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What Are the Effects of a Curricular Emphasis on Gender Equity on Students' Beliefs and Attitudes About Girls in STEM in a 4th Grade STEM Classroom?

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ABSTRACT

This qualitative study examined the effects of a curricular emphasis on gender equity on students' beliefs and attitudes about girls in STEM in a fourth grade STEM classroom. While working on classroom projects, teacher observations of how the students interacted together lead to a curricular intervention to make students aware of inequity in the classroom. The study was open to boys and girls across ten sections of fourth grade classes and every student received the same curriculum. Students were exposed to gender related issues in STEM through literature and a hands-on activity.

Every student filled out pre and post surveys about gender in the classroom. Most surveys showed a shift from boys are better at STEM to everyone is good at STEM. Journaling provided students an outlet to express their feelings and journey through the intervention. Students filled out an entry in a "surprise journal" after every class that illuminated something in the class that was very important to them. In the journals there was an overall theme of shock that women and men are not treated equally.

A transformation began to emerge, creating a tone of girls and boys should be treated equally no matter what. Students became aware of their gender stereotypes and bias and how it effected their thinking in the classroom.

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RESEARCHER STANCE

I was lucky enough to have one of those dads that could fix anything. He would look at it and without hesitation he would have the answer on how to fix it. I would watch him rip things apart and I would think to myself, "how does he know that he can be doing that and not burn the house down?" He had traditional shop training and spent most of his life in a wood shop. He just had that patience and eye for detail, and I remember always being one step behind him. As soon as my hands were big enough to hold a hammer, I was right next to him hitting nails into a piece of wood. If you asked me what I wanted to do when I grew up I would tell you that I wanted to be a carpenter, just like my dad.

As I got a little older my grandmother started to try and sway me in another direction. She said that girls aren't carpenters and that I really liked animals so I should become a vet. She came from the traditional school of thought that women had to be doctors or teachers, and she meant well, I just knew it was not for me. I continued to remain one step behind my dad to learn about what he was doing. I assumed that everyone had a dad like this and was learning how to build and take things apart, that it was a norm in society. There never was a divide for me as to having to be girly or feminine. I followed the path that I wanted to, even if it was considered to be for boys. The concept of gender stereotypes did not

come to my attention until I reached highschool and I had my first real woodshop class.

Woodshop in high school was an elective course and I could not wait to sign up. On the first day of class I looked around and I was the only girl to be found. I was completely shocked that there were no other girls in the class because I had no idea that woodshop was not what girls wanted to do. The boys in the class were looking at me like I was crazy for being there or that I had made a schedule mistake. That was the first moment in my life where I second guessed myself for wanting to build things and take things apart. I even thought about dropping the class because I clearly did not fit in there and I was so uncomfortable. I could feel my skin burning red because I was embarrassed and I just wanted to leave. My teacher would be the deciding factor in all of this, and he immediately squashed all of my fears and doubts.

I remember his opening speech about how woodshop was for everyone and that in all of his years teaching, girls excelled the most. Had he not made his class a gender neutral, inviting classroom, I would have been gone the next day. As highschool continued I took every class of his that I could. I was always in the wood shop, or on the stage building something. When I was in his class, time flew and I never dreaded anything I was doing. It was in his classes that I figured out how I learned so much better by looking at things, taking them apart, and just using my hands to create something. I was also very book smart and excelled in

all of my core classes, but the passion that I had was very different when I was learning how to wire up outlets, or creating a set for the school play.

When I found out that there were opportunities for me to go to school and become a shop teacher, I was instantly sold. I had so much support from my teacher and even the principal of my highschool, that they took me on my college visit. I was so excited to go to school and teach girls that they can build and create. I was going to make a huge difference and it was going to be so much fun.

My very first day of classes in college I looked around and once again, I was the only girl. The professor even got my name wrong and called me Karl, which made every boy laugh in the class. This was a normal occurrence throughout my whole college career. This time things were so different. I was treated like a joke, and I had to prove myself everyday. I was made fun of constantly and called names because they couldn't understand why a girl would want to be a woodshop teacher. It was then that I was stereotyped because I was not girly or feminine. I was not the traditional girl that most people expected me to be. Out of all of the men in my classes only a few recognized that I was there to learn just like they were and supported me. It was not easy, and I felt defeated.

In the end, I had fought through and I had done it, I had graduated and was off to find a job. On my first interview in a school district I told about my difficult journey to become a STEM educator, which is what woodshop has started to morph into. The principal immediately wanted to know how I was going to get

girls to feel the same way that I had felt as a child, if they did not grow up with influential role models or a love for creating things with their hands. I do not remember my answer, but I do remember how right he was. I also remember thinking that if girls had to go through what I went through in college, they would definitely not want to take classes like mine. I did not get the job because they did not see me as the right fit and chose a man over me. This happened to me repeatedly, and I ended up working in a cabinet making shop for year instead, because woodshop teaching jobs were so limited.

The cabinet making shop was such a different experience for me. Just like my teacher in highschool, I was welcomed by the men there. Again, I was the only girl, but I did not feel out of place there. I was good at what I did and I was quickly promoted with consistent raises. This experience made me consider not continuing to pursue a career in teaching. Why would I give this up and go back to a place where I was not respected or treated as an equal? I decided to continue my search for a career teaching STEM due to my determination to bring passion to hands on learning to both boys and girls. Luckily I was able to be hired in a school district which got me on the path that I wanted to be.

On the first day of my school I always ask my new 4th grade students if they expected me to be a woman or a man. Almost always, they think I should have been a man. This really made me think about the beliefs that are already held at a 4th grade level. Taking a page out of my highschool teacher's book, it made it

very easy for me to make girls and boys comfortable in my classroom. I was able to make these students excited about STEM, by showing them my passion and my knowledge. One thing I could not control fully, and continue to struggle with, is how boys treat girls in my classroom. Boys and girls carry this deep rooted stereotype that girls just can not do well in the hands-on portion of STEM.

I watch boys grab things out of girls hands and tell them that they need to do it because girls do not know what they are doing. I also notice that girls are okay with this reaction and allow boys to treat them as though they are insufficient in a STEM classroom. These occurrences take me back to college and revive the feelings of inadequacy because I was a girl and girls do not belong in STEM or woodshop. What girls do not realize is that they can and will excel in these areas if given the opportunity. In an attempt to bring attention to the success that girls can have in STEM, I decided to start sharing my story with all of my students. The best part is how many questions girls would ask about my life, and what it is like to be a woman who made things.

Because STEM encompasses Science, Technology, Engineering, and Math, I started looking at all of the resources that teachers use in those core subjects. I found nothing that had to do with women in these fields. I do not have a textbook and I pull my material from a lot of different areas, and none of them had women in them. Nothing in my curriculum highlighted women in the growing field of STEM. I realized that just being a woman in the classroom, and working to make

the classroom gender neutral was not enough. I was not going to encourage change just by standing in the front of the room telling girls they are equal, I needed to show them that they were equal and able.

This brought me to my area of research in dealing with the issues that are stopping girls from believing they can be successful. Having a background of struggling and pushing to do what I love, I wanted to take that and show girls that it can be done. Because of this I arrived at my research question of *What are the effects of a curricular emphasis on gender equity on students' beliefs and attitudes about girls in STEM in a 4th grade STEM classroom?* Boys and girls will be exposed to successful women in STEM and will learn about the struggle that girls face in STEM to open their eyes to stereotypes around them. Behaviors that are just pushed aside as normal will be challenged and hopefully changed.

REVIEW OF THE LITERATURE

Introduction

Try this thought experiment: name 10 female scientists from any period of history. What about mathematicians? Chances are you were not able to come up with many, if any at all (Upson & Friedman, 2012). This issue has reached such prominence that former President Barack Obama weighed in on the issue, stating that:

> "Failing to engage underrepresented groups will lead to shortfalls in our Nation's STEM workforce and, more importantly, will prevent the STEM professions from capitalizing on the power of human diversity, an historical strength and competitive edge of the American economy and will deprive some of our citizens from the engaging in rewarding and remunerative careers" (Handlesman & Smith, 2016).

The representation of women in STEM careers has been at a stand-still over the past decade, remaining startlingly low, even though women have increased numbers in college-educated careers. Women who earn degrees in STEM tend to leave STEM fields early or choose non-STEM fields when becoming employed, and continue to earn less than men in STEM jobs when holding the same degrees (Beede et al., 2011).

Stereotypes have already crept into my students' viewpoints on girls in STEM, and I want to explore the best ways to uncover these stereotypes in the hopes that students' beliefs about success in STEM become gender-neutral."A 'stereotype' is a generalised view or preconception about attributes or characteristics that are or ought to be possessed by, or the roles that are or should be performed by, members of a particular social group" (Cusack, 2014, p. 16). Gender stereotypes are starting to be noticed in children as young as ten and affect girls more than boys (Cvencek, Meltzoff, & Greenwald, 2011). "A 'gender stereotype' is a generalised view or preconception about attributes or characteristics that are or ought to be possessed by, or the roles that are or should be performed by, men and women" (Cusack, 2014, p. 17). I will be focusing on changing students' beliefs and attitudes about girls in STEM by implementing a curricular emphasis on gender equity.

In the sections that follow I will address important issues in education, the six most prominent factors that are thought to cause the gender gap in STEM, namely gender stereotyping, and a curricular intervention that adapts the transtheoretical model of behavior change beliefs to support girls in STEM.

Stereotype Threat

To address this nuanced issue, literature focuses on the phenomenon of stereotype threat, or the "risk of confirming, as a self-characteristic, a negative stereotype about one's social group" (Steele & Aronson, 1995, p. 797). Although

stereotype threat can manifest in any subject, it is particularly salient in regards to females in STEM-related subjects. Women and girls who value math and are aware of the preconception that boys are better than girls in math are more likely to be affected by stereotype threat (Maloney, Schaeffer, & Beilock, 2013). Even though generalizations are often incorrect about a group, children accept them at an early age (Master & Meltzoff, 2014). For example, it is impossible for every boy to be better at math than every girl, but this is an accepted stereotype. Until given evidence to prove otherwise, minorities and women in the US school systems often believe their aptitude for a subject will be pre-judged, leading to stereotype threat (Inzlicht & Schmader, 2012).

A prime example of stereotype threat is visible in a study of 240 students, who had a previously neutral outlook on gender and performance in mathematics, were exposed to negative stereotypes about gender and math. As a result only girls' scores were shown to drop on standardized math tests. When the stereotype was exposed and evidence backing up the bias was brought to light, their grades increased (Galdi, Cadinu, & Tomasetto, 2014). Studies of undergraduate students show that stereotype threat causes women to avoid subjects that are traditionally masculine, such as science and math, moving toward subjects that do not carry stereotypes about gender-based ability (Davies, Spencer, Quinn, & Gerhardstein, 2000). Stereotype threat is an important aspect of girls' performance in STEM

that requires further investigation and preventative strategies at the pedagogical level. One such area of research addressing this gap is the feminist approach.

Feminist Approach

Outside of the literature focused on stereotype threat, feminist researchers on science education reform (e.g., Barton, 1998; Brickhouse, 2001; Howes, 2002; Rosser,1990; Scantlebury, 1998; Shulman, 2001; Whatley, 1988; Ødegaard, 2001) have developed an alternate view of why girls are underrepresented in STEM. One feminist belief is that while women are underrepresented in STEM, advances should be made to eliminate the masculine undertone that are interwoven in traditional STEM programs, rather than simply increasing female representation (Heybach & Pickup, 2017). Another aspect of feminist theory believes that there needs to be a change in the socio-political factors inhibiting girls' access to STEM fields (Sinnes, 2006). Although these points are certainly valid and feminism plays a large role in moving girls forward, their focus on structural inequalities extends beyond the scope of my influence within my classroom. Even though their arguments about socio-political context are well reasoned, I am not able to practically control external factors to the same degree that I am able to directly affect female representation and gendered stereotypes in my curriculum.

