Providing an Elementary School Environment that Encourages Girls to See their Place in the STEM Fields

Hannah Borchardt
Minnesota State University, Mankato

Hannah Borchardt

Hannah Borchardt grew up in Duluth, Minnesota and received her undergraduate degree in Elementary and Special Education from the University of Minnesota Duluth in 2016. Hannah started teaching at Cromwell-Wright Elementary right out of college and has been there ever since. She recently received her MS in Elementary Education with a Graduate Certificate in Elementary Math from Mankato State University, and she is looking forward to applying what she learned into her classroom. When she is not teaching, Hannah enjoys spending time with her husband and her two Golden Retrievers.

Proper APA Citation for this Article is:
Borchardt, H. (2021). Providing an elementary school environment that encourages girls to see their place in STEM fields. *Innovations and Critical Issues in Teaching and Learning 2*(1), 1-30.
https://cornerstone.lib.mnsu.edu/icitl/vol2/iss1/1

Abstract

For many years, women have been underrepresented in the Science, Technology, Engineering, and Mathematics (STEM) fields at the collegiate and professional levels. The two primary reasons for this underrepresentation are the influence of gender stereotypes and biases surrounding STEM and the lack of female role models in the STEM field. Elementary educators must do what they can to address these issues in an effort to allow girls to see their place in STEM. To help counter the influence of gender stereotypes and biases in STEM, elementary educators should integrate STEM into the classroom for all students to participate and have conversations with students about the gender discrepancies in STEM. To address the need for female role models in STEM, elementary educators should utilize classroom speakers, a diverse classroom library, an inclusive classroom environment, and an effective mentoring program to allow girls to see themselves represented in STEM. While this will not fully eliminate the gender gap in STEM, it will help girls to see their place in the STEM fields from a young age.

Keywords: STEM, gender discrepancy, women in STEM, elementary education, classroom environment

Providing an Elementary School Environment that Encourages Girls to See their Place in the STEM Fields

Introduction

Defining STEM Education

Over the last 20 years, there has been a push towards the integration of science, technology, engineering, and mathematics (STEM) in the elementary classroom. According to the U.S. Department of Education (n.d.), STEM education refers to the critical skills students develop through the integration of science, technology, engineering, and mathematics. STEM is an integrated approach to learning which emphasizes real-world and relevant experiences for students (Vasquez et al., 2013).

The Importance of STEM Education

There are many reasons why STEM education is important, especially at the elementary level. The first reason is that it allows students to develop critical 21st century skills (Brown et al., 2011; Committee on STEM Education, 2018). These 21st century skills include creativity, critical thinking, communication, and collaboration (National Education Association, n.d.; Reagan, 2016). With an integrated STEM approach, students are able to develop creativity by being challenged to find creative solutions to various problems as well as critical thinking skills as they engage in real-world problem-solving scenarios. The collaborative nature of STEM allows for the further development of communication and collaboration as students engage in activities that promote teamwork (Reagan, 2016). The development of these skills is crucial for the 21st century economy because there has been a shift from assembly line jobs to jobs that require independent, analytical thinking (Pew Research Center, 2016).

The second reason STEM education is important is because it leads to higher academic achievement in the STEM subjects. STEM integration has repeatedly resulted in increased student performance due to increased student motivation and engagement (Committee on STEM Education, 2018). Many studies have been done on the correlation between STEM integration and academic achievement (Cotabish et al., 2013; Han et al., 2015; Struyf et al., 2019), and the results consistently support the claim that STEM education leads to increased academic outcomes.

The third reason why STEM education is important is because it promotes a growth mindset (Reagan, 2016). According to Carol Dweck (2010), a growth mindset is the belief that oneself is able to overcome difficult tasks and that each person has the ability to learn and grow. Students are more apt to develop a growth mindset while participating in STEM because it allows them to engage in educational challenges, try different things, and not have to fear being wrong (Reagan, 2016).

Gender Discrepancy in the STEM Fields

Despite efforts being made to increase women's participation in STEM, they continue to be underrepresented in STEM fields (Kricorian et al., 2020; Miner et al., 2018; National Science Foundation, 2016; O'Brien et al., 2015). A research study conducted in the field in 2015 indicated that women held fewer than 30% of STEM jobs despite the fact that they held close to 50% of all jobs in the United States (National Science Foundation, 2015). Also, the number of women receiving bachelor's degrees has continually been significantly less than the number of men receiving bachelor's degrees in the following STEM fields: computer science, engineering, mathematics and statistics, and physics (National Science Foundation, 2016). Research shows men are more likely to pursue a career in STEM than women (O'Brien et al., 2015).

Increasing Women's Participation in the STEM Fields

The underrepresentation of women in STEM is detrimental for two reasons. First, the representation of women in STEM allows for more diversity, more creativity, and more innovation in STEM (Kricorian et al., 2020). Women bring a unique set of skills and ideas to the table, leaving the STEM field incomplete and lacking without them. Second, the National Science Foundation (2018) has reported a shortage of capable workers entering into the STEM field. According to the U.S. Bureau of Labor Statistics (2019), there is predicted to be an 8% increase in STEM occupations from 2019-2029, compared to a 3.4% increase in non-STEM occupations from 2019-2029. Increasing women's participation in STEM is the best way to meet the growing demands of the STEM field. While studying the representation of women in STEM, Greenfield et al. (2002) said it like this, "The underrepresentation of women in science, engineering and technology threatens, above all, our global competitiveness. It is an issue for society, for organizations, for employers and for the individual" (p. 9).

