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Where are the STEM Girls: The effects of Gender Equitable Teaching Strategies on the enrollment of female students in STEM courses?

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Abstract

The purpose of this study was to determine the impact that Gender Equitable Teaching Strategies (GETS) has on young women and their interest in pursuing STEM electives and career pathways at our high school. The research was conducted in an eighth grade STEM course called Automation and Robotics and with a focus group of six female students at the high school in grades 9-12. All 65 eighth grade students received GETS interventions throughout the study, but data was analyzed for the 30 female students only. Data was also gathered from the discussion with the six girls that participated in the focus group discussion. Classroom scheduling was modified to include opportunities for students to meet and interact with female STEM role models. The use of GETS was mindfully implemented in daily instruction with the eighth grade students throughout the nine week study by utilizing open-ended project based problem solving activities, teaching a growth mindset, aligning projects with communal goals, allowing collaborative efforts and multiple attempts to make their solutions work. The effectiveness of these strategies were measured with a STEM attitudes survey, thank you letters written to role models, analysis of data from a focus group discussion recording, and enrollment data. The results indicate positive outcomes for girl's stem identities and their desire to further investigate STEM electives and careers.

For our country to be successful in the global economy, we need to fill many open positions in STEM-related careers. Currently, women are vastly underrepresented in STEM related careers (Herman et al., 2016; Casad et al., 2018; Hill et al., 2010). Employment demand in STEM fields has been growing and is expected to continue growing at a rapid rate (Herman et al., 2016; Hill et al., 2010). To recruit and retain women in STEM fields, teachers of STEM must use interventions that make STEM education inclusive to women throughout their educational years. After all, women make up nearly 50% of our nation's workforce and half of the nation's college-educated workforce (Beede et al., 2011).

Female enrollment in STEM elective courses at East Grand Forks Senior High is low. Notably, female enrollment in the Principles of Biomed course taught by a female science teacher is relatively high (percentage), while enrollment in our engineering courses is predominantly male (94.3%). Last year only three female students, compared to 50 male students, registered for engineering courses offered at the high school. The courses offered are currently titled: Introduction to Engineering Design, Principles of Engineering, Civil Engineering and Architecture, Aerospace Engineering, and VEX Robotics Competition. All students, male and female, are required to take technology education courses in 7th and 8th grade at our middle school. Graduating classes are around 150 students with about a 50 percent mix of boys and girls. Twin Cities Public Television's research into best practices for engaging girls in STEM is known as SciGirls Strategies (TPT, 2013). These practices, known as Gender Equitable Teaching Strategies (GETS) provide a research basis for STEM and CTE teachers to improve their efficacy in STEM (Anderson, 2019; TPT, 2019; Billington, et al, 2013). To improve my ability to recruit and retain girls who take my 8th-grade technology education courses in my secondary engineering classes, I will review the literature supporting SciGirls strategies.

The demand for workers in STEM fields is increasing with the advancements of science and technology. Women currently make up approximately 50 percent of our nation's population, but women are severely underrepresented in STEM career fields (Beede et al., 2011). Diversifying the STEM workforce with the inclusion of women will increase creativity and help companies see problems with a different lens. Because such a large portion or our population is being underrepresented in STEM careers, strategies such as those captured in Twin Cities Public Television's (TPT) GETS include: introduction to role models, establishing communal goals, and teaching a growth mindset to positively effective girls' outlook on their STEM identities (Anderson, 2019; TPT, 2019; Billington, et al, 2013). When girls and young women can identify with STEM, they are more likely to participate in STEM courses and activities. Therefore, The purpose of this study is to see if integrating more gender equitable teaching strategies into my practice will improve female representation in STEM courses at the high school.

Theoretical Framework

Three theoretical frameworks stand out as being highly prevalent in my study. The first is the concept of teaching a Growth Mindset which was developed by Carol Dweck. The second is the Theory of Self-Efficacy which was developed by Albert Bandura. The third is the idea of communal goals which is a concept that stems from Social Role Theory, developed by Alice Eagly.

Growth Mindset Theory was developed by Carol Dweck and associates over many years of research (Hill et al., 2010; Dweck, 2014). Students with a growth mindset believe that success and intelligence are malleable. STEM success can be achieved through effort; failures are viewed as learning experiences that naturally exist as part of the growth process (Hill et al., 2010; Dweck, 2014). Students that have a fixed mindset believe that intelligence and talent are innate; they are threatened by other's successes (Dweck, 2014). They believe if they are "naturally" smart, developing new skills should be easy (Hill et al., p.30, 2010). Having a growth mindset has proven to increase academic achievement because students with a growth mindset are more likely to take academic risks, develop grit, and learn from their mistakes and failures (Lin-Siegler, Dweck et al., 2016; Hill et al., 2010; Dweck, 2014).

One strategy that I used to promote a growth mindset during my study was to have open-ended activities that allowed for many possible solutions and outcomes. They were not limited in complexity or simplicity. Students were allowed ample time to try their ideas out and fix them when they didn't work right away. Failure was expected to occur at some point and that was explained to them before the activities began. During the activities, I served as a facilitator, giving prompts of encouragement when things did not go the way it was expected to.

One component of Albert Bandura's Self Efficacy Theory is Social Modeling. Bandura found that people are motivated when they can witness or be introduced to someone with a similar background that has overcome adversity and found success. Their beliefs in their own abilities to find success like the role model presented to them is heightened. Role Model introductions were a big part of my methodology. It was important to introduce the students that participated in my action research to women that were successful in STEM, of a similar background, and weren't too old or different for them to relate to. Students were asked to compose Thank You letters to the role model presenters. The letters will be used as qualitative data for my study. Common themes will be tracked and analyzed to determine the effectiveness the role models had on the students' STEM identity.

Amanda Diekman is an author in several articles that discuss the concept of communal goals (Diekman, et al, 2016; Diekman, et al, 2015). The articles cite Alice Eagly's Social Role Theory as the driving force for their work on communal goals. Alice Eagly's Social Role Theory states that "through socialization and the formation of gender roles, the behaviors of men and women generally support and sustain the division of labor" (Eagly, A. & Wood, W., 2016). Deikman, et al (2016) show that when communal goals are aligned with STEM careers, women are more likely to opt into a STEM career pathway. They can delineate STEM from a man's social role to one that women can be a part of. Having communal goals means that someone has a desire to help or care for people, work with people, and/or solve societal problems (Diekman et al.., 2010; Diekman & Steinberg, 2013; Diekman et al., 2015; as cited in Casad et al., 2018). Diekman et al. (2015) argues that women are more likely to focus on communal goals than they are to focus on things or gadgets. They have a desire to know that what they are doing is making a difference in the world. Men often have agentic goals, and they seek mastery, competitiveness, higher wages or other achievements (Diekman et al.., 2015; Su & Rounds, 2015).

I was able to align communal goals in my study by encouraging Role Models to explain how their work makes a difference in the world, how they help the environment and/or how they help society. Seeing real life examples that role models provided gave students a sense of community in STEM. Another strategy that was used to establish communal goals during the nine weeks was to assign projects that solved problems related to communal goals.