Gender Gap In STEM

The gender gap in STEM is most studied at the workforce level, with women comprising half of the college-educated workforce, but holding less than 25% of STEM-related jobs (Beede et al., 2011). While women have made tremendous gains in the STEM field over the past decade, they continue to be underrepresented (National Science Board, 2018). A review of research from the fields of psychology, sociology, economics, and education over the past 30 years concluded that there are six possible explanations for underrepresentation: "(a) cognitive ability, (b) relative cognitive strengths, (c) occupational interests or preferences, (d) lifestyle values or work-family balance preferences, (e) field-specific ability beliefs, and (f) gender-related stereotypes and biases" (Wang & Degol, 2016). Taken together, factors that have been shown to explain underrepresentation in STEM may help women make more gains in STEM fields if addressed in the classroom. In the following sections, I will briefly explain the six factors leading to the underrepresentation of women and girls in STEM.

Cognitive ability perception. Scores on the main section of the National Assessment of Educational Progress (NAEP) show statistically male and female cognitive ability differs very little in math scores in elementary school, yet girls are often perceived to do worse than boys in math (Freeman, 2005), which is a fundamental subject in STEM. Another study explores 247 American children between 6 and 10 years of age who completed Implicit Association Tests and explicit self-report measures assessing the association of (a) me with male (gender

identity), (b) male with math (math–gender stereotype), and (c) me with math (math self-concept). The results of this study showed that girls perceived they were not as qualified as boys in math, leading the girls to hold a negative perception of math and their ability to perform well in math, before an actual difference in math achievement exists on state testing (Cvencek et al., 2011). In short, even if girls are able to perform equally as boys on state tests, cognitively they believe they are not able to do so, and this belief results in a drop in performance.

Relative cognitive strengths. Girls tend to pursue careers that fit their interests of reading and verbal abilities rather than abilities in other subjects. Gifted students in math are more likely to pursue STEM careers regardless of their performance in verbal skills, while students with high and equal, but not gifted, scores in math and verbal ability tend to enter non-STEM careers (Wang, Eccles, & Kenny, 2013). Studies examining children's verbal skills share a belief that women tend to have better verbal abilities due to the amount of emphasis parents place on verbal interaction with daughters compared to sons (Leaper, Anderson, & Sanders, 1998). Women have been shown to have more balanced math and verbal abilities, opening up opportunities of interest, rather than ability, for possible career paths, which is thought to be why women often choose challenging non-STEM fields (Wang & Degol, 2016). In short, girls have more

cognitive strengths over several fields making it easier to choose from a variety of jobs that match their interests and tend to choose fields outside of STEM.

Occupational interests or preferences. In a meta-analysis of technical manuals of vocational interest, men typically align themselves with careers that allow them to work with *things*, and women align themselves in careers that allow them to work with *people* or express creativity (Su, Rounds, & Armstrong, 2009). This divergence is believed to start in middle school, where 25 girls who were identified being disinterested in STEM, were found to dislike STEM courses because they are not "feminine or girly enough" (Archer et al., 2013). Girls are taught at an early age to play with girl toys and to do girl things, influencing their preferences later in life (Wang and Degol, 2016). In short, it has been shown that girls have been taught from an early age to be girly and feminine, leading them to choose an occupation that goes along with their beliefs.

Lifestyle values or work-family balance preferences. Lifestyle and work-family balance proves to be a struggle for females in the workforce. Male and female professionals of equal talent and work ethic split views when they reach childbearing age. For example, women who were once able to work full time may have to take a leave, reduce hours, or resign from their positions to take care of the family (Ferriman, 2008). Women and men may be matched in ability, but in America the expectation is that women will be the primary caregivers and homemakers, putting less importance on their career (Wang & Degol, 2016).

Simply put, STEM fields do not always cater to women's nature to be caregivers or match their lifestyle beliefs causing them to choose non STEM fields that are specific to their beliefs and values.

Field-specific ability beliefs. Field specific abilities are thought to be a potential explanation for the underrepresentation of women in STEM. Twelve STEM and eighteen Social Science / Humanity fields, were surveyed showing that professions women believed to require brilliance and ability had a lower representation of women in that field, especially among women with no college education (Meyer, Cimpian, & Leslie, 2015). These beliefs can be traced back to school-aged children. For example, children that do not succeed at a high level academically, learn from an early age that science is not for them because they are not clever or smart enough (Archer et al., 2013). Findings suggest that women avoid challenging themselves in STEM because they believe that they are not smart enough and because they inaccurately believe they do not possess qualities needed to succeed (Wang & Degol, 2016). Gender-related stereotypes are behind the beliefs that women do not have the ability to succeed in STEM.

Gender-related stereotypes. Traditionally women are seen as caring, emotional, and gentle while holding jobs as the caretakers of the family. If they do hold jobs outside the family they are seen as masculine (Kite, Deaux, & Haines, 2008). In a study of parents and children, survey results showed that almost all subscribed to the gender stereotype that science is masculine and literacy is

feminine (Archer et al., 2013). Although parents, teachers, and peers may not be implicitly or intentionally perpetuating stereotypes, the experiences that girls have in math and science are likely giving girls the idea that math and science are masculine domains (Wang & Degol, 2016). Girls have been shown to avoid fields that have a likelihood that they will be judged with gender stereotypes by saying they are not interested, when in reality they are just trying to avoid feeling singled out (Hill, Corbett, & St. Rose, 2010). Gender related stereotypes are noticeable in my classroom and being one out of the six most common factors for the gender gap I would like to combat with an intervention on gender equity.

Gender-Related Stereotypes in School

Gender related stereotypes are troublesome due to the knowledge and growth they restrict to STEM fields. Stereotypes influence students' and societies perception of girls' abilities in science and confidence to perform as a scientist (Hsin-Hui, & Chu, 2010). Self efficacy is determined in large part by gender related stereotypes. Bandura (1986) explains:

> Perceived self-efficacy is concerned with people's beliefs that they can exert control over their motivation and behavior and over their social environment. People's beliefs about their capabilities affect what they choose to do, how much effort they mobilize, how long they will persevere in the face of difficulties, whether they engage in self-

> debilitating or self-encouraging thought patterns, and the amount of stress and depression they experience in taxing situations (p. 9).

The following factors perpetuate gender related stereotypes and affect girls' self-efficacy in STEM: parents, peers, gender, difficulty, and education.

Parents. Parents, specifically mothers, play a large role in a child's education. In a study of 116 graduate students and scientists, survey results indicated that family was the earliest source of interest in science (Maltese & Tai, 2010). Questionnaires filled out by teachers and parents in a longitudinal study found that mothers of daughters thought that girls needed to work harder than boys at math and that girls often underestimate their math skills (Frome & Eccles, 1998). Examinations of middle school girls' self reports supported that girls' motivation for math and science was significantly due to their mothers' support (Leaper, Farkas, & Brown, 2011). For example, when students are picking courses for middle school, parents are shown to talk negatively about school with girls, and allow them to pick less science and math courses when compared to their male classmates (Tenenbaum, 2009). Mothers' beliefs directly influence girls vulnerability to succumbing to 'stereotype threat', only if the mothers saw math as a male dominated subject (Tomasetto, Cadinu, & Alparone, 2011). In short, parent's stereotypes play a large role in girls' beliefs about STEM and are a valuable source of motivation to stick with these subjects in school.

Peers. Girls tend to hold strong peer relationships in science. For example, having peers that shared the same interests in science increased girls' and boys' ability to envision a future as a scientist (Stake & Nickens, 2005). When girls experience pressure to conform from their peers in one area of study, such as English, girls' motivation decreases (Leaper et al., 2011). When girls complete courses in STEM, they believe that finishing would bring positive recognition from peers (Shoffner, Newsome, Minton, & Morris, 2014). Taken together, peers' influence is important to take into consideration in STEM classrooms because if girls think their peers are like minded they will be more motivated to stay and work hard.

Gender. The largest component of life sciences (biological and medical scientists) accounts for 52% of women in the STEM field. Similarly, the field of social sciences was majority female (62%) (National Science Board, 2017). Because of or simply aligned with the cultural stereotype, girls tend to identify with roles where they are able to be nurturing and feminine; this identity could explain the high numbers of women in biological and social sciences, and not engineering (Archer et al., 2013). Sexism in children's books over the past 30 years has recently started to abate, showing women in non-typical roles such as women portraying scientists, yet the change has not been drastic. Young children's books have shown women as being nurturing, having to be rescued, and often indoors (Hamilton, Anderson, Broaddus, & Young, 2006). Simply put,

girls identify with roles different than boys from a very young age, making Science and Math seem as it does not align with their gender identity.

Difficulty. Gender identity plays a role in perceived difficulty in STEM courses. When surveyed, women at the highest levels of education in STEM and comparable to men in education level, believed that the main factor influencing their chosen career path was their perceived ability to succeed in that career (Meyer et al., 2015). If girls interpret subjects as unattainable or beyond their skill level, they connect it with being masculine (Archer, Moote, Francis, DeWitt, & Yeomans, 2016). Leaper et al. (2012) indicated that middle and high school girls were highly motivated by their grades in STEM subjects. For example, boys and girls that experience low academic achievement tend to assume that Science and Math are not for them, even if those are subjects they enjoy (Archer et al., 2013). These studies highlight how women and girls will dismiss a subject based on perceived difficulty, viewing success as unattainable, regardless of their passion for that subject.

Education. It is important to understand how education tends to exacerbate the view girls hold that STEM is going to be too difficult for them. Girls enrolled in after school STEM programs in New York reported that their relationship with the teacher affected their level of interest in the subject taught. Many cited a feeling of judgement from the teacher as making them uncomfortable, consequently impacting their engagement in the class (Mosatche,

Matloff-Nieves, Kekelis, & Lawner, 2013). When tested, STEM classrooms that are filled with stereotypical objects creating a masculine environment, girls felt like they did not belong, removing all interest in that course (Master, Cheryan, & Meltzoff, 2014). Graduate students and scientists were interviewed, out of the 30 females, 52% listed school programs as the spark they needed to become interested in Science (Maltese & Tai, 2009). Allowing all girls to perform leadership roles in science and avoiding stereotype labels such as the "loud and dramatic girl" will provide girls with a positive gender identity (Carlone et al., 2008). This information is crucial to understanding girls' motivation to stick with STEM and in viewing the relationship between early education and girls' motivation to pursue STEM fields in the future.

Teachers' roles in STEM education can be a means to foster and maintain interest for girls (Maltese & Tai, 2010). "Personal encouragement by a teacher was the top recruitment strategy that female students in the CalWomenTech Project reported experiencing" (Milgram, 2007, p.7). A meta-analysis of studies on discrimination in the classroom showed that even with best intentions, educators continue to hold altered expectations and judgements about girls in STEM, mostly expressed nonverbally, without their knowledge (Killpack, & Melon, 2016). Educators have been shown to underestimate girls' ability (Wang & Degol, 2016). It is important to note that male and female teachers can equally have an impact on students, both negatively or positively. However, in surveys

from high school female students, male teachers have caused girls, more than boys, to become concerned with stereotypes in STEM classrooms (Master et al., 2014). In short, teachers, regardless of their gender, must foster learning and encouragement for girls in STEM, while paying close attention to implicit bias in their classrooms. Taking into consideration all of the sources of stereotypes in STEM, it is valuable to combat them as early as possible.

Early Intervention

Children at five years of age have yet to form stereotypes that suggest boys are better in math than girls (Prieto et al., 2017). However, interviews with adults and children aged 10-11 revealed that adult beliefs shaped by gender stereotypes, specifically about girls in STEM fields and classes, were evident (Archer, et al., 2013). When these stereotypes are formed, they affect girls' self-identity differently than boys, by creating an internal belief that boys are better at math than girls (Cvencek et al., 2011). Taken together, these studies show us that the early intervention is necessary because of how quickly gender stereotypes are learned, to form different and lasting conceptions of girls' abilities in math and STEM. Inserting an emphasis on gender equity into the curriculum is one way to form these lasting conceptions.

