org/10.28945/4193

Trinity College Int'L Firefighting Home Robot Contest. (2021, August 24). https://trinityrobotcontest.org/

U.S. Census Bureau. (2021, January 26). *Women making gains in STEM occupations but still underrepresented*. The United States Census Bureau. https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupatiois-but-still-underrepresented.html

U.S. Department of Commerce Economics and Statistics Administration Office of the Chief Economist. (2017, November 13). *Women in STEM: 2017 Update*. ERIC - Education Resources Information Center. https://files.eric.ed.gov/fulltext/ED590906.pdf

Zilberman, A., & Ice, L. (2021, January 19). *Why computer occupations are behind strong STEM employment growth in the 2019–29 decade: Beyond the numbers: U.S. Bureau of Labor Statistics*. U.S. Bureau of Labor Statistics. https://www.bls.gov/opub/btn/volume-10/why-computer-occupations-are-behind-strong-stem-employment-growth.htm