Review of Literature

Growth Mindsets and Stereotypes

Stereotypes about women not being as good at, or not having a place in STEM fields, are some of the biggest roadblocks that keep young girls from pursuing courses and careers in STEM (Hill et al., 2010; TPT, 2013). The stereotype that women are not as good as boys in STEM fields may stem back to an aptitude test that was conducted by psychologists William Cannon and Dallis Perry (Chang, p.20, 2019). The aptitude test was used as a recruitment tool that profiled potential programmers for a company called System Development Corporation. At a time when women made up 37% of computer science graduates, only 186 out of 1,378 programmers that were profiled by Cannon and Perry were women (Chang, p.20, 2019). One characteristic that was concluded by Canon and Perry was programmers are people that enjoy puzzles. The other element, which is a bit more problematic given the gender disparity in the profile samples, was that programmers don't like people, which is a characteristic that is not common in women, but because of the underrepresentation of women in the study the profile was concluded and an enormous stereotype of what a computer science person looks and acts like was born (Chang, 2019). The gap that once existed has narrowed and closed over the past few decades; now there is not a recognizable difference between female and male student success in math; women make up nearly 50 percent of students graduating with degrees in mathematics (NSCG, 2015). Although the gap has closed in math, the numbers are still widely disproportionate in engineering, computer science, and physics degrees, with men making up the majority (NSCG, 2015).

Teachers can use techniques that develop a growth mindset vs. a fixed mindset as an intervention to increase representation of women into their STEM program. The growth mindset concept was developed by Carol Dweck and associates over many years of research (Hill et al., 2010; Dweck, 2014). Students with a growth mindset believe that success and intelligence are malleable. STEM success can be achieved through effort; failures are viewed as learning experiences that naturally exist as part of the growth process (Hill et al., 2010; Dweck, 2014x). Students that have a fixed mindset believe that intelligence and talent are innate; they are threatened by other's successes (Dweck, 2014). They believe if they are "naturally" smart, developing new skills should be easy (Hill et al., p.30, 2010). Having a growth mindset has proven to increase academic achievement because students with a growth mindset are more likely to take academic risks, develop grit, and learn from their mistakes and failures (Lin-Siegler, Dweck et al., 2016; Hill et al., 2010; Dweck, 2014).

The concept of having a growth mindset is beneficial to both male and female students. However, it is especially important to develop a growth mindset for female students when your goal is to increase or retain female representation in STEM (Beede et al., 2011). Having a growth mindset helps girls understand that even if they aren't currently good at something, like STEM, they could be. Growth mindsets allow young women to focus on how they can improve rather than fear of failure (Hill et al., 2010; Dweck, 2014). Girls with fixed mindsets are more likely to believe stereotypes about women in STEM and quit more easily (Hill et al., 2010). Lin-Siegler, Ahn, et al. (2016) conducted a recent study involving two focus groups. The first group read about famous scientists and how they struggled and failed throughout their careers; the other group only read about the accomplishments and successes of famous scientists. The study showed that students were able to relate and connect to scientists that overcame their failures and successes. These stories showed concepts consistent with a growth mindset. Students that read only about the achievements of these scientists did not connect or relate; the study showed that these stories (the stories of only achievements) did more harm than good, and may have deepened fixed mindset characteristics in those students. Students reading struggle stories also showed increased growth in their grades and the other group did not. The use of these stories also falls into another GETS intervention strategy, which is exposing students to role models and looking critically at stereotypes.

Role Models

The use of role models has been proven to be effective in sending the message to underrepresented populations in STEM that STEM includes them (Zachman, 2018; lin-Siegler, Ahn et al., 2016; Herman et al., 2016; Hill et al., 2010; TPT, 2019). Role models are most effective when: 1) They are people that the underrepresented population can relate to (gender, age, race, ethnicity, economic background); 2) They are a person that has overcome adversity to get where they are in the world, and; 3) They represent the underrepresented population in their career field (TPT, 2019; Hill et al., 2016; Herman et al., 2018; Zachman, 2018; Lin-Siegler, Ahn et al., 2016).

If a role model's achievements seem unattainable to the students, it may do more harm than good. Do not "prime" role models to talk about their best attributes and their successes, or how far they want to go in life. Doing this will make their goals and ambitions seem unattainable (Collins, 1996 as cited in Herman, et al., 2016). Avoid using a role model that reinforces the stereotypes of STEM fields. The stereotypical male will not be able to connect with the underrepresented population and will have a negative effect, or strengthen the stereotype (Herman et al., 2016).

For women, introducing them to role models in STEM decreases young women's efficacy concerns, improves their career motivation, increases performance on GRE-like exams, changes how they view success, gives them a woman's perspective of STEM, inspires academic and career dreams, and reduces self-stereotyping (Herman et al., 2016; Hill et al., 2010; Lin-Siegler, Ahn, et al., 2016; TPT, 2019). Role models can be present through in-person visits, webcasting, stories, literature, or videos. SciGirls (TPT, 2019) offers a series of videos that trained role models have prerecorded for teachers to use in class to inspire female students. SciGirls also offers training material for role models that you may find in your community. A document titled *SciGirls Role Model Strategies: Encouraging Girls to Consider STEM Careers* provides prospective role models with a set of best practices to use for their volunteer efforts (TPT, 2019).

Communal Goals

Another strategy recommended by SciGirls (TPT, 2019; Casad et al., 2018; Diekman et al., 2015) that a STEM teacher interested in increasing female representation in their program should consider is: Modifying or using a curriculum that promotes communal goals. Communal goals are a desire to help or care for people, work with people, and/or solve societal problems (Diekman et al.., 2010; Diekman & Steinberg, 2013; Diekman et al., 2015; as cited in Casad et al., 2018). Diekman et al. (2015) and Casad et al. (2018) claim that women are more likely to focus on communal goals than they are to focus on things or gadgets. They have a desire to know that what they are doing is making a difference in the world; while men often have agentic goals; they seek mastery, competitiveness, higher wages or other achievements (Diekman et al.., 2015; Su & Rounds, 2015).

Stereotypes, a misconception of what STEM is, especially with engineering, can make STEM an unappealing career choice for young women and students of color. Even the term engineering can be an instant turnoff for women because of these misconceptions (Anderson, 2019). Some of these misconceptions include: 1) STEM is always technical; 2) STEM has a focus on things and gadgets; 3) Girls are not good at STEM (Diekman et al., 2015). One intervention that helps to change this vision of STEM is to show students the collaborative nature of STEM (Diekman et al., 2010). Give the students real-world examples of projects that were completed and show them how many stakeholders were involved in the project. They need to see the big picture of what is involved in the creation of a new product or innovation.

For instance, an episode of Nightline, originally broadcast in 1999, documents the inner workings of a company called IDEO, which was founded by CEO David Kelly (ABC News Productions, 1999). In this documentary, Kelly demonstrates how his company works. It is not, and never has been, a company where you could identify who the boss is. There are people from all sorts of backgrounds, including lawyers, medical students, engineers, marketing experts and psychologists that have left their professions to work for this company. All these people work together on designing new and innovative projects. In this episode, IDEO reinvented a general shopping cart. Utilizing a video such as this in class will show how collaboration works in STEM careers (ABC News Productions, 1999).

Another trend to avoid when seeking to boost female participation in STEM is focusing too much on the technical skills. For example, if you have coding, robotics, or computer science class, be sure that the curriculum explores where the skills are used and not just how to do technical things

(Zachmann, 2018). For instance, make programming lessons more meaningful with scenarios that include the problem the programming is likely to help solve, not just the programming.

An example of this is used in a documentary video title *Debugging the Gender Gap* (Reynolds, Hartman, & Herring, 2015). In a segment of the video, an animator from Pixar Animations named Danielle Feinberg described her pathway to a STEM career: "You can combine code with anything that you love, and you can have a job doing it. I loved art, and now I love coding, and I get to make [animated] movies (Reynolds, et al., 2015)."

Conclusion

There is a common understanding that to increase the STEM field workforce, the recruitment and retention of women into STEM fields is crucial (Beede et al., 2011; Casad et al., 2018; Hill et al., 2010; Herman et al., 2016; TPT, 2019). The literature shows common themes in Role Models as being the biggest influence on the likelihood of young women taking STEM courses and sticking with STEM as a college and career choice (Zachman, 2018; lin-Siegler, Ahn et al., 2016; Herman et al., 2016; Hill et al., 2010; TPT 2019). Additionally, create an environment that has a noncompetitive environment with communal values, utilizes open-ended problem solving, and teaches growth mindset techniques (Diekman et al., 2015; Zachman, 2018; lin-Siegler, Ahn et al., 2016; Herman et al., 2016; Hill et al., 2010; TPT 2019).