Forming positive lasting conceptions about STEM at an early age is crucial, due to the evidence from transcripts of graduate students which state that interest in STEM begins before students reach middle school (Maltese & Tai,

2010). Gender identity is evident in elementary school students (Cvencek, Meltzoff, & Greenwald, 2011) and a longitudinal study of 7,437 students have shown that gender equity, or being fair and equal, does not always exist in science programs (Kohlhaas, Lin, & Chu, 2010). By introducing girls to the affect gender equity and discrimination in science, girls are more likely to be more motivated and have a higher self-efficacy in STEM (Leaper, Farkas & Brown, 2012). If educators expose girls to how gender stereotypes in STEM are affecting them, and how they can combat them, they are more likely to remain in STEM during their school career. Due to the general lack of gender equity in STEM education, girls benefit from exposure to the stereotypes about bias they are facing and how women have overcome this in the past, grades and class numbers show they react positively and have more motivation in STEM (Hill, Corbett, & St. Rose, 2010). Exposing these stereotypes through a curricular intervention in fourth grade can help change these beliefs and attitudes before lasting stereotypes set in.

Curricular Emphasis on Gender Equity

Questionnaires on "what it means to be a girl" uncovered that girls learning about gender inequalities in STEM have a higher self efficacy, and a higher motivation then before in STEM classes (Leaper et al., 2012). In an intervention to determine and eliminate gender bias among 1,400 scientists, results showed that prior to being exposed to gender bias in the sciences, men held more bias toward women. Curriculum that introduced bias, and was meant to

create an equal learning environment proved to be successful (Moss-Racusin, 2016). After the intervention, gender differences were no longer evident. An afterschool program in New York focuses on leadership curriculum that allows girls to learn about how gender affects their choices in STEM, with the goal of assisting girls to address issues they may face later in STEM careers. A main outcome of this afterschool program is to show that girls can succeed in STEM (Mosatche et al., 2013).

Successful interventions, such an intervention performed by Carnes et al., (2012) to end smoking in teens, saw changes in behavior, using a tactic grounded in the steps needed to understand behavioral change. These steps come from the Transtheoretical Model pioneered by Prochaska and Velicer (1997) and are as follows:

- *Precontemplation*: Unaware that a problem exists.
- *Contemplation*: Aware that one's own behavior needs to change.
- *Preparation:* Planning to make a behavioral change.
- *Action:* Engaging in the new desirable behavior.
- *Maintenance:* Reinforcing the new behavior to prevent relapse.

A study by Isaac, Kaatz, Lee, & Carnes (2012) followed the Transtheoretical Model while implementing an intervention to increase women's self efficacy that are in early stages of STEM careers. The course was offered to women in Engineering, Medicine, and Women Studies.

> "The three basic elements of the course are: 1) learning about gender stereotypes and how they can influence behavior and lead to cognitive biases along with evidence-based strategies to neutralize their impact, 2) self-reflection through weekly journaling, and 3) application of course material to real-world instances through development and discussion of case studies" (p. 311).

As the women began to build self-efficacy and perceived there to be less barriers, their journal entries showed them progressing through the five stages of change, starting to look past stereotypes in STEM. By educating women about gender and leadership stereotypes and by giving women strategies the participants can apply to their own lives, success was shown in journals by "building their self-efficacy beliefs for leadership, increasing their sense of personal value, decreasing their perceptions of barriers for leadership, increasing their feelings of personal mastery for effective leadership" (p. 214). At the close of the course women were found to more literate in bias, mainly implicit bias, and were able to recognize it in themselves and others. Stereotyping became the explanation that women had been looking for as to why they felt uncomfortable or felt like they performed worse in certain situations.

Although this intervention was successful when implemented on college-aged women, due to the importance of early intervention, I plan to adapt it to my 4th grade classroom for both boys and girls. *Table 1* briefly explains the five

steps and how it would look in a successful intervention through the five steps of behavior change with my students.

Table 1.1

Stages of Change in Which Change Processes are Most Emphasized

Stages of Change	In This Stage	Example
Precontemplation	Not intending to take action and are uninformed about the consequences of their behavior	Unaware of their gender bias' in STEM
Contemplation	Students are more aware of pros of changing their behavior	Aware of their gender bias' and gender stereotypes
Preparation	Students have a plan of action to change their behavior	Conceptualize a way they can change those gender bias' and stereotypes
Action	Students make specific modifications in their life to change their behavior	Actively changing their impact on gender bias' and stereotypes in STEM
Maintenance	Working to prevent relapse, more confident in their new behavior	Maintaining their behavior and belief changes on gender bias' and stereotypes in STEM

Note. Adapted from: Prochaska, J. O., Velicer, W. (1997). The Transtheoretical model of health behavior. *American Journal of Health Promotion, 38-48.*

While the study of college-aged women was held over 16 weeks, I have considerably less time to spend with my students on this. As such, the scope of my study must also be limited. My goal is to see how educating girls and boys about the stereotypes girls face in STEM changes their perceptions. Following their journal responses will show me the steps of change that are similar to the intervention by Isaac et. al, (2012) ultimately causing a change in behaviors. I could not locate any studies that dealt with early interventions of both boys and girls on the topic of gender equity.

Summary

The phenomenon of 'stereotype threat' has been shown to negatively affect girls' state math assessments due to the preconception, developed from an early age, that boys are better than girls at math. The gender gap in STEM, and subsequent underrepresentation of women in the field, has likely been influenced by the following factors: cognitive ability, relative cognitive strengths, occupational interests, lifestyle values, field- specific ability beliefs, and gender-related stereotypes. Early intervention is critical to reduce gender-related stereotypes in STEM. Students have been shown to adopt these stereotypes

about gendered performance in math and science as early as five years old. The overall picture painted by research on the intersections of gender and STEM shows the important role classroom teachers can play on shaping positive, equitable perceptions of who is capable of pursuing a career in a STEM-related field.

METHODOLOGY

Research Goals

For my action research, I introduced fourth grade girls and boys to a curricular intervention to show that girls and boys are equal in STEM fields. While teaching I have observed girls and boys creating an inequity due to beliefs that girls are not good at STEM subjects. I am concerned with how students, both male and female, view women's roles in STEM. My question was: What are the effects of a curricular emphasis on gender equity of students' beliefs and attitudes about girls in STEM in a fourth grade classroom? I used surveys, hands-on activities, and observations to collect data for this study.

To begin my study, I submitted my proposal to the Human Services Internal Review Board (HSIRB). Once approved, I submitted my study to my principal and the school board. Once approved by both, I began my study. I used surveys about how they already feel to get a good baseline on their beliefs and feelings about girls in STEM. At the end of every class, students filled out a journal entry about something that surprised them. These journal entries show a shift to a belief that girls are equal in everything. I observed a belief, starting with girls and boys believing they were not equal, to girls and boys believing they were equal. My observations while they were working on hands-on projects were very important for seeing and hearing exactly what girls and boys believe, when they are not being prompted to answer, giving me the most authentic data.

Setting and Participants

I am the only STEM teacher at the Intermediate School in Southern Lehigh. I see every student all year round and it typically ends up being about 750 students. I teach 4th, 5th, and 6th grade students. Southern Lehigh Intermediate School placed in the top 20% for all state test scores. The student to teacher ratio is higher than the state average, but the minority enrollment in the school is much lower (12%) than the state average in Pennsylvania (32%) (Southern Lehigh Intermediate School Profile, 2019).

I opened up the study to all of the 4th grade class. The total number of 4th graders this year is about 220 students, broken up between ten sections. Any student that brought the permission slip back, signed by a parent or guardian, was accepted, as long as they also agreed to be part of the study. A total of 63 students turned in signed forms. There were 30 females and 33 males. I made sure there were at least one female and one male in each section participating. Nine students were identified as having an IEP or 504 and the study was adapted to meet the individual needs of those students.

Data Gathering Methods

I conducted a pre-survey (Appendix C), which was a general student survey on feelings on STEM. I used this to get a baseline for what the students already feel about themselves and others in STEM. These questions were related to women in STEM, their home life, and what they feel about the course. I read

over this survey with the students because of their age, allowing them to ask questions and ask for understanding.

Observations were conducted throughout the entire process. I had a list of behaviors I watched for while students worked on hands-on projects. I looked for things such as participation, who was more dominating, who pulled away, who had more ideas, etc. I wanted to see girls and boys participating equally. Hands-on activities were broken into two parts. Literature showed that most texts do not show women in STEM roles (e.g., Hamilton, Anderson, Broaddus, & Young, 2006, Wang & Degol, 2016), so I chose a book called *Rosie Revere, Engineer* and we read it as a class. We talked about STEM statistics and students then made a loop plane like in the book. This was a great opportunity for observations. Next, students pulled inventions out of a bag and decided whether a man or a woman invented it. This was discussed as a whole class and gender inequity was highlighted.

Journal entries were used to discuss feelings during the design challenge activity. They followed a "surprise journal prompt" (Appendix F) where they talked about something that surprised them, what that meant to them, and what did that tell them about themselves. Students filled out a surprise journal entry at the end of every class.

Students were given the same survey (Appendix C) they were given in the beginning. It was conducted the same way, where I read every question to allow

students to ask questions. The survey was given to see if feelings changed after doing the activity. I was hoping to see a shift toward girls and boys being equal in STEM.

Research Design

The following is a week-by-week timeline of my study.

Week one - October 11, 2018

- Explained study to my fourth grade students.
- Handed out a permission slip to each student and read it together to make sure everyone understood.
- Conducted pre-content survey as a class and answered any questions about the survey.
- Introduced the "surprise journal" and gave time to fill in the first entry.
- Kept observation log up to date with each section as they worked.

Week 2 - October 22, 2018

- Collected permission slips from students and read over student assent forms with each student. Students that were still interested in being part of the study signed the assent forms.
- Read *Rosie Revere Engineer* with the class.
- Provided students with facts about women and men in STEM.
- Introduced "loop plane" activity to go along with the book.
- Independent work time to fill out their "surprise journal".

- Kept observation log up to date with each section as they worked.

Week 3 - October 25, 2018

- Discussion on the main points in *Rosie Revere, Engineer*.
- Discussion on Donna Strickland winning the Nobel Peace Prize in Physics.
- Discussion on wage gap in STEM careers.
- Introduction of invention activity and time to start the activity.
- Independent work time to fill out their "surprise journal".
- Kept observation log up to date with each section as they worked.

Week 4 - November 5th, 2018

- Discussion of who invented each item. Students noted which inventions they got correct and which inventions they got wrong.
- Independent work time to fill out their "surprise journal".
- Kept observation log up to date with each section as they worked.

Week 5 - November 12, 2018

- Discussion of who invented each item. Students noted which inventions they got correct and which inventions they got wrong.
- Independent work time to fill out their "surprise journal".
- Turned in their "surprise journal".
- Completed post-curricular survey.
- Kept observation log up to date with each section as they worked.

Trustworthiness Statement

To begin the process of my action research study I had to ensure that my study would be appropriate for my students. First, I had to have my study and my materials approved by my principal. Once approved, my proposal was submitted to the Human Subjects Internal Review Board at Moravian College to be checked again for appropriateness and to make certain my study is ethical. McNiff (2017) states: "Involving other people in research demands ethical awareness: this is not just a matter of courtesy but also a legal obligation" (p. 125). To obtain approval I had to outline how I was going to run the study and what would be expected from my students. I explained how students would be allowed to leave the study at any time, by request of their parent or themselves, without penalty. I also explained how all of the information would be kept anonymous and secure at all times and information would be destroyed at the end of the study.