Several studies have examined ways to increase women's participation in STEM. Some of the approaches include utilizing mentoring programs for girls (Kricorian, 2020; Stoeger et al., 2013), implementing The Students Advancing through Involvement in Research Program (STAIRSTEP) theoretical framework (Doerschuk et al., 2016), offering after school STEM programs (Chittum et al., 2017), and exposing girls to successful females in the STEM field (Bottia et al., 2015; Stout et al., 2010). The purpose of this article is to describe strategies elementary teachers can use to create an environment that encourages girls to see their place in STEM.

Literature Review

Much of the literature surrounding gender discrepancies in STEM focuses on statistics of women's involvement in STEM at the collegiate and professional levels (McCullough, 2011; Miner et al., 2018; National Science Foundation, 2016/2018) and explanations for the gender discrepancies in STEM (Handley et al., 2015; McCullough, 2011; Miner et al., 2018; O'Brien et al., 2015; Schuster & Martiny, 2016; Xie et al., 2015). While much of the literature focuses on women in STEM at the professional level, something should be done at the elementary level as that is when potential interventions could have the biggest impact (Brophy et al., 2008). Thus, it is critical for elementary educators to be aware of the gender discrepancies in STEM so that they can begin to evoke change.

Representation of Women in STEM

Studies have shown, women are less likely to participate in STEM at both the collegiate and professional levels (McCullough, 2011; Miner et al., 2018; National Science Foundation, 2016/2018). The National Center for Science and Engineering Statistics (2019) and the National Science Foundation (2016) found that 42% of the people receiving degrees in Mathematics and Statistics were women, 21% in Engineering, and 19% each in Computer Science and Physics. In contrast, the American Enterprise Institute (2016) found that 84.2% of the people who received degrees in Health Professions and related Programs were women, 82.5% in Public Administration and Social Services, 80% in Education, and 77% in Psychology.

Women also continue to remain underrepresented in the STEM workforce, especially in engineering, computer science, and the physical sciences (National Science Foundation, 2018). Women hold fewer than 30% of STEM jobs in the United States (Miner et al., 2018; National Science Foundation, 2015). Another research study found similar results (50% of total jobs and only 28% of science and engineering jobs) (National Science Foundation, 2018).

Reasons for Gender Discrepancy in STEM

There are many different explanations for the underrepresented of women in STEM. One group of researchers identified two lenses for explaining gender inequality in STEM: the individual lens and the social-structural lens (Miner et al., 2018). The individual lens seeks to explain the gender discrepancy by identifying characteristics of individual women. The primary argument from this viewpoint suggests that women are not as interested in STEM and therefore choose to not pursue STEM as often as men do, emphasizing the woman's choice. The social-structural lens seeks to explain the discrepancy by identifying barriers in society which discourage women from pursuing a career in STEM. An example is that women don't pursue STEM as frequently as men because of systematic biases they've experienced surrounding the field. The researchers found that neither lens is correct nor incorrect, rather each on its own is incomplete. Further, they pose the idea that many of the arguments from the individual lens are actually a result of issues within the social-structural lens (Miner et al., 2018). For example, a woman might choose to not pursue a career in STEM because of biases she did not realize were affecting her. Thus, an integration of both lenses must be considered and addressed when discussing the reason for and the solutions to the underrepresentation of women in STEM (Miner et al., 2018).

Other studies indicated women in STEM are more prone to experiencing discrimination and implicit bias based on normalized assumptions of the role of women in STEM, such as being treated as though they are incapable because they are female, not being given the same opportunities as their male counterparts, or simply being told they do not have a place in STEM (Handley et al., 2015; Ito & McPherson, 2018; Schuster & Martiny, 2016). Settles et al. (2016) found that both discrimination and harassment were issues experienced by women in STEM.

Schuster & Martiny (2016) further investigated the stereotypes surrounding women in STEM. The authors found that more women experienced negative gender stereotypes surrounding STEM than men (Schuster & Martiny, 2016). Further, they found that anticipated gender stereotypes also had a negative effect on females. Males did not demonstrate the same effect (Schuster & Martiny, 2016). These findings clearly demonstrate the effects of negative stereotypes on women entering the STEM fields. These are all factors that could discourage women from pursuing a career in STEM.

There is a considerable amount of scientific evidence that suggests having a role model with shared characteristics can increase one's likelihood of pursuing a career in STEM (McCullough, 2011; Stout et al., 2010). McCullough (2011) found the lack of female role models and mentors in STEM to be a valid reason for the underrepresentation of women in STEM; there are not an adequate number of "experts" in the field for girls to look up to (McCullough, 2011). Stout et al. (2010) found when girls were exposed to female STEM experts, they demonstrated "increased positive attitudes, self-efficacy, and connection with the discipline" (p. 14). Without a sufficient number of female role models in STEM, young girls are less likely to see themselves as having a place in STEM (Stout et al., 2010).

Various researchers argue that the gender discrepancy in STEM is a result of women's lifestyle choices or obligations. In 2005, the president of Harvard, Larry Summers, proposed that the lack of women in STEM was a result of women prioritizing family life over spending time at work (McCullough, 2011). These researchers would argue that this claim could be supported with statistics that show women still traditionally remain responsible for more household and childcare work than men do, which could impact their ability to be fully devoted to their job

(McCullough, 2011). While there is no substantiated research to back these claims, it is worth noting that some believe this to be a reason for the underrepresentation of women in STEM.