Methodology

This study and the research within it were conducted by utilizing the principles of action research, and more specifically participatory action research. The goal of participatory action research "is to investigate reality so that it can be changed" (Hendricks, 2017) as a group. In this study, the girls and young women involved were aware of the interventions that took place and were active participants in the process of changing the culture and climate of the program. In order to do this, gender equitable teaching strategies (GETS) (TPT, 2019) were utilized with 65 eighth grade students (25 females, and 40 males) over a nine-week Technology Education class called Automation and Robotics. The study began on January 28th. The participants in the study come from a medium sized school district in Northern Minnesota. The strategies were evaluated for effectiveness through mixed methods that included a pre/post intervention STEM Identity Survey (NCSEE, 2013), classroom observations, and analysis of students' thank you notes to participating role models. Changes to course enrollments for high school STEM elective classes, comparing this year's students to previous years enrollments, was used as the benchmark for measuring meaningful change.

All eighth-grade students were given a passive consent form (see Appendix B) 6 days before the study began, none of the students nor their parents chose to opt out of the data collection process of the study.

At the beginning of the study I discussed STEM and gender equity issues with a focus group that consisted of six young women from our high school that had taken at least one STEM course or were a member of the robotics team (currently or at one point in time). The focus group participated in an 84 minute audio recorded discussion about: their experiences with STEM, what they feel could be done to increase young women's interest in our STEM/CTE classes, and what barriers currently exist to young women choosing these classes.

A list of questions (see Appendix D) was used to guide the discussion. These participants completed an active consent form (see Appendix A) one week before the discussion took place. All six of the participants agreed to have their data used in the study. I explained that the discussion would be recorded and transcribed later. Common themes from the transcribed discussion were identified and coded using grounded theory. Grounded theory is a method of analyzing data such as, field notes, conversations, or other forms of content. The data is organized into specific categories that are "grounded," or consistent within the data (Chong, C., & Yeo, K., 2015).

During the first week of the study, students participated in a survey adapted from Student Attitudes Toward STEM (see Appendix C) that was developed by the National Center for STEM Elementary Education (NCSEE, 2015) for use with upper elementary and middle level students. This survey was used to develop baseline data on students' attitudes toward STEM before experiencing the interventions of this action research project. It was administered to students through a google form. The survey was repeated at the end of the quarter to help determine the effectiveness of the interventions.

In order to promote a growth mindset to the eighth graders, open ended activities that allowed students to come up with a wide array of solutions were offered. They were also given plenty of time to complete the activities, which allowed them to try some wild ideas without fear of failure. An example activity that I had 8th grade girls and boys complete during the study was to design and build a pull toy that would be a fun toy for toddler aged children. Students worked in teams of 3-4. The only constraints they had on the project was time, size, and materials that could be used. They needed to demonstrate their knowledge of mechanisms by utilizing at least 1 mechanism in their design, but they were not limited in complexity or simplicity. Students were given a full week to complete this project which allowed them to try different ideas, or modify their plan, as they went through the process.

Most of the activities that were conducted in this class were similar in nature. For example, during our programming unit, students were given several open-ended challenges that they could complete. There were eight challenges presented to teams of three to four students. Challenges included the construction and coding of:

- an automated pet feeder
- an automated car that will take someone and their friend to a movie

- traffic light controls with and emergency vehicle function
- a toll booth gate
- a bascule bridges
- a three-floor elevator
- a chair lift for grandma or grandpa to get them up and down stairs.

Students were required to complete at least three of these before the quarter ended. Those that finished early could complete other tasks in the list or create a scenario of their own.

During the nine-week study, I recruited STEM role models from our region to visit with students. Students met with a woman from Minnesota State University Moorhead, who talked to them about her education, her career as a construction manager and her reasoning for leaving the field to become a professor for the construction management program at MSUM. The presenter also had students participate in a mini construction management challenge, where they had to try to build a tall structure with specific supplies, manage the time to build their structure, and manage the costs of their materials. Bonuses were awarded for timeliness and cost savings. Students composed thank you letters to the presenter during the following class period. They were provided with a STEM role Model Thank You Letter Template (see Appendix E). The thank you letters have also been analyzed using grounded theory, and common themes from the letters have been categorized.

Another way eighth grade students were introduced to female role models was a field trip to Thief River Falls, MN, where the National Center for Autonomous Technology (NCAT) hosted a career exploration event in partnership with Northland Community Technical College (NCTC). NCAT who also works closely with DigiKey was able to bring two women to speak about their work at DigiKey, and NCTC provided two young women that were in their final semester of the Aerospace Maintenance program to talk about their career choices and how they decided that a career in STEM was for them.

After the speakers presented to the group, they were divided up into groups to tour the different STEM offerings that are available at the college. Students were able to learn about NCAT'S drone technologies, automation and robotics, electronics, aerospace maintenance, and geospatial imagery analysis. Students were again provided the STEM Role Model Thank You Letter and were asked to compose thank you letters to the presenter during the following class period. The thank you letters have been reviewed for common themes using grounded theory.

In order to promote communal goals, activities were chosen to model the ways in which STEM is a means to: solve real world problems, design solutions that help or care for people, and collaborate with others. For example, the pull toy activity that students did showed students that they can help children learn and have fun through design. Coding challenges that were created involved helping grandma or grandpa get up the stairs, or make sure that the family pet was fed on time each day. Another way that communal goals were shown to students during their field trip experience was through the role models' presentations. Role models were asked to provide examples of how communal goals fit into their careers. Students were able to see firsthand how the role models' careers make a difference in the world. To determine role model effectiveness on portraying communal goals, the thank you letters were analyzed for common themes related to communal goals.

Through this methodology, many common themes emerged in the data that will be shown in the *Data Analysis.* Facilitating activities with open-ended problems, promoting a growth mindset and the influence of role models all had a significant role in girls' STEM identities in this study. In the following section these results, and themes will be discussed and analyzed.

Data Analysis

STEM Identity Survey

The first major data component of this study was a STEM identity survey (NCSEE, 2015) that was used to determine a baseline for student's attitudes toward STEM and their perceived ability to be good at STEM topics. This survey was administered to both boys and girls in the class. Table 1 below shows some examples of the questions asked in the STEM Identity Survey (see Appendix C).

Table 1:
Examples of STEM Identity Survey Questions

Examples from Attitudes Towards STEM Identity Survey (See Appendix C)	
Math	When I am older, I might choose a job that uses math.
	Math has been my worst subject.
Science	After I finish high school, I will use science often.
	When I am older, knowing science will hep me earn money.
Technology and Engineering	Designing products or computer programs will be important in my future jobs.
	I am interested in what makes machines work.

The results of this survey were determined by calculating the combined mean of each section (scores ranged from 1-5, or strongly disagree to strongly agree) of the survey for both the baseline survey and the end of quarter survey. In *Figure 1* below, you will see a comparison between the baseline survey and end-of-quarter survey. A higher mean indicates a more positive attitude towards one's STEM identity.