I submitted all of my documents and my study materials. These documents included: the student assent form, the parent consent form, the principal consent form, pre and post surveys, and observation forms. Once approved, these letters were available to be given to students and parents to be signed. McNiff (2017) suggests to "give a letter to those persons who have difficulties in reading and read it through with them" (p. 126). I believed that fourth grade students would benefit from this and would help keep the study ethical by creating stronger understanding. In order to be approved I had to assign each of my participants a

number to keep them anonymous. That number was used in all observation forms and data collections.

All students were given the opportunity to join the study and any that turned in a signed consent form were included if they also agreed. I have ten sections of fourth graders so I made sure there were boys and girls from each class. These students were of all ability levels, some with IEPs and 504s. Adjustments to the curriculum were made in order to remain compliant with IEPs and 504s. That information was kept confidential and was not part of the study. Any students that were not part of the study received the same curriculum so they could benefit from the information. Students in the study were not singled out in class and precautions were made so students did not feel uncomfortable while being observed.

Once all signed documents were received, the study could begin. These signed documents were kept for reference. The study ran five weeks, meeting every day of the week. Due to curriculum restrictions it could not be longer than that so anything that needed to be changed would have to wait until the next year. According to Hendricks (2017) it is important to have multiple ways to collect data so no important information is lost. Class audio was collected to allow me to go back and listen to what was being said and giving me the availability to observe students more closely while working while filling out my observation sheet. Journaling was important to take notes of what was happening in the class

while it was happening. Pre and post survey data was valuable in determining if a change of beliefs was occurring. By having more than one source to collect data, I was able to triangulate data sources and increase credibility (Hendricks, 2017).

Reviewing data with a colleague, that is not a part of the study, was important to allow other points of view to be presented and helped reduce bias. Having my own journal of my interpretations of what was happening in the study allowed me to look back and notice if bias was forming. A colleague also evaluated this journal, and this practice helps keep the study valid. During the study "a researcher continually reflects on what is occurring during the study…" (Hendricks, 2017). Meeting with a validation group other than your colleague on a regular basis allows questions to be asked about the research and the evidence to help answer any questions that may be missed. These meetings are meant to raise questions to help keep the research valid (McNiff, 2017).

Even though my goal of my study was to change behaviors in my classroom, I had to recognize that there was a possibility that my research may produce different results than the results that I desired. According to McNiff (2017) we should "always be prepared to be open to what the data reveals. Sometimes the data will show us disconfirming data, things we would rather not see, which will mean changing practices" (p. 123). It was important to remember that I am working on making my classroom better and even data that does not show what I had hoped is important data.

NARRATIVE

The STEM classroom at my school is set up in a manner to allow students to take as much control of their surroundings as possible. When students enter the classroom, I want them to feel empowered and comfortable enough to immediately get the classroom ready for them by doing things like: change the class section number to theirs, they get their folders out, they get pencils and erasers if needed, and they sit and chat and draw on their folder until the entire is class is present and ready. I have the classroom arranged with four giant sets of tables in the front classroom area with chairs facing each other so students are always set up to collaborate with others in the class. The back classroom area is where all of the tools and machines are. I am able to see the back classroom area through a set of windows so I am able to monitor what is going on at all times. When students work, they pick wherever is most comfortable to them; some of them sit on the floor, some sit at the tables, and some sit in the hall if they need it to be quieter.

Students are in control of their learning and typically go through things at their own pace. After I teach them what I would like them to do, highlighting safety issues, they get started and I play the role of a facilitator of learning. I am available to help solve issues, ask questions, or step in and learn about what they are doing so I can keep them on the right path. Over the years, when I was watching, my main concern was how boys treat girls when working on projects. I

noticed that boys would take charge in the hands-on aspects of projects, and girls would typically accept this as normal and not try to take charge. When I saw this I started to take note of the frequency and decided it would be something that I needed to address.

On October 11th, 12th, 16th, and 17th of 2018, I introduced my study to my fourth grade students. A common response throughout the introduction of the unit was extreme excitement. I explained that all of my students would participate in activities for the study and any of the students that wanted to, and that had parent permission, could have their information used. I began to explain why I chose the study that I did, and I had a lot of hands waiting for me. I explained that I wanted to watch how girls and boys worked together in my class, and make sure that they were treating each other equally. Once I watched how they worked together, I would then see how I could make it better for all students to feel equal in my classroom.

I began to answer the questions that students had, because at the end of my explanation the majority of the kids in each class had questions. They were very concerned with the possibility that their work could be in my thesis. They were not concerned about my using their information, but with the likelihood that their story could be in my thesis, and were extremely hopeful for that to happen. I realized that I did not make it clear enough for them that I would not be publishing their names making them famous. I gave every student a copy of the

study permissions slip (Appendix A) and explained that they had to return it signed by their parent or guardian in order for them to be part of the study. I was not expecting many students to return them because they would have to take them home, get them signed, and remember to bring them to me a week later. This was a hard task for them to remember, some adults have a hard time remembering things a week later. Additionally on these dates, I administered the pre-content survey (Appendix C).

The purpose of the pre-content survey was to gauge students' feelings about their abilities in STEM. I concentrated on five questions in the pre and post survey for my analysis. I believed these questions would tell me if they learned from my curricular intervention. I wanted to know: Are girls and boys equally as smart in STEM, could they have a job in STEM when they grew up, was STEM only for boys, was it ok to make mistakes in front of the class, and was STEM for them? I chose these questions because they were directly impacted by the curriculum intervention. The remaining questions on the survey helped me gauge how comfortable each student felt in my classroom.

I read each question on the survey out loud to the class and they asked me questions as I read. Many students would call out comments in response to their answers to their questions. One girl specifically started a debate on what jobs could be considered STEM.

She said “Fashion designers have jobs in STEM. They are doing science by making stuff, and they are doing math by measuring the stuff. So if I was a fashion designer I would be doing STEM.”

They also laugh at questions about gender. It made me wonder if the question made them uncomfortable. I also wondered if they were doing this to make it seem like they are against girls and boys being different so I could give them a positive response.

The one question that did not get a large response out loud was question 8. It stated that girls and boys are equal in STEM. Instead of boys and girls laughing and thinking that it was something funny, they tended to answer this one in private. This made me think that they were scared to share this answer with other students in the class.

At the end of these classes, I also showed them how to fill out their surprise journals (Appendix D) that they will be filling out at the end of each class. I was given the idea of the surprise journal in an article by Julia Galef. The idea behind it is to have students notice moments of surprise in order to question the way they think (Galef, 2015). A great example of what I would like to see would be is if students notice they are handling a situation wrong and notice that it needs improvement. The first entry was used as an example to show them how to do the journal. The entry was about something that was surprising to them any time that day. The prompt went as follows:

Moment of surprise:

Why it was surprising:

What this tells me:

The example I gave was:

"Moment of surprise: When I woke up late.

Why it was surprising: I thought I set my alarm and I did not.

What this tells me: This tells me that I did not set my alarm and I really need to double check every night so it would not happen again".

After the first entry they had to write about something that surprised them that day in STEM class.

On October 22nd, 23rd, and 24th of 2018, I started to get permission slips back from the students. I was blown away by how many kids remembered to bring them. This showed me that they really were excited to participate. I was surprised when I noticed that some parents had written notes to me on the permission slips. One boy's parents were both in the Engineering field and wanted to know the results of my study. I had two separate parents wish me luck with my study and one commented "Awesome Miss Bennett!" The final note that I received said, "Is this still true? It doesn't seem so anymore." I found this very interesting because in my research I found that parents were a very big factor in determining how girls and boys see STEM classes. Therefore, if this parent did not acknowledge there was an issue, chances are their child would not either.

Every student that returned a permission slip then signed a student consent form (Appendix B) that I read to him or her to ensure they understood.

I read the students a book called *Rosie Revere, Engineer.* I specifically chose this book because it is a part of a series of books about girls that are shown in STEM roles. The other two books in the series are *Ada Twist*, *Scientist* and *Iggy Peck, Architect*. Other reasons why I chose this book was: the book was written for this age rage, and when I polled the students only two had heard of the book. The book had many great lessons on not making fun of someone who is trying, treating girls that enjoy building with respect, and never giving up. An optional workbook offered many great hands-on project ideas. I decided to read the book to the whole class and have them sit on the floor together to continue the same practices as in their ELA classes. This allowed me to ask them questions about women in STEM and have a less formal discussion.

Overall, I observed that students enjoyed the story. They were all engaged in learning what happened next to Rosie. I learned that many students did not know who Rosie the Riveter was, and I had to explain that to make the story make sense. I gave the students facts about girls in STEM, such as: only fifteen percent of engineers in the US are women, women often get paid less for the same job, and women tend to drop out of STEM degrees in college because of the environment. Their reactions to the facts that I gave them really stood out. They were really upset that women are not treated fairly. Many of them had picked up

their own version of facts including: women and men were completely equal in number in all jobs.

Students then completed an activity that went along with the book called a loop plane (Appendix E/F). The loop plane activity brought on so much excitement. The loop plane was a straw with one big paper strip loop taped on the back, and a smaller paper strip loop on the front. They had to create the original loop plane from a diagram and strips of paper and tape that was provided. They got up and threw the plane to see how many tiles long that it flew and recorded it in a table. They were then free to make any change that they wanted to see if it helped their plane fly farther or made it fly worse. Each time they made a change, they tested it and recorded the distance it flew in in their activity journal. This activity allowed me to observe the students working independently, but they had to share supplies like tape and scissors. I observed the same behaviors that I generally see when students are working on projects together.

In general, I learned that my fourth grade students are impulsive. During this project I recognized these character traits first hand. Boys generally did not follow directions because they were too worried about throwing their planes. They were easily distracted by the roll of tape and having to share.

One boy said, “Girls are disgusting” when frustrated with his project.

I observed girls being very insecure about their decisions and needed me to assure them that they were doing things correctly.

Another girl in his class whispered, “Ugh, what am I doing with my life? I suck at this.”

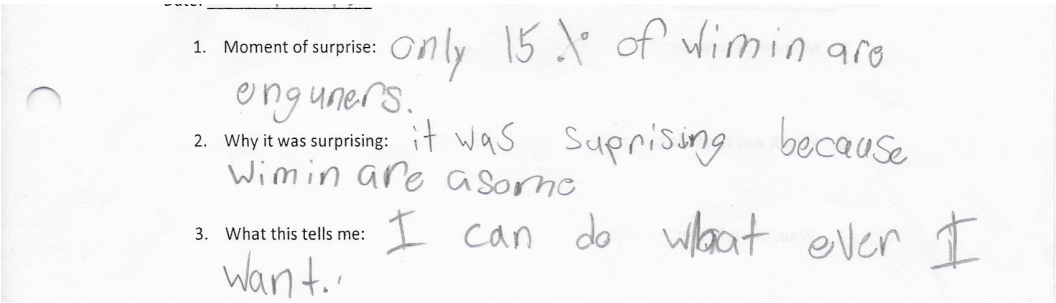
Girls showed that they either wanted to help their classmates that were struggling, or they were so discouraged when they would make a tiny mistake. A few girls would get so down on themselves that they could not focus to finish their planes. When it was possible, I would try and boost a girl’s confidence in their plane idea and use it as an example in front of the class. I noticed that when I did that, students would ask her for help instead of me. I could see a change in that student, and I could tell they were empowered to lead and help other students in the class.

This was the first time they wrote in their surprise journal (Appendix D) about something that surprised them in STEM. I was expecting a lot of students to not have anything to write about because this was their first time doing this type of assignment. I did have to remind them that it could be anything that happened in STEM, and I saw a look of understanding on a lot of faces. I left enough time for any students that wanted to share their moment of surprise. It seemed that there were always a handful of girls that wanted to share, and maybe one or two boys. By having students share their moments of surprise, it helped other students understand the assignment.