Similarly, additional researchers argue that the gender discrepancy in STEM can be attributed to innate abilities in mathematics or science. However, there is no data to support this claim. Research studies examining the differences between female and male achievement in K-12 education found there was no significant difference between female students' achievement in mathematics and science and male students' achievement in mathematics and science (Brophy et al., 2008; National Science Foundation, 2018). Despite these findings, there are still some who believe the gender discrepancy in STEM is a result of a gender discrepancy in academic ability.

Increasing Women's Participation in the STEM Fields

Several studies have examined ways to increase women's participation in STEM. Kricorian et al. (2020) found that girls who had exposure to a female role model in STEM were more likely to pursue a STEM career themselves. Over half (54%) of the people that responded to the same survey said that meeting a STEM professional of their same gender and ethnicity would effectively encourage them to pursue STEM (Kricorian, 2020). When girls are exposed to successful women in STEM, they are more likely to see their place in STEM (Kricorian, 2020; Stout et al., 2011; Zaniewski & Reinholz, 2016).

Similarly, Stoeger et al. (2013) found that the use of a year-long online mentoring program increased girls' likelihood of pursuing STEM careers. They found that the following components led to more successful results: starting at an early age, having a same-sex mentor, consistent communication, on-task discussions, and as small of an age gap between mentor and mentee as possible. Girls are more likely to pursue a career in STEM if they participate in a strong mentoring program (Atkins et al., 2020; Stoeger et al., 2013).

Other researchers have examined the effects of girls' participation in afterschool science programs (Adams et al., 2014; Chittum et al., 2017; Hughes et al., 2013; Jayaratne et al., 2003; Koch et al., 2010; Tyler-Wood et al., 2012; Watermeyer, 2012). Tyler-Wood et al. (2012) studied the effectiveness of Bringing Up Girls in Science (BUGS), a science-based afterschool program for 4th and 5th grade girls. They found that girls who participated in BUGS had greater scientific knowledge, more self-confidence in STEM, and a greater appreciation for science, though they were unable to identify a direct correlation between participation in this program and the decision to pursue a career in STEM. Chittum et al. (2017) analyzed the effects of Studio STEM, an afterschool STEM program, on students' motivation and engagement. Chittum et al. (2017) found that afterschool programs focused on STEM could help increase students' motivation and interest in STEM, though they didn't specifically report on how this impacted girls' participation in STEM. It has been conclusively shown that afterschool STEM programs are effective in increasing girls' interest in STEM, which would increase girls' likelihood of pursuing a future in STEM (Adams et al., 2014; Chittum et al., 2017; Hughes et al., 2013; Jayaratne et al., 2003; Koch et al., 2010; Tyler-Wood et al., 2012; Watermeyer, 2012).

The Intersection of Race and Gender in STEM

While the focus of this paper is on overcoming gender discrepancies in STEM, there is an even greater disconnect between the number of women in STEM and the number of Women of Color in STEM. Research studies have shown that women accounted for 29% of all science and engineering occupations while underrepresented minorities (individuals who are black, Hispanic, or American Indian or Alaska Native) accounted for only 13.3% of all science and engineering occupations; out of the 13.3%, only 5% were women (National Science Foundation, 2018/2020; Pew Research Center, 2018). While the gender discrepancy in STEM must be addressed, the

intersection of race and gender in STEM cannot be ignored. Further research is needed to address this ongoing issue.

Application

How to Encourage Women's Participation in STEM from a Young Age

One of the most important things educators can do to increase women's participation in STEM is to start interventions while the girls are still young. By the time they are 12 years old, most girls have already experienced stereotypes surrounding their involvement in STEM (Brophy et al., 2008). Before they complete middle school, many girls have already made up their minds about whether or not they will pursue a career in STEM. By engaging in STEM education and having the opportunity to see their place in STEM at a young age, girls will be more likely to consider pursuing a future in STEM when that time comes.

What does it mean to "start young?" There are many things educators should do to address both the individual lens and the social-structure lens in an effort to encourage girls to see their place in STEM education, remembering that often the components of the individual lens are a result of components of the social-structural lens. Educators should integrate STEM education in the elementary classroom, giving all students a chance to participate. They should invite women from STEM fields into the classroom as guest speakers, allowing girls to see and talk with potential role models. Educators should diversify their classroom library in an effort to include books that represent women and Women of Color in STEM and make sure their classroom does not masculinize the STEM subjects any further. Educators should verbally address any instances of bias or stereotyping they encounter in their classroom. Additionally, they should advocate for the implementation of a mentoring program, as well as an afterschool STEM program, specifically for girls in STEM. A combination of these things could help young

girls, including young Black and Brown girls, to see their place in STEM, thereby opening the door for them to consider a future in a STEM field.

Provide STEM Opportunities for All Students

Educators must commit to engaging all students in STEM, as it is important for all students to have access to STEM education (U.S. Department of Education, n.d.). This access should not depend on gender, race, ability, or socioeconomic status. This means STEM integration should take place when all students are able to partake, during the school day. It should not solely take place before or after school, while students are being pulled out, or as an elective where students must choose between multiple activities. Specifically, girls, including Black and Brown girls, must have the same access to STEM as boys do as it will help them to view themselves as capable of participating in STEM.