Although both genders experienced growth in their attitudes toward STEM, *Figure 1 (Girls Data) and Figure 2 (Boys Data)* shows that female students' total growth was higher than the boys. The boys started with higher STEM identity scores, as one would predict would be the case. As you can see in *Figure 1*, there was a positive gain in our girls' attitude towards their STEM identity in each subject. Girl's overall attitudes towards STEM ended where the boys began, and the boys attitude grew at a lower rate than the girls. The largest gains occurred in the subjects of Technology and Engineering. Perhaps the reasoning for this is that the curriculum taught in this course has a heavy focus on these subjects. Science gains may be linked to how the problem-solving process was taught. The emphasis was not on finding the correct solution right away, rather, it was on the process of trial and error and investigating new ideas. The marginal gains in math could be associated with seeing the application of math within a real-world problem, for example, understanding how gear ratio can affect the speed and torque of a mechanism. Other factors, such as the influence that math and science teachers had on the students during this time period should also be considered.

Figure 1: Attitudes Towards STEM Identity Findings (Girls)

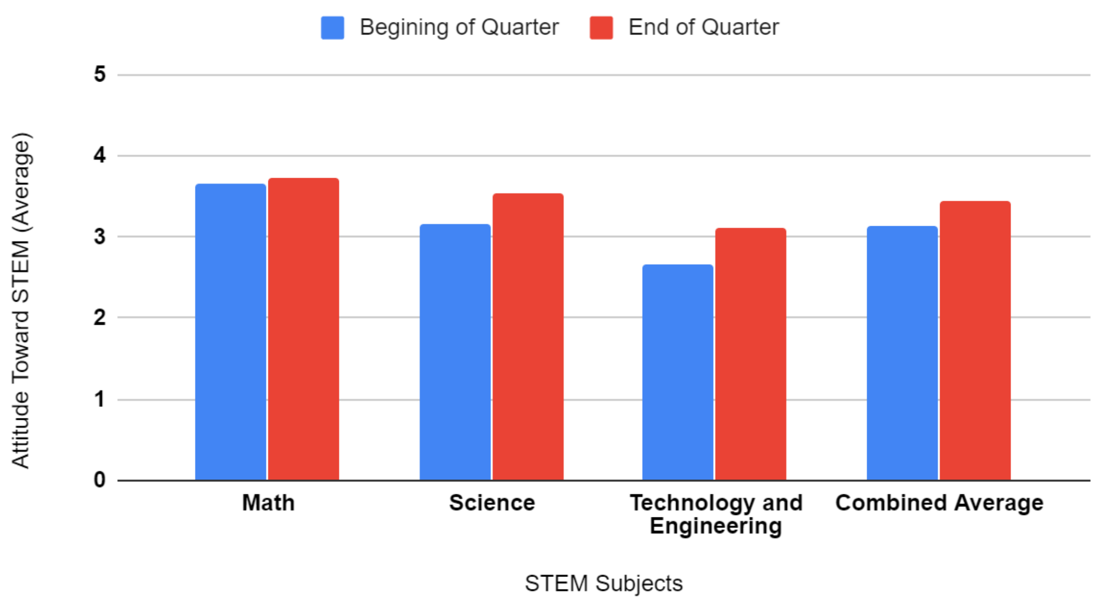
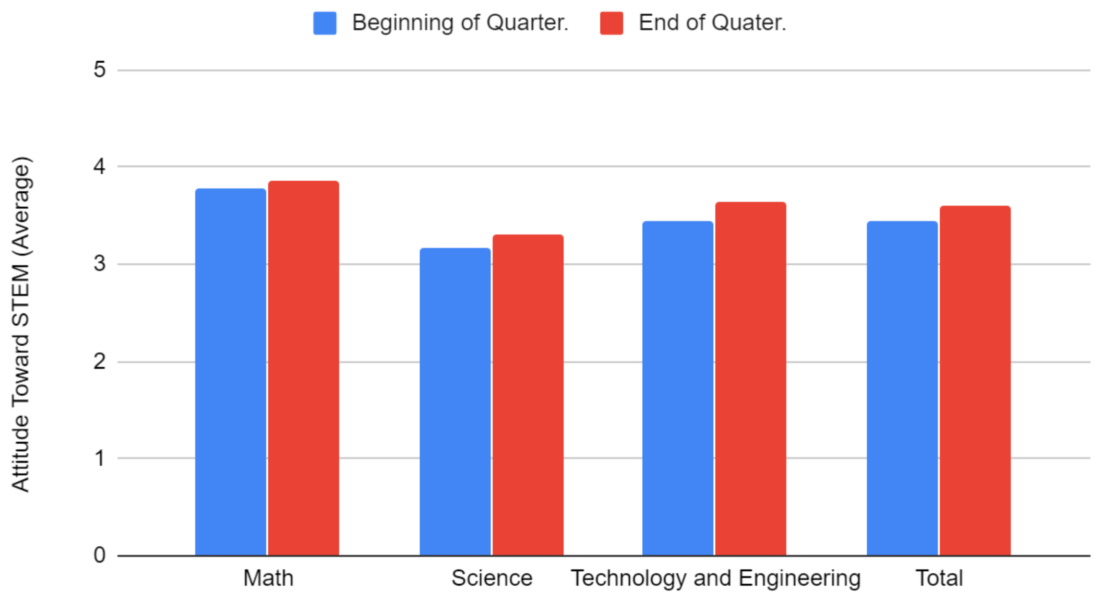


Figure 2: Attitudes toward STEM identity (Male Students)



Role Model Thank You Letters

Understanding the impact that introducing female role models had on the students was another major component of this research. Throughout the nine weeks, students were introduced to three role models.

Shortly after the role model interventions, students were asked to write a thank you note in response to their experience. A template (see Appendix E) was provided to guide students thoughts about their experience. Grounded theory (Chong, C., & Yeo, K., 2015) was used to analyze their letters. They were coded by the researcher to determine common themes, and a variety of themes were uncovered. *Figure 3* Shows the most common themes that occurred in the student thank you notes. There was a total of 45 thank you note submissions from female students written to the first role model in combination with the letters written to NCAT/NCTC. Within those letters, 69 items were categorized into 5 common themes. The table consists of data only from female students, as they were the focus of the study.

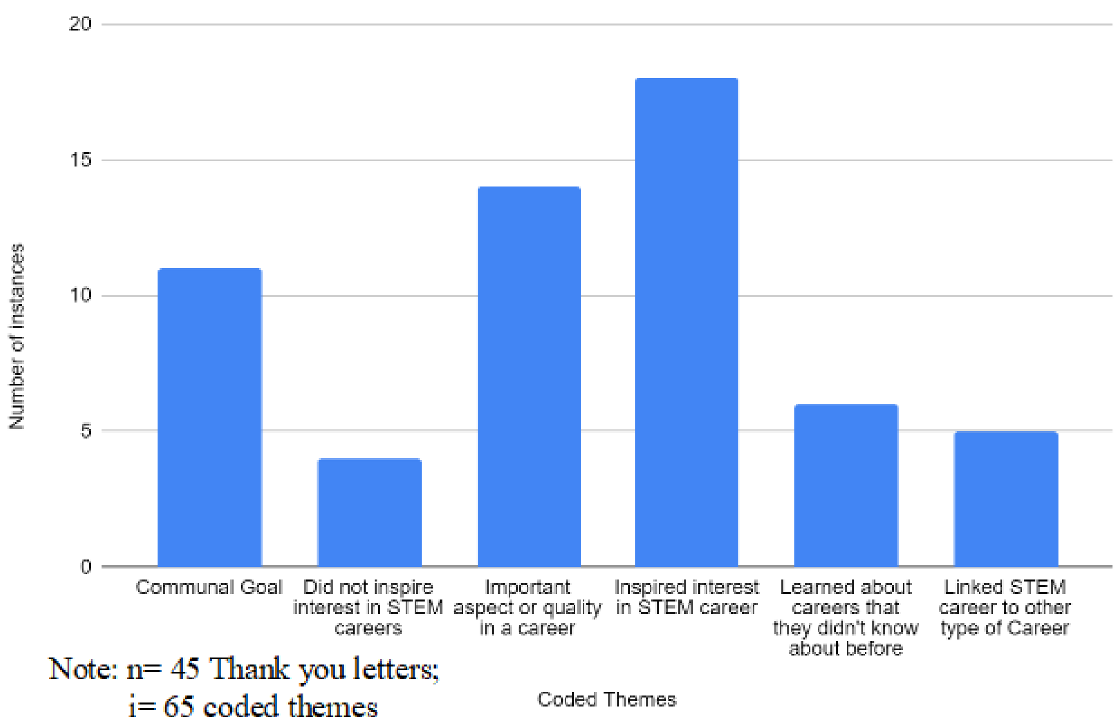
Three of the most prevalent themes that emerged from the data were an interest in careers that have communal goals, inspiration to pursue or learn more about STEM courses and careers, and the identification of aspects or qualities that are important, in the students mind, for their career. Other items are listed in *Figure 3* which are also relevant to the study but were not mentioned as often by the students.