One girl shared that she was surprised that we read a book in STEM. “Moment of surprise: We read a book. Why it was surprising: It is STEM and you

don't read in STEM. What this tells me: You can read in STEM". Several students agreed with her. In another section I had a boy say "Moment of surprise: Only 15% of engineers are women. Why it was surprising: I expected an equal amount of each gender. What this tells me: that boys should let girls do more".

Figure 3.1 Surprise Journal Entry by a Girl


1. Moment of surprise: only 15 % of wimin are enguners.
2. Why it was surprising: it was suprising because wimin are asome
3. What this tells me: I can do what ever I want.

There were several entries about the "loop plane". One boy wrote, "Moment of surprise: loop plane. Why it was surprising: it flew the whole room. What this tells me: is that I never will give up". A girl from another section wrote: "Moment of surprise: the loop planes. Why it was surprising: it was perfect. What this tells me: I'm a good builder". There were many examples of entries that showed me that the "surprise journal" was working the way I had hoped. For example one girl wrote "Moment of surprise: the loop planes went farther than I thought they would. Why it was surprising: They were made out of straws, tape, and paper. What this tells me: I shouldn't just expect something could happen".

On October 25th, 26th, 29th, 30th, and 31st of 2018 the class began with an overview of what we did in the class before. There was a discussion about the

book *Rosie Revere, Engineer.* I asked each class what they took away from the story, and why they thought that I decided to read that book to them. One girl stated, “Keep trying and never give up”. A boy in the same section said, “failure isn’t bad”. Many of them were surprised to learn about the statistics that I shared with them before the book and believed that they were not fair. It just so happened that on this day Donna Strickland became only the third woman to win the Nobel Peace Prize in Physics in one hundred and eighteen years. Wage gap was a hot topic in every class.

One girl shouted, “If they go to school, they should have the same opportunities!”

Boys and girls were upset, which was the first time that I started to see boys have empathy for women in STEM.

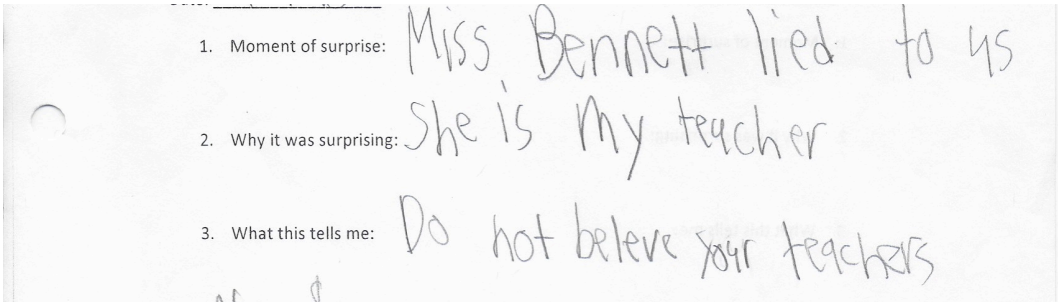
A visibly angered girl said, “[Boys] don’t believe that girls can invent anything.”

The next activity I introduced was an activity where they had to pull inventions out of a bag and decide whether a man or a woman invented it (Appendix G). On each table I had a bag with twenty-four different inventions in the bag. A woman invented twelve and a man invented twelve. The inventions invented by a woman were: solar heating, Kevlar, car heater, Monopoly, chocolate chip cookies, wifi, non-reflective glass, x-rays, liquid paper, submarine telescope, windshield wipers, and computer code. The inventions invented by

men were: printing press, anesthesia, potato chips, plastic, pizza, penicillin, steam engine, light bulb, Facebook, telescope, gas mask, and AC electricity. Their directions were to pull the inventions out of the bag one by one as a table. Each person would get a turn pulling one invention out of the bag and they would decide who invented it on their own. Finally they wrote the invention on a paper under woman or man.

The first section of students had papers with lines on them and the kids counted so they knew that there were going to be twelve inventions for men and twelve for women. I decided to take the lines away because I wanted them to be able to guess. When I took the lines away the remaining classes wanted to know how many women and how many men, and I told them that they would just have to do the activity to find out. One student believed that I lied to him about the number of women and men in the activity and in his surprise journal he wrote "Moment of surprise: Miss Bennett lied to us. Why it was surprising: she is my teacher. What this tells me: do not believe your teachers". After that entry in his surprise journal he did not fill in any more entries.

Figure 3.2 Surprise Journal Entry by a Boy



1. Moment of surprise: Miss Bennett lied to us
2. Why it was surprising: She is my teacher
3. What this tells me: Do not believe your teachers

When each class started the activity I saw that boys were usually the first to immediately grab the bag off of the table and fight over it. I noticed that girls ran the activity once the initial grabbing took place. I heard many connections with women and food.

A girl said, “Chocolate chip cookie, so girl”.

A girl in a different section yelled, “That’s a girl! What girl doesn’t like chocolate chip cookies!”

I also heard connections between social media and women.

A girl said, “Women go on Instagram and stuff”.

Another boy in the same class responded “yeah, girls love sharing on Facebook!”

One boy was very upset when he found out that women generally make less money than men and then he also did not believe that women could invent any of the inventions on the table.

He raised his hand and grumbled, “I am angry about it, girl don’t get paid as much and it’s not fair”.

While students were working, I walked around the room to see some of their papers. Many students were trying to hide the answers they had written down. There were two boys in particular that were trying to hide their papers who had every invention was made by a man. Some students showed me that they had already seen this invention in another class.

One girl was thinking out loud, “can girls make car things?”

A very common comment was made out loud throughout all of the sections about cookies: “Cookies are a girl’s best friend”.

In one class I had girls sticking up for themself and other women. This class had a few very strong, vocal girls that speak their minds.

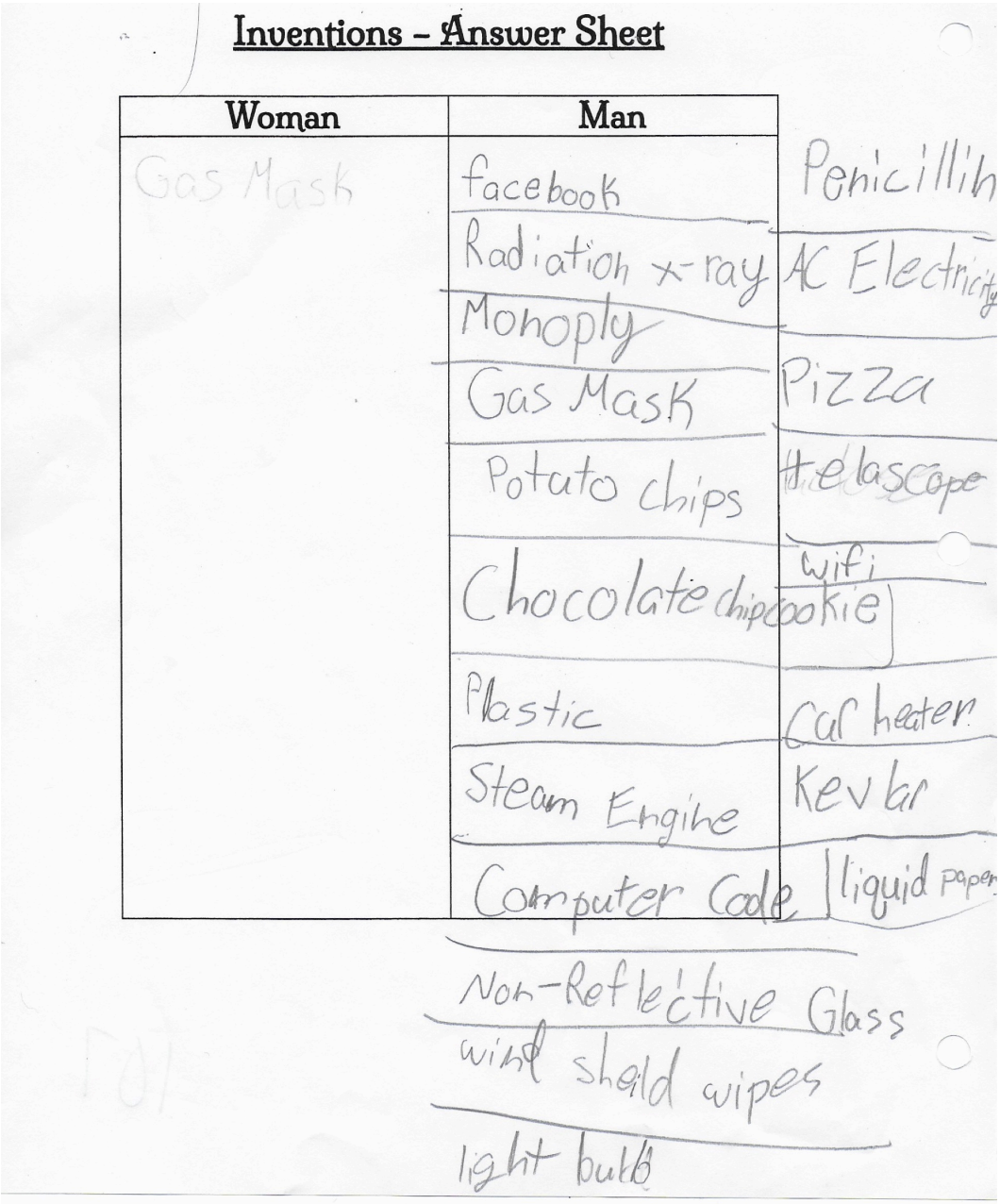
A boy said, “That HAS to be a boy”.

A girl replied, “It doesn’t HAVE to be!”

At the end of class one girl wanted to tell me “girls should not get doubted we should never doubt someone’s dreams”.

This activity exposed all of their learned stereotypes and bias that I was working against. These kids have spent their whole lives learning that women do this, and men do that. By exposing them a to very small number of facts that go against these learned beliefs, there were students that could recognize how things are unequal.

Figure 3.3 Invention Sheet by a Boy



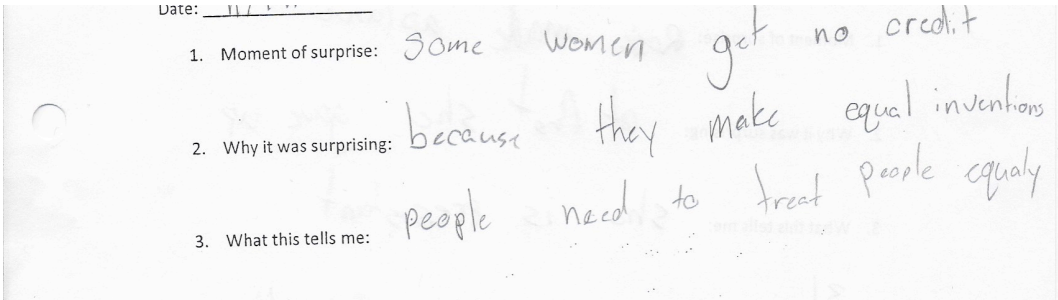
Inventions – Answer Sheet

Woman	Man	
Gas Mask	facebook	Penicillin
	Radiation x-ray	AC Electricity
	Monoply	
	Gas Mask	Pizza
	Potato chips	telascope
	Chocolate chip cookie	wifi
	Plastic	car heater
	Steam Engine	Kevlar
	Computer Code	liquid paper
	Non-Reflective Glass	
	wind sheild wipes	
	light bulb	

The surprise journal (Appendix D) entries for these classes revolved around Donna Strickland and equal pay. One girl's entry was: "Moment of

surprise: only 3 women won the Nobel Peace Prize. Why it was surprising: because 3 is a lowe number. What this tells me: I shud be a inventer". One boy had a similar entry but it told him "girls need to invent more". Another girl wrote about how "It was surprising: men and women are equal. What this tells me: That men and women sometimes get treated differently". I believed by sharing with them information that was against what they had learned, I was starting to make them realize that women and men are not equal in STEM, but we should be.