The nature of STEM allows for it to easily be integrated into the elementary classroom without the teacher having to make too many changes or modifications to his/her practice. The purpose of STEM education is to engage students in real-world scenarios that are cross-curricular, meaning the students are engaged in more than one STEM discipline at a time. This could be the integration of science and mathematics, mathematics and technology, science, engineering, and technology, or any other combination of the four disciplines. There are many websites designed to help educators begin the process of implementing STEM integration in their classrooms. One example is www.teachengineering.org. This site offers free STEM curriculum for K-12 classrooms. Educators can search by grade, subject area, or lesson idea. It is easy to use and could serve as a great first step for educators wanting to implement STEM integration.

Provide Examples of Role Models

Classroom Speakers

Based on the knowledge that many girls experience gender biases and stereotypes in STEM, educators must do what they can to dismantle these ideas. One of the most effective ways to combat these stereotypes is to expose students to examples of successful women and Women of Color in STEM related fields (Dasgupta & Stout, 2014). Educators should arrange for women in STEM to come in as guest speakers. These guest speakers could include any women currently working in a STEM field. For example, if the students are doing a project where they are learning about civil engineering by building bridges in class, the teacher might choose to have a female engineer come teach a lesson or speak to the class about what goes into an actual building project. While this is a great way of exposing girls to potential role models in STEM, the lack of women in STEM positions could potentially make this challenging (McCullough, 2011). If guest speakers aren't available or the teacher is unable to find a local woman in a particular field, there are a plethora of resources online that represent women in STEM fields. See *Appendix A* for a list of websites that could be used to showcase women in STEM in the classroom. These resources could be used for research projects, student biographies, or as varying perspectives on scientific topics. Educators must expose students to the idea that women, including Black and Brown women, can be successful in STEM (Kricorian et al., 2020).

Classroom Libraries

Another way that educators can combat these gender stereotypes is by promoting classroom libraries that include STEM related books with women and Women of Color as main characters. If every STEM related book has a male lead, the gender stereotype surrounding STEM will only be perpetuated; educators must include books that showcase women in STEM in their classroom libraries. In addition to providing students the opportunity to read and interact

with these books, teachers can utilize these books as read-alouds to foster classroom discussions. To start, educators should examine the books they have in their classroom libraries and ask themselves if women and Women of Color are being fairly represented in STEM related books. If the answer is no, educators should seek to add more diverse books that feature women and Women of Color in STEM. See *Appendix B* for a list of suggested books. The inclusion of books (biographies) that feature women and Women of Color in STEM allows for girls to see that they have a place in STEM (Stout et al., 2010).

Classroom Environment

Educators should look at how they portray science and mathematics in their classrooms. Are the examples of scientists or mathematicians mostly men? Are primarily "masculine" colors used to portray these subjects? For example, many teachers choose to hang up posters in their classrooms. If all of the posters displayed in a classroom contain male scientists or mathematicians (i.e. Albert Einstein, Isaac Newton, Thomas Edison, etc.), girls begin to believe the stereotype that STEM is for men (Charlesworth & Banaji, 2019). Instead, educators could invest in posters that feature diverse figures in STEM, including both women and minorities. Educators must evaluate subtle ways that they may perpetuate these biases or stereotypes by reflecting on their classroom environment. Then, they must commit to making the changes necessary to ensure women in STEM are being fairly represented in their classrooms, and that they are not further perpetuating gender stereotypes in STEM education.

Have Conversations

Educators must speak up when they hear evidence of any gender biases or gender stereotypes in their classroom as this could help to break potential gender stereotypes (Lewis Jr. et al., 2019). For example, if a girl is playing with Legos and a comment is made about Legos

being for boys, the teacher should step in and speak against the stereotype being spoken. Along those same lines, educators should avoid creating scenarios where students are assigned an activity based on their gender. For example, educators should not say "boys can play with Legos and girls can color," as statements like this only perpetuate the stereotypes. Educators should encourage all students in all activities, regardless of their gender.

While it is important for educators to interject as they hear instances of gender biases or stereotypes, it is even more important for educators to have direct conversations with their students addressing the gender stereotypes in STEM. Educators should inform their students of the gender discrepancy in STEM and explain why there is such a discrepancy. This could give educators an opportunity to explicitly speak against the stereotypes that girls may encounter (i.e. that boys are naturally better at math and science, that girls can't handle the workload in STEM, and that girls do not belong in STEM). These types of conversations could take place within the context of a STEM activity, while discussing well-known scientists or mathematicians, or even within the context of a "what do you want to be when you grow up" classroom activity. Educators have a unique influence on students' ideas and perceptions. They should use their voice to speak up and speak out against gender stereotypes and biases in STEM so that girls know they have a place in STEM (Lewis Jr. et al., 2019).

Establish a STEM Mentoring Program for Girls

Educators should advocate for the establishment of a strong, research-based STEM mentoring program for girls. This is the approach best supported by research to increase girls' likelihood of pursuing a future in STEM. While there have been many studies that focus on the effectiveness of mentoring programs for girls, there is some variation in how these programs are

executed. There are, however, some qualities or characteristics that have proven to be more successful.