As the literature showed, communal goals are important aspects or qualities that women tend to seek in a career (Diekman et al.., 2010; Diekman & Steinberg, 2013; Diekman et al., 2015; Casad et al., 2018). When a communal goal was mentioned by a student, it was categorized as a communal goal and as *important aspects of a career*. It was interesting that there were 14 occurrences where a student mentioned an aspect of a career that was not related to communal goals. These items were related to the opportunity for travel (5), a higher salary (4), a variety in day-to-day tasks (3), and flexibility (2).

The most prevalent, consistent, theme was that the role models had inspired the students to pursue a STEM related career or to explore STEM as a career option. This occurred in 40% of the thank you letters collected and is encouraging because it was the main hope and purpose of this study. It was exciting to see all the reasons that students were interested in pursuing STEM. One student was excited about participating in the image analysis activities at the NCAT/NCTC field trip. She explained that she has always been interested in being an FBI agent, and never realized how closely related STEM careers could be to that. Another girl stated that she “never knew about a career related to image analysis.” She said that she has always been, “really good at solving puzzles, identifying patterns, and looking for things that don’t fit into the scene.” She said it was cool to find out that you can have a career in image analysis doing those same things.

Taking the students on a field trip and introducing them to several different STEM role models, career paths, and STEM related activities was undoubtedly an effective way to influence girls STEM identity in a positive way. The real life applications that related to communal goals, other qualities that aligned with what the young women felt were important in a career, and the exposure to several different career options have the potential to have a lasting impact on the students. During the COVID019 crisis, I had several student's express disappointment that they were not going to get to go on the same field trip that the 3rd quarter group had gone on. You could tell that it was talked about throughout the grade level and made a big difference in their career aspirations.

Figure 3: Role Model Thank You Letter Common Themes



Enrollment Records

Table 2 is a comparison table that shows registration numbers that were collected in the spring before the following school year and immediately after the initial registration periods. These numbers are intended to show if the interventions administered were effective in influencing girls' decisions to choose a STEM course in the following school year. Only numbers for courses that the researcher has taught are shown. Student registration occurred in the last couple of weeks of the study. In the 2019-2020 school year, the courses were all a full year class. Next school year, 2020-2021, each of the courses in the table will be divided into two separate semester courses (see *Table 4*). Course names and descriptions were modified before registration began, as was recommended by the student focus group and the literature review (see *Table 4*). In order to simplify the comparison, I left the course names as they were at the beginning of the 2019-2020 school year.

Table 2:

Registration Comparison

Courses	2019-2020 female enrollment per class	2020-2021 female enrollment per class
Introduction to Engineering	0	3
Principles of Engineering	1	0
Civil Engineering and Architecture	0	3
Aerospace Engineering	0	1
VEX Robotics Competition	1	2
Total females enrolled	2	9

It is important to note that the results shown in *Table 2* are limited to courses that are taught or have been taught by the researcher, and they fall within the STEM elective category in our school's Catalogue of Courses. Other courses that also fall under the spectrum of STEM were not included in this data because the interventions were not implemented and documented by other instructors. Some of these courses include your typical trades courses, science electives, and math electives. The interventions that were implemented with the eighth graders may have had a much more profound impact on girls and young women's enrollment in STEM at our school if the same interventions were provided by our Math and Science teachers as well.

Focus Group Discussion

A discussion that included six former students, facilitated by me, was conducted for the researcher to understand the viewpoints of girls that have taken STEM courses in the past. I wanted to know what they thought about their experience in a STEM course or with the robotics team, why they thought that girls seemed to be avoiding STEM courses at our school and what they thought about the course descriptions and their titles that appeared in our school catalogue (see Appendix A). The group met for 84 minutes. Grounded Theory (Chong, C., & Yeo, K., 2015) was used to discover common themes in the transcription of this discussion. Many themes emerged from the analysis and they clarified the aforementioned items. See *Table 3* for a list of coded themes and the number of items that related to them in the discussion.

When asked "What made you interested in STEM? a couple of common themes emerged that also aligned with what was discovered in the literature review. One theme was the influence a role model has on girls. Most of the girls had a role model, some male and some female, that was a big influencer on their decision to participate in STEM activities and courses. It was interesting to hear that many of them referenced their father's as being a huge driving influence on them. One girl stated "Our dad, he owns [a plumbing and heating company] in town, so we kind of grew up in a shop, working with ductwork and sheet metal. I think that is what got me and [my sister] into building. We basically lived in that shop with our dad as kids." Many of the girls cited one elementary teacher as a role model for science. Her passion for science and all the outdoor learning activities and lab days they had in her class had a big influence on the girls. "Some days she'd show up to class in a rainbow-colored raincoat, when that happened you knew it was going to be an outdoor lab day." One girl talked about her aunt, who is a coder for DigiKey being a reason for her joining the robotics team. She also mentioned that it was always cool to go visit her workplace, because you do not really expect to see girls working there, but there are more of them there than you would think.

Table 3:
STEM Girls Focus Group

Common Themes	*Total items relating to theme*
Challenges stereotypes	*9*
Growth mindset	*8*
Communal goals	*19*
Past experience	*18*
Reason for not participating	*18*
Reason for Participating in STEM	*26*
Role model	*14*
Wanting to prove something	*14*

The other common theme that was present and sometimes overlapped the role model theme, was the past experiences that these girls were involved with as children. Almost all the girls had participated in a STEM camp of some sorts. A couple of the girls participated in a Lego Robotics Camp, and a couple of them participated in Science camps at the university in town. They said that those experiences helped them learn how cool the STEM fields are. One student referred to activities related to dry ice, that the elementary teacher role model facilitated, as being impactful on her decision to pursue a career in science. She said “When [the teacher] showed up with a box of dry ice, it was going to be a good day!”

Another valuable part of this discussion was their perspective on why other girls were not participating in STEM courses, other than the AP Biomed course mentioned in the introduction. Some of their responses were expected, while others were not. It was expected to hear that the lack of female students taking the courses was a major barrier. The girls said that when you are in the hallway “all you see [and hear] is guys going into the STEM lab.” Girls do not want to be outnumbered. One expected response from the discussion was that the course descriptions were “super intimidating.” The descriptions were lengthy, and one girl stated that “the words were so big, I didn’t even know what some of them meant.” The girls all agreed that the course descriptions made the courses seem like they were only for the super intelligent students. They made comments about people being scared to take the courses because they did not want to hurt their GPA.

On several occasions throughout the discussion, the girls mentioned experiences of sexism that may also be a factor for why girls have chosen to stay away from STEM courses at the high school. Several stories were told about a time when a male peer talked down to them, downplayed their ideas, or intimidated them. Although it was unfortunate that these incidents had happened, it was awesome to hear that most of the girls challenged the stereotypes and sexism when they happened. Most of the girls expressed that they wanted to prove the offenders wrong.