Figure 3.4 Surprise Journal Entry by a Boy


Date: _____

1. Moment of surprise: Some women get no credit
2. Why it was surprising: because they make equal inventions
3. What this tells me: people need to treat people equaly

On November 5th, 6th, 7th, 8th, and 9th of 2018 we went over each invention that they pulled out of the bag and learned if it was a man or woman who invented it (Appendix G). I gave facts about the invention and explained how many of the women who invented the items were not given credit or money for their inventions. This part of the activity brought out their stereotypes even more. For example, one girl believed that bullet proof vests had to be made by a man because only men are police officers. Another girl believed that things that had to

do with cars had to be made by a man because when her mom's car breaks down and has to go to a shop, a guy always fixes it.

Several students wrote that only men can invent things, and if a woman did invent something it had to do with food. I had done this activity with students in summer camp and I saw the same thing happen. I heard a lot of students get upset at the end of the activity because of women not getting credit for their inventions.

One girl stated "What! Why does this keep happening! Girls are amazing and can do anything".

In another class I had a boy tell me "When a girl invented x-rays, that showed me that girls can invent anything".

One boy said, "Girls should get more credit!"

Another said, "Why do guys always claim stuff?"

It was very interesting to see how the students were so upset with how women were treated. They wanted to know if women continue to be treated this way, but would answer their own questions with comments like:

"Women need more attention!"

And "Girls and boys should be treated equally."

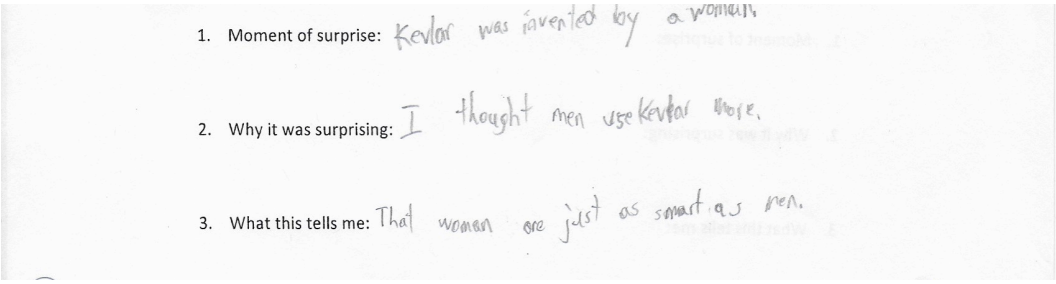
It was amazing to me how in just a short amount of time I was able to confront them with a few stereotypes and it sparked a movement for change. I learned how prevalent boy's and girl's bias is by putting it in their terms and at

their level. I believe that what they learned would stick with them because a lot of the students really seemed upset by what people have gone through. The best part about it was it was not only girls reacting this way, but boys as well.

The surprise journal entries were about the inventions they learned about. Many were upset with how women were treated. For example one boy entered: "Moment of surprise: girls got no credet. Why it was surprising: because they made a lot of stuff. What this tells me: they are not treated well". Others were about how they were surprised about whether a man or a woman created something. A boy answered, "Moment of surprise: A woman made kevlar. Why it was surprising: because men oweys yus it. What this tell me: it is not aways what I think".

The most important entries to my study were made from girls that decided that they were equal to boys and boys that now supported girls. One girl wrote that she learned that "men and women are equal". One boy learned that "girls can made stuff that guys use" and "That tells me girls can do anything boys can". One girl explained that her moment of surprise was "computer code was by a girl" and it told her that "boys and girls are equal". One boy shared that he realized that "men ar mean to grils (except for me)". One boy realized that "girls should get more credit". One boy responded, "men should give more credit to women".

Figure 3.5 Surprise Journal Entry by a Boy



1. Moment of surprise: Kevlar was invented by a woman.
2. Why it was surprising: I thought men use Kevlar more.
3. What this tells me: That women are just as smart as men.

Out of all of the journal entries I only had four students who did not seem to understand the assignment or the curriculum. One girl wrote, “I don’t know” for all of her entries. One boy wrote things like “boys can do anything” and “boys are intelligent”. I did not doubt this to be true; it just did not follow the curriculum presented. A boy in another section wrote “I found out that there are more boys than girls.” and “I thought it was surprising because that means that women have more baby boys than girls”. I did not mention anything about birth rates in the curriculum. The rest of the students were able to find something that surprised them every class period and they frequently asked me if it was time to write in their journals. There were many students that enjoyed sharing at the end of class, and frequently were the same students that liked to share.

As the study came to a close, it was time to conduct the post curriculum survey. The survey was the same as their pre content survey.

One girl immediately questioned “this again?”

We went over each question again as a class and I allowed them to ask any questions they needed if they did not understand something. This time I did not

hear as many laughs and giggles when there was a question about gender for them to answer.

It was time for me to collect the work they had done and one girl pulled me aside and asked, “is your study done now?”

Realizing that I was done delivering the curriculum and the pre and post tests, it was time to explain to them what I would be doing now. I told them that they helped me so much, and everything they did was so important.

The last thing a student asked me was “when are we going to get a new surprise journal?”

We talked about how my study would be written down for others to see. I told them what they taught me: everyone has a set of beliefs, and it is possible to start to change them by being confronted with truth and facts, no matter what age we are.

DATA ANALYSIS

Throughout the course of my study I used several methods to collect data. I began by administering a pre content survey (Appendix C). During class time, I observed students' behaviors and recorded them in a journal. I then added my own thoughts and observations to that journal at the end of each class. At the end of each class period, students wrote a journal entry about their surprises in class and they were collected at the end of my study (Appendix D). After the content was delivered a post content survey was conducted and collected. (Appendix C).

Surveys

All 220 students in my class were given a pre and post content survey (Appendix C). Both surveys were the same and I read the questions to them. The answers were on a five-point scale with 1 being strongly disagree, 2 agree, 3 not sure, 4 agree and 5 strongly agree. On the back they circled whether they were male or female and recorded their age. The students that were in my study were assigned a number so those student's surveys were collected separately and the number was recorded on the back for record keeping purposes.

For the surveys I wanted to know: Are girls and boys equal in STEM, could they have a job in STEM when they grew up, was STEM only for boys, was it ok to make mistakes in front of the class, and was STEM for them? I chose these questions because they were directly affected by the curriculum

intervention. The other questions helped me gauge how comfortable each student felt in my classroom.

I noticed that in the pre survey 19 students out of 63 students believed that girls and boys were not equal in STEM. 23 students did not believe they could have a job in STEM when they grew up. Two students believed that STEM was only for boys. Nine students believed that it was important to not make mistakes in front of everyone in STEM. Finally, 21 students believed that STEM was just not for them.

In the post survey (Appendix C) I noticed a change occur. Eleven students out of 63 students believed that girls and boys were not equal in STEM. 29 students did not believe they could have a job in STEM when they grew up. Three students believed that STEM was only for boys. Seven students believed that it was important to not make mistakes in front of everyone in STEM. 24 students believed that STEM was not for them.

Even though these were small changes, I found that more students believed that girls and boys were equal in STEM. I also saw that students felt more comfortable making mistakes in my class, which is important while working on hands on projects in groups and pairs. I found that more students believed that STEM was only for boys and that STEM was just not for them. I also found that many students still believed they could not have a job in STEM when they got older.

I was curious to see why so many students still did not believe they could have a job in STEM when they were older. I simply revisited that question with each group of students.

I asked "could you tell me why you do not believe you could have a job in STEM when you grow up?"

One girl said, "I might want to have a different kind of job"

Another boy said, "I do not know what kind of job I will have when I grow up, it might not be in STEM."

This told me that I did not make this question clear with them. I wanted to know if they thought they were capable of having a job in STEM when they grew up. It seemed that they believed I was asking them if they would have a job in STEM when they grew up. I believe that all of the questions that I wrote could be rewritten at a lower level to make them easier for fourth graders to understand.

Observations

I took observations in a journal every class while students were working. I observed the behaviors that I had been noticing previously in my classroom where boys were more forward and wanted to control the activities and girls were more passive. As I exposed the class to statistics about women in STEM I began to see girls and boys become angry about how women are treated. I heard students express how they wished that girls and boys were treated equally and that they

believed everyone was able to do STEM. I had a few girls that really started sticking up for themselves and other girls.

At the end of class I would go through my journal and add my thoughts and beliefs about what I had observed in class. I really started to notice how students arrived to my class with stereotypes about girls and boys that they believed to be normal. Some of these stereotypes were hard to combat because they had lived with them their whole life. However, it was evident to me that what I was exposing them to at least made them question their beliefs, therefore creating an opportunity for change.

In the beginning of my study I observed behaviors about gender in STEM like laughing when we talked about girls and boys in STEM. I also had girls expressing interest in going into a male dominated field like a girl was interested in becoming an NFL football player, with boys reacting like she was completely crazy. When students worked together on their first hands-on activity I noticed that girls had very low confidence on their ability to create their planes. They worked much slower than boys and it made boys get aggressive over materials. Boys typically worked so fast they did not follow directions because they were more concerned with being able to throw their planes. I saw many girls that wanted to help other students instead of worry about their own project. At the end of the class when students were completing their surprise journals I heard that

students did not really know what to write about. I had to help give them ideas about what I was looking for.

During the second activity, where they had to pick inventions out of a bag and determine whether it was a male or female, I started to notice students being more considerate of other students. I also noticed girls having more confidence during the activity. Instead of girls just allowing boys to run the activity, I witnessed several girls that would stand up and run the activity for their table. They would make sure things were being run correctly, and they were not allowing boys to take over. Some students did bicker back and forth and I believe this was just due to personalities. At the end of these classes students were asking me when it was time to fill out their surveys. They were silent while filling them out and they all had something to write about.

While we were going over the second activity, students would answer and expose their learned gender stereotypes. These stereotypes came from their experiences at home, and they affected their choices in school. At this point however, students were answering back with their feelings about gender stereotypes. When students would hear that that girls were not being treated equally, they started to get upset. They expressed anger toward the inequality, and wanted to know how to change it.

Surprise Journals

At the end of each class students wrote about something that surprised them in a journal (Appendix D). I only had four students that did not fill out every entry. 59 of the students had entries that were connected to what we had learned that day and were filled out completely. I noticed that students that did not speak up in class about the activities, were writing about it in their journals. It provided a platform for them to express their feelings without being embarrassed or by feeling like they were being singled out.

In the beginning of the study students struggled with what to write. I had to help many of them by explaining what I was looking for. There were many entries about reading *Rosie, the Riveter*. Many students did not believe that they would be reading a book in STEM. I was hoping they would have taken more away from the lessons in the book. Only a few students wrote about how they learned that they should never give up, which is one of the main lessons taught in the book. I read a few entries about how they were surprised in their ability to build the loop plane and how they should believe in themselves more.

Once they understood the process of the journal, they immediately pulled it out at the end of class. They were silent as they wrote and many of them were excited to share. I started to see a change in their entries. Instead of being surprised about what they had done in STEM, they started to be surprised about what was happening to people in STEM. They expressed anger about how women had been treated in the past. Boys and girls also expressed empathy with what had

happened to women in the past, and wanted to know how to change it. It became important to them that no one should be doubted in STEM, no matter what gender they are.

Data Analysis Process

In order to analyze my data I decided that to keep things organized I would have to put all of the information for all 63 students in one place. I kept the answers to all of the survey questions and the invention activity in a spreadsheet. I was able to group them by class, mark whether they were a girl or a boy, and I was able to compare each student to group. This helped me see any information that I was missing and it easily allowed me to notice any patterns.