Stoeger et al. (2013) identified six characteristics of a successful online STEM mentoring program for girls, however these practices could be adapted for a face-to-face mentoring program as well. First, girls should be paired with a mentor of the same sex. This can be challenging, as there are a limited number of women in STEM fields, however it is a crucial component of an effective mentorship (Stoeger et al., 2013). This is important because it really allows girls to see themselves in the STEM field. While a mentorship between members of the opposite sex could be beneficial, the most effective programs paired girls with same-sex mentors.

Second, the mentorship program should start as early as possible, as without intervention, girls' likelihood of pursuing STEM diminishes as time goes by (Stoeger et al., 2013; LaForce et al., 2016). Studies show that waiting until girls are in high school is too late because, by then, they will have already been exposed to the gender stereotypes and biases that deter them from seeing their place in STEM. Mentorship programs would ideally start in elementary school.

Third, there should be frequent interaction between the mentor and the mentee. Stoeger et al.'s (2013) study recommends interactions at least once a week. This frequent interaction could be face-to-face or virtual, but it's important for communication to be consistent. Along the lines of communication, the fourth characteristic of an effective mentoring program is that the mentor must share knowledge, answer questions, offer guidance, and serve as a counselor for the mentee. The mentor should be a professional who is able to assist and guide the mentee (Stoeger et al., 2013). Mentoring programs are effective because they give girls the space and time to actually envision themselves in STEM. One way this can happen is by girls getting the chance to

ask questions and learn more about a potential future in STEM. An effective mentoring program should allow for clear, consistent, open communication between the mentor and the mentee.

Next, the most effective mentorship arrangements are between mentors and mentees close in age (Stoeger et al., 2013). This helps the mentee see themselves in STEM. It is important to note that this is not always achievable. Again, due to the lack of women in STEM fields, it can be hard to find potential women mentors, especially ones that are younger or closer to the girl in age. However, researchers have found that the closer the mentor and mentee are in age, the better. It can also be beneficial for mentees to have access to a broad number of mentors rather than just one, as this increases their exposure to women in STEM (Stoeger et al., 2013). Again, this might not always be possible, but it has proven to be beneficial for the girls in the mentorship program.

Finally, if the mentorship is conducted virtually, a rich STEM environment can be created in the form of chat rooms, forums, or STEM focused discussions. This type of an online environment can help educate and inspire girls (Stoeger et al., 2013). This could allow for collaboration or discussion amongst mentors and mentees, and it could better help girls see their place in STEM.

Establish an Afterschool STEM Program for Girls

In addition to advocating for a strong mentoring program, educators should also advocate for an afterschool STEM program for girls. Girls who participate in an afterschool STEM program are more confident in their scientific knowledge and abilities, are more likely to view themselves as capable in STEM, and are more interested in STEM topics (Adams et al., 2014; Chittum et al., 2017; Hughes et al., 2013; Jayaratne et al., 2003; Koch et al., 2010; Tyler-Wood et al., 2012; Watermeyer, 2012). These three things have a direct impact on girls' eventual

decision to pursue a career in STEM. Providing girls with an afterschool STEM program opens the door for girls in STEM.

The Need for Reflection

Educators must make it a priority to reflect on their practice in order to shape their own critical lens in an effort to increase girls' participation in STEM. Researchers have conclusively found that reflection is a critical practice in education (Marcos & Tillema, 2006). When teachers take the time to reflect on their own internal biases surrounding women in STEM, they are able to develop their own critical lens which impacts their instructional decisions.

Educators should ask themselves and honestly reflect on the following questions: How am I perpetuating stereotypes and biases surrounding women in STEM, intentionally or unintentionally? How am I representing women in STEM in my classroom? Are women in STEM being represented in my classroom? What about Women of Color in STEM? How are girls positioned in my classroom, specifically in regard to STEM subjects? Do girls have equal opportunities as boys to participate in STEM? What am I doing in my classroom to dismantle the stereotypes surrounding women in STEM? Is there anything else I can be doing to better address this issue? What opportunities do I have to encourage girls to see their place in STEM? By taking time to honestly and repeatedly reflect on these questions, educators are better able to identify areas of innate biases, better dismantle these stereotypes and biases, and better encourage girls to see their place in STEM.

The Need for Systematic Change

While the focus of this paper is on what educators can do to encourage girls to see their place in STEM, these strategies alone will not solve the gender discrepancy dilemma in STEM. Systematic changes must take place. For example, one of the most successful methods for

increasing girls' participation in STEM is the use of a mentoring program. While educators can advocate for this type of program or even work to organize this type of program, educators don't make decisions about funding. Without adequate funding, this type of program would not be possible. Further, part of the gender discrepancy in STEM can be attributed to STEM companies not hiring women or Women of Color at the same rate that they hire men. One study sought to uncover discreet gender biases in the hiring process by presenting science faculty with identical application materials, only differing by gender/name. They found that both male and female faculty tended toward the male applicants and offered the female applicants considerably smaller starting salaries despite the males and females presenting identical application materials (Moss-Racusin et al., 2012). While educators can help to lessen the gap, there are some things that fall outside of the control of educators. These issues must be addressed at a higher level.

Discussion

Women in STEM?