> I think those two couldn’t handle it, when we joined robotics. We were two girls coming in there and we basically told them you’re not going to tell me what to do. They weren’t accepting of it. It was like, they were going to do everything in their power to make sure that they were the ones doing everything.

-- Focus group participant

One of the biggest issues that the girls cited for being a reason that girls were not taking the STEM courses was scheduling conflicts and post-secondary enrollment opportunities (PSEO) college in high school courses. At the time I never considered this, however, it is a large limitation on this study, as well as a reason for girls to not take STEM courses. Girls and boys are required to take two semesters of Physical Education, they are required to have two art credits, and two years ago our school began requiring every student to take a personal finance class. The girls told me that they were planning on taking a STEM course their sophomore year, but they did not have room in their schedule because they had to take the personal finance class. Other girls talked about how “foreign languages aren’t required, but they are basically required.” The part of the discussion that I had not considered was that by the time a girl is a Junior, she has taken all the required courses and is now eligible for PSEO college in high school courses. They mentioned that it is easy for most people to take these classes, and most people do. They can take one PSEO course their first semester, as early as 10th grade, but are not limited to the number they can take after that. These can fulfill the elective requirements they have remaining. It becomes a choice of getting college credit or taking an elective that does not offer the college credit. The girls said, “you would probably get more girls in STEM if they could get college credit.”

When asked the question, “When imagining your dream job, what are the most important aspects or qualities it would have?” The girls’ responses, for the most part, demonstrated the aspect of communal goals, which was expected based on the literature. Communal goals made up 73% of the reasons for choosing STEM courses. One girl expressed that she was interested in being a kindergarten teacher and that she would want to help teach them how to code robots. Other girls discussed a desire to work for some of the big companies in our region because of the impact they have on the regional community. They all agreed that they want to do something that will help other people. Reasons for participating in STEM appeared more times, at a ratio of 13:9, over reasons for not participating.

Another major aspect of the focus group's discussion was the modification of old course descriptions and renaming of the courses (see *Table 4*). Participants viewed each course and it's description one at a time. Students made comments about things that should be omitted or simplified in the course description. They also discussed the word "engineering" and how "we should just get rid of the word for everything." All the participants seemed to agree that the courses should no longer be full-year courses. They thought that they should be divided into two separate, but related classes. For example, "Civil Engineering and Architecture," should be divided into "Residential Architecture" as a single semester class. "Commercial Architecture" would be related, but a separate semester course (See *Table 4*).

Table 4:

Comparison of Old Course Names/Descriptions and New Course Names and Descriptions

Old Course Description	New Course Descriptions
Introduction to Engineering Design Grades 9-12 Prerequisite: None Introduction to Engineering Design (IED) is a high school level foundation course in the PLTW Engineering Program. In IED students are introduced to the engineering profession and a common approach to the solution of engineering problems, an engineering design process. Utilizing the activity-project-based (APB) teaching and learning pedagogy, students will progress from completing structured activities to solving open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills. Through both individual and collaborative team activities, projects, and problems, students will solve problems as they practice common engineering design and development protocols such as project management and peer review. Students will develop skill in technical representation and documentation of design solutions according to accepted technical standards, and they will use current 3D design and modeling software to represent and communicate solutions. In addition, the development of	**A1 - Designing Our world (Fall Semester)** Grades 9-12 Prerequisite: None This is a hands-on and collaborative course where students implement steps of the Design Process to solve design challenges, create, and build product solutions. Students learn to use sketching/drafting techniques and basic 3D modeling to communicate their designs. Weekly or biweekly design challenges occur where you are given an assortment of materials and challenged to solve a problem with them. **A2 - Inventions and Innovations (Spring Semester)** In this course students collaborate in teams and utilize the design process to design, model and build products that solve a problem that exists in their lives or community. Students utilize Autodesk Inventor, an industry level CAD program, to create 3D models of their design solutions. Major Projects include the Puzzle Cube Design challenge, Innovation of an existing product, creating an invention of your own design, and the Catapult Challenge.

computational methods that are commonly used in engineering problem solving, including statistical analysis and mathematical modeling, are emphasized. Ethical issues related to professional practice and product development are also presented.	
Civil Engineering and Architecture Grades 10-12 Prerequisite: IED or Instructor Approval, Algebra I Civil Engineering and Architecture (CEA) is a high school level specialization course in the PLTW Engineering Program. In CEA students are introduced to important aspects of building and site design and development. They apply math, science, and standard engineering practices to design both residential and commercial projects and document their work using 3D architectural design software. Utilizing the activity-project-based (APB) teaching and learning pedagogy, students will progress from completing structured activities to solving open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills.	**B1 - Residential Architectural Design (Fall Semester)** Grades 10-12 Prerequisite: IED or Instructor Approval, Algebra I Students that take this course will learn to use the principles and elements of design in residential architectural projects. Students learn about interior and exterior design, floor planning, and how to tie in local utilities to their residential home designs. Students learn to solve problems related to residential homes such as managing stormwater run-off. Students will design a home of their own that includes exterior, interior, and landscaping design as a final semester project. **B2 - Commercial Architectural Design (Spring Semester)** Students that take this course will learn to use the principles and elements of design in commercial architectural projects. Students learn about interior and exterior design, floor planning, landscaping, structural design and more. Students learn to solve problems related to commercial buildings, such as, how to manage stormwater run-off and how to design a safe roof system that can handle snow loads for our region. During the 2nd quarter of this class students will work in teams to design a commercial building proposal for an unoccupied lot in East Grand Forks. Each team will be assigned a local architect to work with on their building designs. The architect will meet with the teams 3 times throughout the design process. They will provide guidance, feedback, and help students meet building code requirements for their proposals.
Principals of Engineering (Block Second Semester) Grades 10-12 Prerequisites: Geometry, Introduction to Engineering (recommended) Principles of Engineering (POE) is a foundation course of the high school engineering pathway. This survey course exposes students to some of the major concepts that they will encounter in a college engineering course of study. Through problems that engage and challenge, students explore a broad range of engineering topics, including mechanisms, the strength of materials and structures, automation, and kinematics. The course applies and concurrently develops secondary level knowledge and skills in mathematics, science, and technology. Students can develop skills and understanding of course concepts through activity-, project-, and problem-based (APB) learning. By solving rigorous and relevant design problems using engineering and science concepts within a collaborative learning environment, APB learning challenges students to continually hone their interpersonal skills, creative abilities, and problem-solving skills. Students will also learn how to document their work and communicate their solutions to their peers and members of the professional community. It also allows students to develop strategies to enable and direct their own learning, which is the ultimate goal of education. This course is designed for students that are considering a career in any engineering field, have an interest in industrial processes, and/or are looking for ways to apply concepts that they have learned in math, science and technology courses to real world problems.	**C1 - Energy and Power (Fall Semester)** Grades 10-12 Prerequisites: Geometry, Introduction to Engineering (recommended) Students work in collaborative teams, just as they will in the workforce, to solve real world problems that are mechanical and/or electrical in nature. Students learn how to solve these real world problems by applying what they learn about mechanical and electrical systems. Major design challenges include, 1) Building a Rube Goldberg machine, 2) Designing and constructing electrical circuits, 3) Simulating a power distribution system for the city that utilizes renewable and nonrenewable energy. **C2 - Automate Your World! (Spring Semester)** This course introduces the Internet of Things (IoT). Students will learn basic programming logic, learn how to use sensors in their coding challenges, and apply what they learn to several design challenges. We begin by learning how to program machines to integrate sensors and motors to execute tasks of our choosing. Students are able to choose from many design challenges, such as designing a lift, feeding a pet on cue, or translating small motion actions (clicking a button) to large motion action (closing the drapes, watering a plant), programming a soccer/hockey goal scoring machine, or removing a threat from a shared space. The final programming challenge is to design a machine that can sort recyclable materials (simulated with marbles of different materials). In the other portion of the course students learn about structural design and material selection. Students learn how prosthetics and the