During my research on the gender gap in STEM, I learned that there are six factors that are possible explanations for underrepresentation of women in STEM. The six factors are cognitive ability, relative cognitive strengths, occupational interests or preferences, lifestyle values or work-family balance preferences, field- specific ability beliefs, and gender-related stereotypes and biases (Wang & Degol, 2016). I used these six factors to create part of my bins for coding.

I also added self-efficacy, stereotype threat, equity, empathy, confidence, and lack of confidence because I was looking for these behaviors during observations. These behaviors were found to be prevalent in students in this age range. These behaviors also were found to be reasons for girls and boys to be

interested in STEM. I wanted to see if it were true this was, and how often they played a part in the way they think and act.

The bin for cognitive ability was combined with relative cognitive strengths and was based on how well I believed students were able to understand the curriculum. I looked for times where I saw that the information that I presented to them was at their level and times where students may have had a hard time understanding the information. The bin for lifestyle values or work-family balance preferences, included times where I saw that what they believed was from what they learned from their family. Many times this is where I saw gender stereotypes occur. Another bin was for occupational interests or preferences, showed times where students were interested in STEM and the curriculum being presented and times where they were not interested. The field-specific ability beliefs bin included information where students believed they could do something and times where they believed they could not do something. Finally, the gender-related stereotypes and biases bin was for every time a student exposed a gender-related stereotype or bias that they carried and brought to the classroom. I created my bins from coding my observation log and the student's journals, and *Figure 4.1* shows where every topic was covered in my data. I was able to relate my codes together based on what I saw in my data.

Figure 4.1

Codes	Page Numbers	Related Codes
Gender-related stereotypes	1, 2, 3, 6, 7, 8, 9, 10, 14, 15, 17, 35, 37, 43, 48, 49, 50, 61, 76, 81, 86, 87, 92, 98, 100, 101, 102, 104, 107, 111, 119, 120, 123, 125, 126, 134, 136, 143, 146, 149, 152, 161, 170, 179, 180, 182, 185, 197	Bias, Cognitive Ability, Lifestyle values or work-family balance preferences, Field-specific ability beliefs, Stereotype threat
Bias	1, 2, 3, 5, 6, 7, 8, 9, 10, 14, 15, 17, 23, 34, 35, 37, 48, 49, 50, 52, 56, 61, 63, 64, 67, 73, 74, 75, 82, 83, 87, 89, 92, 98, 100, 101, 107, 109, 111, 114, 119, 120, 126, 128, 133, 134, 136, 137, 143, 145, 146, 148, 154, 163, 175, 178, 179, 184, 185, 187, 193	Gender-related stereotypes, Cognitive Ability, Lifestyle values or work-family balance preferences, Field-specific ability beliefs, Stereotype threat
Self Efficacy	3, 5, 6, 7, 8, 9, 10, 22, 36, 52, 67, 84, 96, 105, 120, 121, 123, 138, 197	Cognitive ability, Field-specific ability beliefs, Parents, Equity, Confidence
Stereotype threat	1, 2, 3, 4, 6, 7, 8, 9, 10, 28, 52, 67, 87	Gender-related stereotypes, Cognitive Ability, Lifestyle values or work-family balance preferences, Field-specific ability beliefs
Cognitive ability	1, 3, 4, 5, 6, 7, 8, 9, 10, 17, 34, 46, 57, 65, 67, 71, 76, 90, 93, 116, 141, 168, 171, 192, 194	Occupational interests or preferences, Lifestyle values or work-family balance preferences, Field-specific ability beliefs

Figure 4.1 (Continued)		
Occupational interests or preferences	2, 8, 9, 10, 11, 13, 15, 21, 31, 33, 41, 43, 44, 47, 48, 51, 52, 54, 55, 58, 59, 63, 65, 68, 69, 72, 74, 77, 79, 82, 85, 88, 91, 97, 103, 108, 109, 112, 117, 127, 137, 140, 142, 148, 151, 153, 157, 160, 163, 166, 169, 172, 175, 181, 184, 187, 190, 193	Lifestyle values or work-family balance preferences, Field-specific ability beliefs
Lifestyle values or work-family balance preferences	1, 2, 3, 5, 6, 8, 9, 57	Gender-related stereotypes, Bias, Stereotype threat, Occupational interests or preferences, Field-specific ability beliefs, Equity, Confidence
Field-specific ability beliefs	2, 3, 4, 5, 6, 8, 9, 10, 11, 14, 15, 16, 17, 18, 21, 22, 24, 25, 33, 34, 37, 40, 41, 47, 48, 61, 72, 87, 88, 91, 94, 105, 108, 109, 112, 117, 121, 127, 142, 153, 156	Gender-related stereotypes, Bias, Cognitive Ability, Lifestyle values or work-family balance preferences, Stereotype threat, Occupational interests or preferences, Confidence
Equity	8, 9, 10, 12, 13, 21, 22, 25, 26, 31, 33, 37, 40, 41, 42, 43, 44, 51, 54, 60, 65, 66, 68, 69, 77, 78, 79, 84, 85, 87, 88, 91, 94, 97, 102, 103, 105, 106, 110, 112, 116, 117, 118, 121, 122, 123, 127, 129, 131, 132, 135, 139, 140, 144, 150, 151, 153, 155, 157, 160, 162, 164, 166, 169, 172, 173, 181, 182, 190, 191, 195, 196	Gender-related stereotypes, Bias, Cognitive Ability, Lifestyle values or work-family balance preferences, Stereotype threat, Occupational interests or preferences, Confidence, Lack of confidence

Figure. 4.2 (Continued)		
Empathy	1, 4, 6, 7, 8, 9, 10, 36, 39, 43, 50, 57, 71, 76, 81, 84, 93, 96, 99, 102, 106, 116, 126, 129, 132, 135, 138, 144, 147, 150, 153, 156, 159, 162, 165, 167, 171, 174, 177, 180, 186, 197	Self Efficacy, Gender-related stereotypes, Bias, Cognitive Ability, Lifestyle values or work-family balance preferences, Stereotype threat, Occupational interests or preferences, Confidence, Lack of confidence
Confidence	5, 6, 8, 10, 21, 22, 25, 33, 34, 55, 59, 62, 63, 65, 69, 72, 77, 79, 84, 85, 87, 88, 91, 97, 103, 105, 114, 117, 126, 130, 140, 142, 148, 157, 162, 163, 166, 172, 181, 190, 193, 195	Self Efficacy, Cognitive Ability, Lifestyle values or work-family balance preferences, Occupational interests or preferences
Lack of Confidence	2, 3, 4, 5, 10, 28, 31, 37, 40, 44, 47, 50, 52, 54, 58, 63, 65, 68, 72, 74, 82, 94, 100, 106, 114, 121, 124, 130, 133, 137, 145, 148, 151, 154, 157, 160, 169, 175, 178, 181, 184, 186, 187, 190, 195	Gender-related stereotypes, Bias, Cognitive Ability, Lifestyle values or work-family balance preferences, Stereotype threat, Occupational interests or preferences

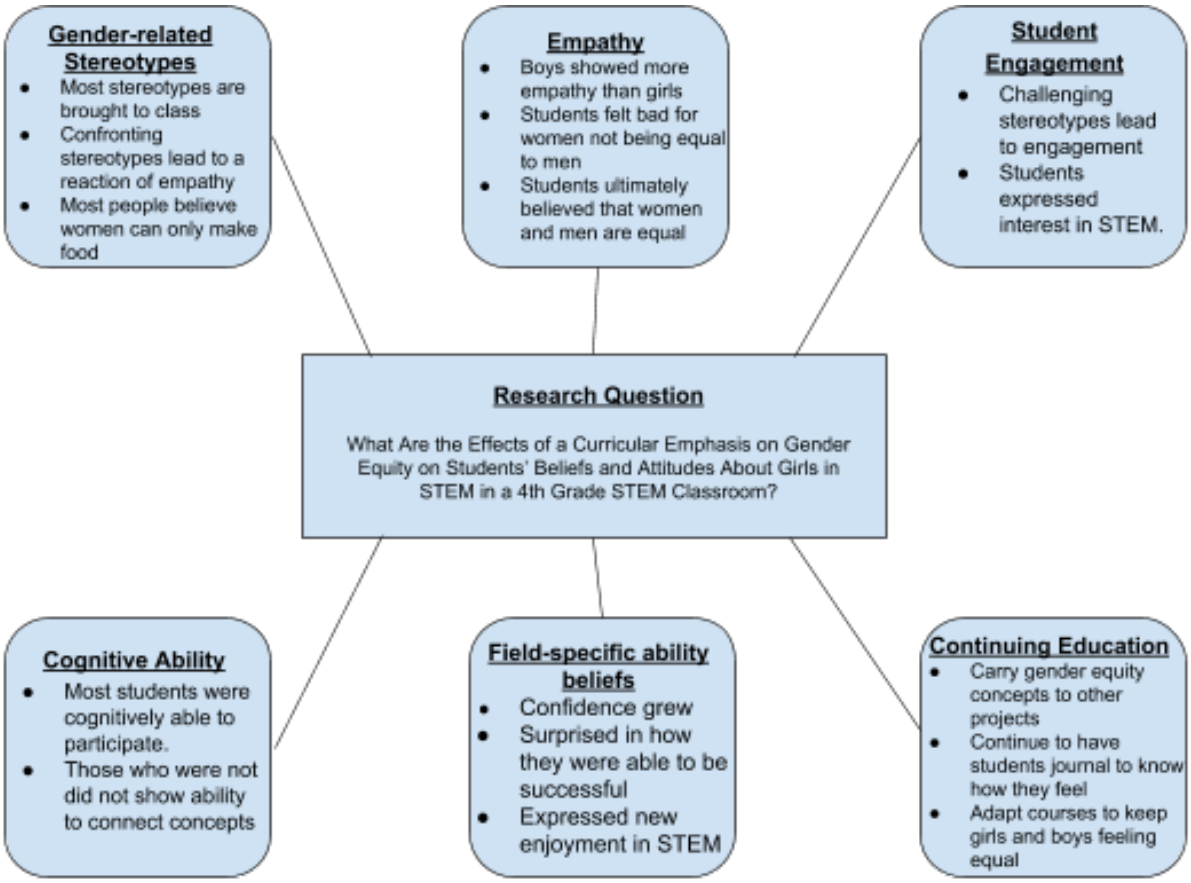


Figure: 4.2 Codes and Bins Graphic

THEMES

Analysis of the data demonstrates the need for students to be taught about gender equity and stereotypes in my classroom. The use of qualitative codes led me to five preliminary themes, including: Gender-Related Stereotypes, Empathy, Student Engagement, Cognitive Ability, and Field-Specific Ability. From these main five thematic topics, I was able to establish theme statements that became clear and could be supported by the research study data. The following are the five themes that arose followed by their explanations.

THEME STATEMENTS

Gender-related stereotypes: *Students often came to class with preconceived gender stereotypes and bias that they learned outside of the classroom. These stereotypes controlled their confidence, their belief of whether or not they could be successful, and their feeling of equality. Most students believed that women could only deal in subjects that had to do with food.*

Gender related stereotypes come with students to my classroom. When we talked about inventions, it was evident that students carry a very strong bias against women being capable of doing things that are considered to be male tasks. Students commented on how women are supposed to be the ones that cook and they often filled out their invention activity showing they believed women could only invent things that have to do with food. Often in education there is the effect

on girls and boys to do worse in science and math based on what we say and do. Delpit (2012) explains:

> "Stereotype threat is the experience of anxiety or concern in a situation where a person has the potential to confirm a negative stereotype about the social group to which they belong. Steele initially looked at the performance of men and women in a mathematics class, where men typically out performed women. The group of men and women were given a difficult test in mathematics. Some of the participants were told that men and women typically scored similarly on this particular test. The participants who were not given instructions showed the expected gender gap in performance - the women scored lower than the men. In contrast, the group that was told that the test did not typically show gender difference displayed no gender-based score differences" (p. 17).