Data has conclusively shown that women are underrepresented in STEM (Kricorian et al., 2020; Miner et al., 2018; National Science Foundation, 2020). This is true in college STEM courses and programs, in STEM careers, and in leadership positions within STEM fields. With the growing number of STEM jobs and the increasing demand for these jobs to be filled, something must be done to increase the participation of women in STEM education. Women bring a unique sense of creativity, problem solving, and critical thinking skills to the table. Because women are not fairly represented in STEM, these ideas and approaches are not being utilized. Until women are fairly represented, the STEM field will continue to be a male-dominated field, which only perpetuates the gender stereotype surrounding STEM and further

discourages women from pursuing it. Something must be done to increase women's participation in STEM.

Why is There a Discrepancy and What can Elementary Educators do?

The gender discrepancy in STEM can be attributed to many factors, the most prominent being girls' self-perceptions due to gender biases or stereotypes surrounding STEM (Handley et al., 2015; Ito & McPherson, 2018; Schuster & Martiny, 2016; Settles et al., 2016) and a lack of female role models in STEM for girls to look up to (McCullough, 2011; Stout et al., 2010). Elementary educators must do everything they can to address these two factors in order to lessen the gender gap and encourage girls to see their place in STEM. There are four strategies outlined in this article that elementary educators can utilize: providing STEM opportunities for all students; having conversations addressing gender biases or stereotypes in STEM; exposing girls to potential role models in STEM; advocating for a strong mentoring program for girls.

In an effort to address the gender stereotypes and biases surrounding STEM from a young age, elementary educators should provide STEM opportunities for all students and have conversations with their students about these gender stereotypes. It is important for elementary educators to integrate STEM into the general education classroom (U.S. Department of Education, n.d.). This opens the door for all girls to begin to see their place in STEM from an early age, before they are exposed to and influenced by too many gender stereotypes. By participating in STEM, girls will begin to feel like they are capable of participating in STEM, which will result in girls feeling like they have a place in STEM. Further, educators should have conversations with their students surrounding biases or gender stereotypes in STEM (Lewis Jr. et al., 2019). Educators should "call out" instances of false stereotypes and should initiate conversations with students about girls' place in STEM. Educators often are very influential in

young students' lives (Split et al., 2012); girls could be very positively impacted by a teacher's encouragement toward STEM. These two strategies could counteract the gender stereotypes the girls will encounter and help girls to see their place in STEM.

The other biggest factor deterring girls from pursuing STEM is the lack of exposure to female role models in the field. There are two ways elementary educators can address this issue: exposing girls to potential role models and advocating for the use of a strong mentoring program. Educators should expose girls to potential role models in STEM, which can be done in a variety of ways: via classroom speakers, an inclusive and diverse classroom library, or an intentional classroom environment setting. By exposing girls to successful women in STEM, girls are better able to see themselves in the STEM field (Charlesworth & Banaji, 2019; Dasgupta & Stout, 2014; McCullough, 2011; Stout et al., 2016). It is important to note that this exposure should include both women in STEM as well as Women of Color in STEM. Educators should also advocate for the development of a strong STEM mentoring program for all girls (LaForce et al., 2016; Stoeger et al., 2013). This could be in-person or virtual, but many studies have proven the effectiveness of increasing girls' participation in STEM through the use of a mentoring program. These two practices could help elementary aged girls to see their place in STEM.

Future Directions for this Topic

The concept of STEM integration has been around for less than 20 years (National Science Foundation, 2001), which means what we know about STEM is still evolving and developing. Further and continual research must be conducted on this topic. Specifically, there is a need for longitudinal studies to be conducted on the effectiveness of STEM interventions at the elementary level. These studies should follow girls and boys of all races and ethnic backgrounds from elementary school through adulthood in an effort to calculate the effectiveness of the

following strategies: Integrating STEM into the elementary classroom so all students can participate (U.S. Department of Education, n.d.), bringing in classroom speakers (Dasgupta & Stout, 2014; Kricorian et al., 2020), diversifying classroom libraries (Stout et al., 2010), evaluating classroom environments (Charlesworth & Banaji, 2019), having conversations about gender discrepancies in STEM (Lewis Jr. et al., 2019), and establishing a strong mentoring program (Stoeger et al., 2013). Did the interventions actually impact the students' future career choices? Which strategies were most effective? Did they increase both girls' and boys' participation in STEM? More research studies employing all three types of research methodologies (quantitative, qualitative, and mixed) in different settings need to be conducted. In doing so, educators would have a better understanding of which strategies best encouraged girls to see their place in STEM.

Though it is not the focus of this paper, there is also a need for systematic change in regard to gender equality in STEM. Continued studies must be done on the systematic reasons for the gender discrepancy in STEM. Do women have the same access to STEM as men do (Moss-Racusin et al., 2012)? What about Women of Color? Is the system flawed? What can be done to address the social-structural lens of gender inequality in STEM? These are questions that must also be addressed in order for further change to occur.

Conclusion

Women deserve to be fairly represented in STEM. For too long, gender biases and stereotypes have allowed for STEM to remain a male dominated field. The lack of women in STEM only makes it more difficult for women to see their place in STEM, further perpetuating the issue. The most effective interventions for lessening the gender gap in STEM should begin in elementary school, before girls have been led to believe that STEM is for men. Elementary

educators should do everything they can to help girls, especially Girls of Color, to see their place in STEM so that as girls grow up, they are able to decide for themselves if they want to pursue a career in STEM. By following the strategies outlined in this article, in particular, bringing females and females of color in a prominent position in the classroom through books and mentoring, elementary educators can help encourage girls to see their place in STEM.