	skeletal structure of the human being can compare to structural design of buildings and bridges.
Aerospace Engineering Grades 10-12 Prerequisites: Algebra and a PLTW course, Algebra II or Physics Aerospace Engineering ignites students' learning in the fundamentals of atmospheric and space flight. Aerospace Engineering is one of the specialization courses in the PLTW Engineering program. The course deepens the skills and knowledge of an engineering student within the context of atmospheric and space flight. Students explore the fundamentals of flight in air and space as they bring the concepts to life by designing and testing components related to flight such as an airfoil, propulsion system, and a rocket. They learn orbital mechanics concepts and apply these by creating models using industry-standard software. They also apply aerospace concepts to alternative applications such as a wind turbine and parachute. Students simulate a progression of operations to explore a planet, including creating a map of the terrain with a model satellite and using the map to execute a mission using an autonomous robot.	**D1 - Let's Take Flight! (Fall Semester)** Grades 10-12 Prerequisites: Algebra and a PLTW course, Algebra II or Physics In this course, students learn about the physics of flight through hands-on building activities and design challenges. Students will learn about flight navigation and piloting an aircraft using state of the art flight simulator software and VR simulators. Students learn about materials used in aircraft and how they are built. The Design challenges for this course include: Paper Airplane Challenger, Glyder Design Challenge, Airfoil Design Challenge, Engine Design Challenge, and The Long-distance Flight.
	D2 - Mission to Mars (Spring Semester) In this course students will learn about rocket design, satellite orbits, space travel, and what it would take to get the human body to Mars. Students use the design process to solve many challenges such as the rocket design challenge, space junk mitigation, and The Mission to Mars.

The focus group's participation in this study has been extremely valuable. The feedback that was given backed many components that were found in the literature, and their unique perspective on the climate and culture within our building was essential to my efforts in restructuring the STEM program at our school. The young women that participated in the focus group at the high school wanted to be champions for the cause, so not only did they participate in the focus group discussion, but later they participated as interviewees in a short film documentary, titled *STEM: Girls Allowed!(see Appendix F).* This film is about overcoming STEM stereotypes, inclusion, and why girls should have more representation in STEM fields and classes.

Although the findings from this study are limited at this point, the results were encouraging. It isn't possible to know which element of the intervention created the most impact, nor can we know if the improvements that happened would have happened without any intervention. But based on the cumulative data it appears that male STEM and CTE teachers can make significant improvements to the enrollment of female students in their courses and programs with relatively minor changes.

Action Plan

This study sought to determine whether the implementation of GETS (TPT, 2019) and introduction to female role models would positively impact eighth grade girls and young women's STEM identities in a midwest school district." Based on the findings of this study, it was determined that girls' STEM identities can be positively impacted by the implementation of GETS Strategies (TPT, 2019). After analyzing student responses to STEM role model experiences they demonstrated an increased interest in STEM courses and careers, expanded the range of career opportunities in STEM they would consider, and recognized that STEM careers have many qualities that they sought in a career. All of these responses align with findings in the literature review.

Through a focus group discussion with former and current female STEM students, many factors that play a role in the lack of female participation in STEM courses in our school district came to light. The "boys club" stigma itself is hard to overcome. Female students identified scheduling conflicts, the opportunity for PSEO, fear of taking courses that could lower GPAs, intimidating course names and descriptions, and sexism from male classmates as potential obstacles to equitable enrollment of males and females in our high school STEM courses. Many of these were also found to be true when researching the strategies in the literature review. One factor that did not show up in the literature was the scheduling issues and PSEO opportunities that many students of both genders take advantage of in their upperclassmen years that limit their elective course options.

In order to continue to expand female representation in STEM courses at our high school it would be helpful if all STEM faculty would adopt gender equitable teaching strategies, such as introducing STEM role models, teaching a growth mindset, and aligning course content with communal goals . Organizing opportunities for students to experience female role models from STEM fields in the school or on field trips several times throughout the year should be built into the yearly plan for both middle and high school students. It also may be beneficial to facilitate an informed discussion related to scheduling hurdles with administration and counselors at our school to allow our students more access to STEM opportunities and electives.

The continued study of the effects that GETS and the use of role models have on gender disparities that still exist in our nation may further narrow the root of these disparities and stereotypes. It is encouraging to see the movement of STEM inclusion being spotlighted across the country. I expect that over the next couple of years we will see major changes in the demographics of our STEM program that will provide more unique and creative experiences for those that participate. Continuing to inspire teachers nationwide to utilize these strategies may help close the gender gap, change the mindsets of both girls and boys, and create workplaces full of diverse viewpoints and opinions that will help to create environmentally sustainable products and affordable life enhancing services that this nation deserves.

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Appendix A

Where are the STEM Girls? Interventions to increase female representation in STEM courses
Active Consent Form

Dear [Participant],
As you may know, I am a St. Catherine University student pursuing a Master of Education degree. An important part of my program is the Action Research project.

As the STEM and CTE teacher of students at East Grand Forks Senior High and Central Middle School, I have chosen to learn about Gender Equitable Teaching Strategies because of the underrepresentation of females in STEM courses at our high school. For our country to be successful in the global economy, we need to fill many open positions in STEM-related careers. Currently, women are vastly underrepresented in STEM related careers. Employment demand in STEM fields has been growing and is expected to continue growing at a rapid rate. To recruit and retain women in STEM fields, teachers of STEM must use interventions that make STEM education inclusive to women throughout their educational years. I am hoping to improve my practice by teaching with these strategies. I am working with a faculty member at St. Catherine University and a project coach to complete this project.

I will be writing about the results that I get from this research, however none of the writing that I do will include the name of this school, the names of any students, or any references that would make it possible to identify outcomes connected to a particular student. Only I will have access to identifiable data for this study; I will keep it confidential.

When I am done, my work will be electronically available online at the St. Kate's library in a system called SOPHIA, which holds published reports written by faculty and graduate students at St. Catherine University. The goal of sharing my final research study report is to help other teachers who are also trying to improve the effectiveness of their teaching.

There are no foreseeable risks associated with participating in this study. It is program improvement oriented.

Procedures:
If you decide to participate, you will be asked to participate in a semi-structured discussion with other former female students that have taken a STEM course in the past. This one-time meeting will take between 30-60 minutes. The data collected from the discussion will be used to help me become a better instructor for girls in the future.

This study is voluntary. If you decide you do want to be a participant and/or have your data from audio recording included in my study, you need to check the appropriate box(es), sign this form, and return it by January 27th, 2020 . If at any time you decide you do not want to continue participation and/or allow your data to be included in the study, you can notify me and I will remove included data to the best of my ability.

If you decide you do not want to participate and/or have your data included in my study, you do not need to do anything. There is no penalty for not participating or having your data involved in the study.

Your decision of whether or not to allow use of your data will have no impact on your relationship with the school or any of the teachers involved in the research.

If you have any questions, please feel free to contact me, _______________. You may ask questions now, or if you have any additional questions later, you can ask me or my project coach Siri Anderson - ssanderson2@stkate.edu who will be happy to answer them. If you have other questions or concerns regarding the study and would like to talk to someone other than the researcher(s), you may also contact Dr. John Schmitt, Chair of the St. Catherine University Institutional Review Board, at (651) 690-7739.

You may keep a copy of this form for your records.

Please check all that apply. I DO want to:

❑ I agree to participate in the voluntary focus group and have my data included in the study.