Students were introduced to the phenomenon of stereotype threat. Through observations and their journaling it showed that they did not want to be different in school, on tests, and in jobs. They want to be treated equal because they are equal.

Empathy: *Students showed empathy toward women after the lessons and believed everyone should be treated equally, whether male or female. Boys expressed the most amount of empathy and both explained that they believed girls and boys could do the same things equally.*

In the beginning of the study I introduced boys and girls to statistics about STEM jobs. I gave statistics about the low percentage of women in STEM careers, the wage gap in STEM, and how many women do not get credit for their inventions. As I read their journals, I began to see a shift in their responses. In the beginning their entries were about themselves and as they learned more about gender stereotyping and the bias they carried, the more they wrote about their feelings for other people. Just as Freire (1970) stated, "Students, as they are increasingly posed with problems relating to themselves in the world and with the world, will feel increasingly challenged and obligated to respond to that challenge (p. 56).

Student Engagement: *Students were engaged when their beliefs were challenged. Students changed their expressions of inequality, gender-related stereotypes, and lack of confidence, to that of empathy, confidence, and equity. Students expressed interests in STEM that they seemed to not expect in the beginning.*

In the beginning of the study, while I was conducting my pre-content survey, I heard many students talk about how they can not do STEM because they are just not good at math or they can not build things. As soon as I began to give facts about gender in STEM I immediately noticed how students began to believe that it was not fair. In their journals they wrote about how everyone should be treated equally. They also began to write about how they believed they could do

things that they never could before, like building something that worked. Frier (1970) said "In problem-posing education, people develop their power to perceive critically the way they exist in the world with which and in which they find themselves; they come to see the world not as static reality, but as a reality in process, in transformation" (p.83). The students were in transformation, and began to believe in themselves and in equality.

Cognitive Ability: *Most students were at the cognitive level that allowed them to understand gender-related stereotypes, bias, and inequity. They were able to recognize it in themselves and were able to recognize a need for change.*

Dewey (1938) explained, "Experience does not go simply inside a person. It does go on there, for it influences the formation of attitudes of desire and purpose. But this is not the whole story. Every genuine experience has an active side which changes in some degree the objective conditions under which experiences are had" (p. 39). Students' life experiences happen to each one individually and influence their beliefs and values. However, they are not totally created by the individual. Teachers have the ability, to some degree, to create an environment or experience to control outcome. The most important part of this is to do this in such a manner that is at their cognitive level.

It was important to create content about equity that was at a fourth grade level. When I read their journals I had to remember that these students were still very young, and gender-stereotypes, bias, and gender equity are very complex

things. I believe by giving them facts about gender and bias and creating a simple activity, they were able to understand it. In their journals I read comments about how girls and boys should be equal, everyone should be treated the same, and boys should not be mean to girls. At their cognitive level, they showed understanding of the concepts.

Field-specific ability beliefs: *Boys and girls gained confidence in their abilities in STEM and were surprised when they were successful in something that was perceived to be hard.*

One of the best parts about my class is being able to learn concepts through hands-on activities, allowing students to see and touch project and giving them something concrete to touch. Typically STEM is not offered in schools until sixth grade so allowing students to have it earlier is beneficial. Dewey (1938) believed

> The final justification of shops, kitchens, and so on in the school is not just that they afford opportunity for activity, but that they provide opportunity for the kind of activity or for the acquisition of mechanical skills which leads students to attend to the relation of means and ends, and then to consideration of the way things interact with one another to produce definite effects (p. 84-85).

There were many journal entries written about how students were proud of themselves for building something. They were also empowered because they

made something that worked really well. By combining equity content in my curriculum and hands-on activities, students were able to start to believe they were better at STEM, and would be able to change stereotypes and bias by proving those beliefs wrong.

THE NEXT ACTION RESEARCH CYCLE

Throughout my study, I saw so many students understand and recognize their stereotypes and bias toward women and men. It was wonderful to see how they did not believe it was fair and wanted to change it. Due to their age I think the most important thing was that it showed they do have the capacity for change.

In the future I would like to see if what they learned has an ongoing effect on how they treat others in the STEM room. I have the opportunity to see them for two more years after this, allowing me the chance to see if what I did caused a lasting impression on them. It would be beneficial to offer some refreshers on gender equity in the STEM room through the following years.

The biggest thing I want to change next time would be to limit my sample size. Having 63 students was very time consuming to interpret data and keep track of. I would like to see how much more detail I could get if just chose one class to work with, instead of opening it up to the entire fourth grade. I also had a couple of classes that had very vocal girls and very vocal boys and they would be interesting to study the difference between those two classes.

In conclusion, I worked with boys and girls on exposing stereotype and bias in their lives and in the classroom. I found that students carried stereotypes and bias from their surroundings already and when they were confronted with them, many students expressed the need to change. I believe this is a great starting point for fourth graders and I will continue to work with them.

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APPENDIX A

Parent Consent Form

Dear Parent / Guardian:

I am a graduate student under the direction of Professor Gleason in the Education Department at Moravian College I am conducting a research study to better understand gender equity in the 4th grade STEM (Science, Technology, Engineering, and Math) classroom.

Your child's participation will involve filling out a brief survey and answering questions in a short interview. Your participation, as well as that of your child, in this study is voluntary. If you or your child chooses not to participate or to withdraw from the study at any time, there will be no penalty as (it will not affect your child's grade, treatment, or care, whichever applies). Should you elect to discontinue participation, any information already collected will be discarded. The results of the research study may be published, but your child's name will not be used.

Although there may be no direct benefit to your child, the possible benefit of your child's participation is to help understand why girls lose interest in STEM. It will also help understand how we can change the views of boys and girls in the STEM classroom on girl's roles in STEM.
If you have any questions concerning this research study or your child's participation in the study, please email me at bennettk@slsd.org or Professor Gleason at gleasont@moravian.edu.

Sincerely,
Kari Bennett

4-6th Grade STEM
JPLIS

I give consent for my child _____ to participate in the above study.

I DO NOT give consent for my child _____ to participate in the above study.

Parent's Name (print): _____

Parent's Signature _____ (Date) _____

APPENDIX B

Student Consent Form

To whom it may concern,

I have been informed that my parent(s) have given permission for me to participate, if I want to, in a study concerning gender equity in the STEM (Science, Technology, Education, and Math) classroom. I will help learn about girls and boys in the STEM classroom. My participation in this project is voluntary and I have been told that I may stop my participation in this study at any time. If I choose not to participate, it will not impact my grade in any way. If I stop, all information that is collected will be discarded.

Print Name: _____

Signature and Date: _____

APPENDIX C
Student Survey

Pre and Post Student Survey

HERE ARE SOME QUESTIONS ABOUT YOU AS A STUDENT IN THIS CLASS. PLEASE PLACE A CHECK IN THE BOX TO THE RIGHT OF EACH STATEMENT THAT BEST DESCRIBES WHAT YOU THINK.

	1 Strongly Disagree	2 Disagree	3 Not Sure	4 Agree	5 Strongly Agree
1.I'm certain I can master the skills taught in class this year in STEM (Science, Technology, Engineering, and Math)					
2. I enjoy STEM (Science, Technology, Engineering, and Math)					
3. My chances of succeeding later in life depend on doing well in school.					
4. People that have jobs in STEM (Science, Technology, Engineering, or Math) are smarter than me.					
5. It's very important to me that I don't look smarter than others in class.					
6. My family would be happy for me if I got a job in STEM (Science, Technology, Engineering, or Math).					
7. One of my goals is to show others that class work is easy for me.					
8. Girls and boys are equal in					

STEM (Science, Technology, Engineering, and Math).					
9. My teacher favors girls in the STEM (Science, Technology, Engineering, or Math) classroom.					
10. I can have a job in STEM (Science, Technology, Engineering, or Math) when I grow up.					
11. In our class, it's OK to make mistakes as long as you are learning.					
12. In our class, trying hard is very important.					
13. I have been told I can be successful in STEM (Science, Technology, Engineering, and Math) by a teacher or parent.					
14. STEM (Science, Technology, Engineering, and Math) is only for boys.					
15. In our class, it's important that you don't make mistakes in front of everyone.					
16. STEM (Science, Technology, Engineering, and Math) is just not for me.					

I am (circle one to right)	Male	Female
My age is:		

APPENDIX D

Surprise Journal

Surprise! Please answer the following questions after every STEM class.

Date: _____

1. Moment of surprise:

2. Why it was surprising:

3. What this tells me:

Date: _____

1. Moment of surprise:

2. Why it was surprising:

3. What this tells me:

Date: _____

1. Moment of surprise:

2. Why it was surprising:

3. What this tells me:

APPENDIX E

Loop Plane Activity Part 1

Name: _____ Date: _____

Loop PLANE Engineering

PLAN

Sketch your plane!

My loop plane will be made out of:

_____

_____

_____

_____

Build and fly your plane!

RESULTS

3. How far did your plane travel? Modify and retry

List modifications made for each new loop plane test flight.	Use floor tiles or any other unit of formal or informal measurement
REGULAR LOOP PLANE	

4. What changes have you made? Why?

_____

_____

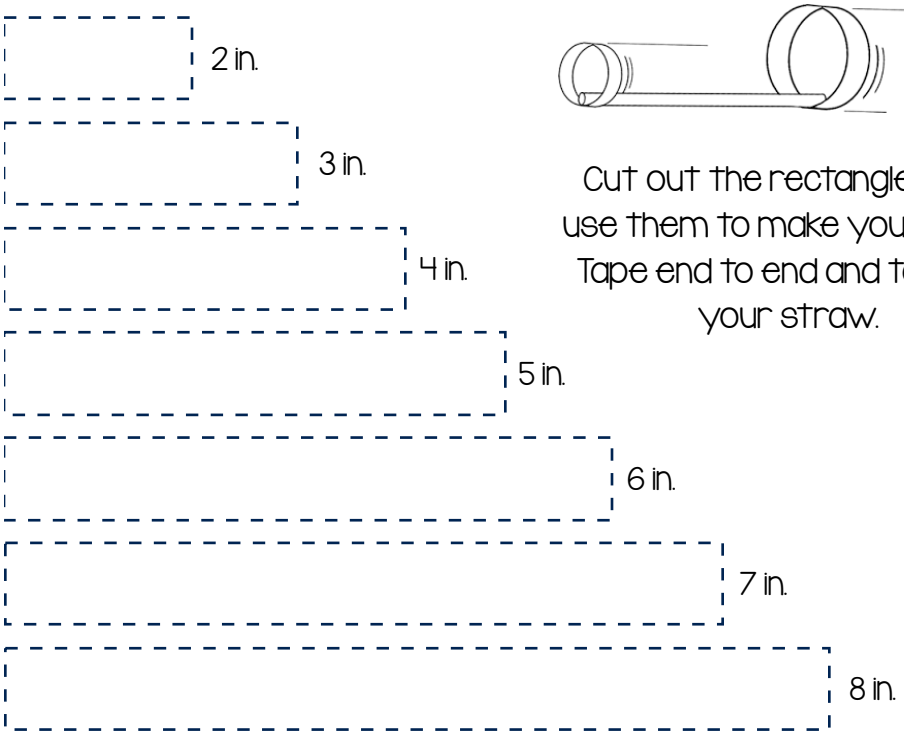
_____

Draw the final version of your plane with modifications labeled.

Adapted from: https://www.teacherspayteachers.com/Product/Rosie-Revere-Engineer-Book-Companion-and-STEM-project-1975280

APPENDIX F

Loop Plane Activity Part 2



Cut out the rectangles and use them to make your loops. Tape end to end and tape to your straw.

Adapted from: https://www.teacherspayteachers.com/Product/Rosie-Revere-Engineer-Book-Companion-and-STEM-project-1975280

APPENDIX G

Inventions Activity Answer Sheet

Inventions – Answer Sheet

Woman	Man