References

Adams, J. D., Gupta, P., & Cotumaccio, A. (2014). Long-term participants: A museum program enhances girls' STEM interest, motivation, and persistence. *Afterschool Matters, 20*, 13-20.

Atkins, K., Dougan, B. M., Dromgold-Sermen, M. S., Potter, H., Sathy, V., & Panter, A. T. (2020). "Looking at myself in the future": How mentoring shapes scientific identity for STEM students from underrepresented groups. *International Journal of STEM Education, 7*(42).

Bottia, M. C., Stearns, E., Mickelson, R. A., Moller, S., & Valentino, L. (2015). Growing the roots of STEM majors: Female math and science high school faculty and the participation of students in STEM. *Economics of Education Review, 45,* 14-27.

Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P-12 classrooms. *Journal of Engineering Education, 97*(3), 369-387.

Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding STEM: Current perceptions. *Technology and Engineering Teacher, 70*(6) 5-9.

Charlesworth, T. E. S., & Banaji, M. R. (2019). Gender in science, technology, engineering, and mathematics: Issues, causes, solutions. *The Journal of Neuroscience, 39*(37), 7228-7243.

Chittum, J. R., Jones, B. D., Akalin, S., & Schram, A. B. (2017). The effects of an afterschool STEM program on students' motivation and engagement. *International Journal of STEM Education, 4*(1), 11-16.

Committee on STEM Education. (2018). *Charting a course for success: America's strategy for STEM education.* National Science and Technology Council.

https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

Cotabish, A., Dailey, D., Robinson, A., & Hughes, G. (2013). The effects of a STEM intervention on elementary students' science knowledge and skills: The effects of a STEM intervention. *School Science and Mathematics, 113*(5), 215-226.

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences, 1*(1), 21-29.

Doerschuk, P., Bahrim, C., Daniel, J., Kruger, J., Mann, J., & Martin, C. (2016). Closing the gaps and filling the STEM pipeline: A multidisciplinary approach. *Journal of Science Education and Technology, 25*(4).

Dweck, C. S. (2010). Even geniuses work hard. *Giving Students Meaningful Work, 68*(1), 16-20.

Greenfield, S., Peters, J., Lane, N., Rees, T., and Samuels, G. (2002). *A report on women in science, engineering, and technology for the Secretary of State for Trade and Industry*.

Han, S., Capraro, R., & Capraro, M. M. (2014). How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of student factors on achievement. *International Journal of Science and Mathematics Education, 13*(5), 1089-1113.

Handley, I. M., Brown, E. R., Moss-Racusin, C. A., & Smith, J. L. (2015). Quality of evidence revealing subtle gender biases in science is in the eye of the beholder. *Proceedings of the National Academy of Sciences of the United States of America, 112*(43), 13201-13206.

Hughes, R. M., Nzekwe, B., & Molyneaux, K. J. (2013). The single sex debate for girls in science: a comparison between two informal science programs on middle school students' STEM identity formation. *Research in Science Education, 43*(5), 1979-2007.

Ito, T. A., & McPherson, E. (2018). Factors influencing high school students' interest in pSTEM. *Frontiers in Psychology, 9.*

Jayaratne, T. E., Thomas, N. G., & Trautmann, M. (2003). Intervention program to keep girls in the science pipeline: Outcome differences by ethnic status. *Journal of Research in Science Teaching, 40*(4), 393-414.

Koch, M., Georges, A., Gorges, T., & Fujii, R. (2010). Engaging youth with STEM professionals in afterschool programs. *Meridian, 13*(1), 1-15.

Kricorian, K., Seu, M., Lopez, D., Ureta, E., & Equils, O. (2020). Factors influencing participation of underrepresented students in STEM fields: Matched mentors and mindsets. *International Journal of STEM Education, 7*(1), 1-9. Doi: 10.1186/s40594-020-00219-2

LaForce, M., Noble, E., King, H., Century, J., Blackwell, C., Holt, S., Ibrahim, A., & Loo, S. (2016). The eight essential elements of inclusive STEM high schools. *International Journal of STEM Education, 3*(1), 1-11.

Lewis Jr., N. A., Sekaquaptwea, D., & Meadows, L. A. (2019). Modeling gender counter-stereotypic group behavior: A brief video intervention reduces participation gender gaps on STEM teams. *Social Psychology of Education, 22*, 557-577.

Marcos, J. J. M., & Tillema, H. (2006). Studying studies on teacher reflection and action: An appraisal of research contributions. *Science Direct, 1*(2), 112-132.

McCullough, L. (2011). Women's leadership in science, technology, engineering, & mathematics: Barriers to participation. *Forum on Public Policy: A Journal of the Oxford Round Table.*

Miner, K. N., Walker, J. M., Bergman, M. E., Jean, V. A., Carter-Sowell, A., January, S. C., & Kaunas, C. (2018). From "Her" problem to "Our" problem: Using an individual lens versus a social-structural lens to understand gender inequality in STEM. *Industrial and Organizational Psychology, 11*(2), 267-290.

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handlesman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences, 109*(41), 16,474-16,479.

National Education Association. (2012). Preparing 21st century students for a global society: An educator's guide to "the four Cs." Washington, DC.