________________________________ ________________
Signature of Participant in Research Date

________________________________ ________________
Signature of Parent of Participant under 18 Date

________________________________ ________________
Signature of Researcher Date

Please respond by January 27th, 2020

Appendix B

Where are the STEM Girls: Interventions to increase female representation in STEM courses?

Parental Permission Form

1/22/2020

Dear Parents,

In addition to being your child's 8th grade Technology teacher, I am a St. Catherine University student pursuing a Master of Education. As a capstone to my program, I need to complete an Action Research project. Because women are vastly underrepresented in STEM (science, technology, engineering, and Math) career fields and high school elective STEM courses, I have chosen to study the impact of Gender Equitable Teaching Strategies (GETS) in my classroom. The goal of GETS is to positively impact female perception of STEM careers and promote them as a viable career pathway.

During the third quarter, your daughters will be involved in project-based learning where growth mindset (believing that success is malleable, and it can be achieved through effort) will be modeled. I will also be introducing them to several female role models that have a background in STEM as a career. These activities are a regular part of my 8th grade Technology class activities. All students will participate as members of the class. In order to understand the outcomes, I plan to analyze the data obtained from the results of this data to determine the effectiveness of GETS and role models on positively increasing student interest and perception of STEM electives in high school and career pathways. All strategies implemented and assessments given are part of normal educational practice.

In addition to the strategies mentioned above, I will be organizing a small focus group of female students that I have taught in the past or will be teaching this upcoming quarter. The group will be facilitated by __________. The group will discuss past/present experiences with STEM courses, the perceived effectiveness of GETS (for students that are currently receiving interventions) or what they have seen work in the past, and what did not work. The focus group responses will be audio recorded and transcribed as part of a data collection process for the study.

The purpose of this letter is to notify you of this research and to allow you the opportunity to exclude your child's results/data from my study.

If you decide you want your child's data to be in my study, you don't need to do anything at this point.

If you decide you do NOT want your child's data included in my study, please note that on this form below and return it by January 27th, 2020. Note that your child will still participate in the interventions above, but her data will not be included in my analysis.

In order to help you make an informed decision, please note the following:

- I am working with a faculty member at St. Kate's and an advisor to complete this project.
- This research project will contribute to the study and research of GETS and its effectiveness in impacting positive perception of STEM electives and career pathways for women. Data collected will contribute to the STEM community's knowledge and research base surrounding gender equitable teaching strategies.

- I will be writing about the results that I get from this research. However, none of the writing that I do will include the name of this school, the names of any students, or any references that would make it possible to identify outcomes connected to a particular student. Other people will not know if your child is in my study.
- The final report of my study will be electronically available online at the St. Catherine University library. The goal of sharing my research study is to help other teachers who are also trying to improve their teaching.
- There is no penalty for not having your child's data involved in the study, I will simply delete his or her responses from my data set.

If you have any questions, please feel free to contact me at ________________. You may ask questions now, or if you have any questions later, you can ask me, or my advisor Siri Anderson - ssanderson2@stkate.edu, who will be happy to answer them. If you have questions or concerns regarding the study and would like to talk to someone other than the researcher, you may also contact Dr. John Schmitt, Chair of the St. Catherine University Institutional Review Board, at (651) 690-7739.

You may keep a copy of this form for your records.

______________________________ ________________

Jared Sanger Date

OPT OUT: Parents, in order to exclude your child's data from the study, please sign and return by January 27th, 2020.

I do NOT want my child's data to be included in this study.

______________________________ ________________

Signature of Parent Date

Appendix C

Sanger Student Attitudes Towards STEM and Computer Science

Questions Responses

Student Attitudes Towards STEM and Computer Science

DIRECTIONS: There are lists of statements on the following pages. Please read each statement and think about your life and how you feel. Do you agree or disagree with the statement? How strongly do you agree or disagree? For each statement, select a single radio button for each statement that is the best answer. There are no "right" or "wrong" answers!

First name: *

Short answer text

Age:

Short answer text

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

When I am older, I might choose a job that uses math.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Math is hard for me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am the type of student who does well in math.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I can understand most subjects easily, but math is difficult for me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I can get good grades in math.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am good at math.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Science Section

Please remember! Select a single radio button for each statement that is the best answer for your life and how you feel.

I feel good about myself when I do science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I might choose a career in science.

After I finish high school, I will use science often.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

When I am older, knowing science will hep me earn money.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

When I am older, I will need to understand science for my job.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I know I can do well in science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Science will be important to me in my future career.

Strongly Disagree Strongly Agree

I can understand most subjects easily, but science is hard for me to understand.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

In the future, I could do harder science work.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Engineering and Technology Section

Please remember! Select a single radio button for each statement that is the best answer for your life and how you feel.

I like to imagine making new products.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

If I learn computer science, then I can improve things that people use every day.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am good at building or fixing things.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am interested in what makes machines works.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Designing products or computer programs will be important in my future jobs.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am curious about how digital technology works.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I want to be creative in my future jobs.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Knowing how to use math and science together will help me to invent useful things.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I believe I can be successful in computer science and engineering.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Why are you at Katie Coders?

Long answer text

What else would you like us to know about you, if anything?

Long answer text

References

ADAPTED OCTOBER 2015 KATIE CODERS STUDENT ATTITUDES TOWARD STEM SURVEY

*DEVELOPED FROM THE UPPER ELEMENTARY SCHOOLS (4-5TH) S-STEM SURVEY

FRIDAY INSTITUTE FOR EDUCATIONAL INNOVATION (2012)

Appendix D

STEM Focus Group Discussion Questions:

1. What was the reason you chose to take a course in STEM?
2. Why do you think other girls are not taking STEM courses?
3. What is one thing you would change in the STEM courses you have taken?
4. What made you interested in STEM
    a. Follow up if needed: Did you have an experience with STEM (Camps, classroom activities, facility tour) that may have sparked your interest in STEM before taking the class?
5. Is there someone in your life that is a role model for STEM?
6. Did you have any worries signing up for the STEM class, if so what were they?
7. When imagining your dream job, what are the most important aspects or qualities it would have?
8. Do you think that a career in STEM would allow you to make a difference in the world?
9. Do you believe you can improve in STEM subjects like Math?
10. What are some of the benefits you are aware of related to STEM careers?
11. If you were to pursue a degree or career in STEM, what would be some of the biggest challenges?
12. When you look at the current course description of the course you took, what is your impression of it?
    a. What changes would you suggest that may increase female interest in the course?
    b. What would be a better name for the course?

Appendix E

STEM Role Model Thank You Letter Template

Dear (Name of Role Model),

Thank you for (fill in something like: taking time out of your busy schedule to talk to us about your work in [STEM field]). One thing that really interested me about the experiences that got you where you are today was (fill in an example or two and why it was interesting to you). I think (some part of their job) is really cool because (fill in explanation).

(If the presenter has inspired you to look into STEM fields as a career option please explain why and what part of STEM you may be interested in). Thank you!

Sincerely,

(Print name here and sign above)

Appendix F

STEM: Girls Allowed!

Synopsis: For our country to be successful in the global economy, we need to fill many open positions in STEM-related careers. Currently, women are vastly underrepresented in STEM related careers. Employment demand in STEM fields has been growing and is expected to continue growing at a rapid rate. Because women make up nearly 50% of our nation's workforce and half of the nation's college-educated workforce, this film portrays STEM electives at our high school as an all-inclusive subject of study. The interviewer allows the interviewees to guide the discussion throughout the film. Former students describe their experiences taking STEM electives. Several role models who work in STEM careers provide their experiences working in a STEM field and discuss the obstacles they had to overcome to get where they are today. Other interviews in the film explain how a diverse workforce creates better and more creative innovations.

See the full film at the following link: https://youtu.be/7fQL6zS7p9E