National Science Foundation (NSF). (2016/2018/2020). Science & Engineering Indicators. *National Center for Science and Engineering Statistics (NCSES).* https://ncses.nsf.gov/pubs/nsf19304/

National Science Foundation (NSF). (2015/2019). Women, minorities, and persons with disabilities in science and engineering. *National Center for Science and Engineering Statistics (NCSES).* https://ncses.nsf.gov/indicators

O'Brien, L. T., Adams, G., Blodorn, A., Garcia, D. M., & Hammer, E. (2015). Ethnic variation in gender-STEM stereotypes and STEM participation: An intersectional approach. *Cultural Diversity and Ethnic Minority Psychology, 21*(2), 169-180.

The state of American jobs: How the shifting economic landscape is reshaping work and society and affecting the way people think about the skills and training they need to get ahead.

(2016). Pew Research Center. https://www.pewsocialtrends.org/2016/10/06/the-state-of-american-jobs/.

Reagan, M. T. (2016). *STEM-Infusing the elementary classroom.* Corwin Press.

Schuster, C., & Martiny, S. E. (2017). Not feeling good in STEM: Effects of stereotype activation and anticipated affect on women's career aspirations. *Sex Roles: A Journal of Research, 76*(1-2), 40-55.

Science, technology, engineering, and math, including computer science. (n.d.). U.S. Department of Education. https://www.ed.gov/stem

Settles, I. H., Cortina, L. M., Malley, J., & Stewart, A. J. (2016). The climate for women in academic science: The good, the bad, and the changeable. *Psychology of Women Quarterly, 30*(1), 47-58.

Split, J. L., Hughes, J. N., Wu, J., & Kwok, O. (2012). Dynamics of teacher-student relationships: Stability and change across elementary school and the influence on children's academic success. *Child Development, 83*(4), 1180-1195.

Stoeger, H., Duan, X., Schirner, S., Greindl, T., & Ziegler, A. (2013). The effectiveness of a one-year online mentoring program for girls in STEM. *Computers & Education, 69*, 408-418.

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in Science, Technology, Engineering, and Mathematics (STEM). *Journal of Personality and Social Psychology,* 1-16.

Struyf, A., De Loof, H., Boeve-de Pauw, J., & Petegem, P. V. (2019). Students' engagement in different STEM learning environments: Integrated STEM education as promising practice? *International Journal of Science Education, 41*(10), 1387-1407.

Tyler-Wood, T., Ellison, A., Lim, O., & Periathiruvadi, S. (2012). Bringing up girls in science (BUGS): The effectiveness of an afterschool environmental science program for increasing female students' interest in science careers. *Journal of Science Education and Technology, 21,* 46-55.

U.S. Bureau of Labor Statistics. (2020). Employment projections: Employment in STEM occupations. *Bureau of Labor Statistics*. https://www.bls.gov/emp/tables/stem-employment.htm

Vasquez, J. A., Sneider, C., & Comer, M. (2013). *STEM lesson essentials, grades 3-8: Integrating science, technology, engineering, and mathematics.* Heinemann Educational Books.

Watermeyer, R. (2012). Confirming the legitimacy of female participation in science, technology, engineering, and mathematics (STEM): Evaluation of a UK STEM initiative for girls. *British Journal of Sociology of Education, 33*(5), 679-700.

Xie, Y., Fant, M., & Shauman, K. (2015). STEM education. *The Annual Review of Sociology, 41(1), 331-357.*

Zaniewski, A. M., & Reinholz, D. (2016). Increasing STEM success: a near-peer mentoring program in the physical sciences. *International Journal of STEM Education, 3*(14).

Appendix A

Resources for Highlighting Women in STEM in the Classroom.

Website	Description
https://obamawhitehouse.archives.gov/women-in-stem	This website gives personal stories about women involved in STEM.
https://thebestschools.org/features/50-top-women-in-stem/	This website gives information about the top 50 women in STEM.
https://www.globalcitizen.org/en/content/17-top-female-scientists-who-have-changed-the-worl/	This article details 17 female scientists that left an impact on the world.
https://www.teachervision.com/women-stem	This website gives information about women in all areas of STEM.
https://ssec.si.edu/girls-and-women-in-stem	This portion of the Smithsonian Science Education Center's website gives resources for students to learn more about women in STEM.

Appendix B

Elementary Level Books That Feature Women in STEM.

Shark Lady: The True Story of Eugenie Clark by Jess Keating
Grace Hopper: Queen of Computer Code by Laurie Wallmark
The Amazing Scientist Series by Julia Finley Mosca: *The Doctor with an Eye for Eyes: The Story of Dr. Patricia Bath* *The Girl Who Thought in Pictures: The Story of Dr. Temple Grandin* *The Girl with a Mind for Math: The Story of Raye Montague* *The Astronaut With a Song for the Stars: The Story of Dr. Ellen Ochoa*
Rosie Revere, Engineer by Andrea Beaty
Ada Twist, Scientist by Andrea Beaty
Swimming With Sharks: The Daring Discoveries of Eugenie Clark by Heather Lang
The Fourteenth Goldfish by Jennifer L. Holm
Finding Wonders: Three Girls Who Changed Science by Jeannine Atkins
Women in Science: 50 Fearless Pioneers Who Changed the World by Rachel Ignotofsky
Me… Jane by Patrick McDonnell
Mae Among The Stars by Roda Ahmed
I Am Marie Curie by Brad Meltzer
Who Says Women Can't Be Doctors? The Story of Elizabeth Blackwell by Tanya Lee Stone