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An Equal Education: Reducing Gender Bias in STEM Education

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Abstract

The STEM field has become one of the most high-paying and impactful fields in our society. However, data shows that women only make up 25% of STEM employees and 30% of STEM graduates. To understand how these inequities emerged, it is important to look at the beginning of the STEM education pipeline. The purpose of this research is to discover how schools can reduce gender bias in their classrooms. My research discusses two main causes of the lack of female participation in STEM: microaggressions and implicit biases. Microaggressions are implicit or explicit actions or comments that are aimed at someone's abilities based on a certain characteristic, in this case gender. Implicit bias is the unconscious bias some may hold against women in STEM. These issues are commonly seen within STEM education, both among peers and educators. My proposed solution to reduce gender bias in classrooms is to create an outreach program that provides girls the support they need to be successful in STEM. The first outcome for this program would be to provide a support system for female STEM students throughout their education. This would be done by hosting study sessions, research opportunities, and a student-mentor program. The second outcome for this program would be to educate teachers and administrators on how they can support their female STEM students. I believe this initiative would help not only educate the public on the issue, but also encourage more female students to pursue a career in a STEM pathway.

Background

For centuries women have struggled to get out of the home sphere and into the workforce. Today, women have managed to make their way into jobs that they would not have been able to 20 years ago. However, the fight for equality is still not over. STEM is one of the most impactful and high-paying fields in our society today, but there's a problem: women only make up 25% of STEM employees. Furthermore, women only make up 30% of STEM degree holders, and even then most choose to go into a different field with their degree (Andrus, Jacobs, and Kurlioff, 2018, p. 47). To understand why female involvement is lacking in STEM, we must look at the beginning of the "STEM pipeline". The STEM pipeline refers to the pathway one follows throughout their STEM education and career. While many schools and extracurricular programs have taken the initiative to create programs to increase persistence in the STEM pipeline, many fail to consider the inequities of STEM education for underrepresented students, such as students of color, first generation students, and women. To address this problem, we must first establish the difference between inequality and inequity. Inequality refers to an unequal distribution of resources or support for students. While some may argue that we need to fight for equality within the STEM pipeline, this does not take into consideration that some students need more support than others. For example, women in the STEM pipeline face many obstacles such as stereotypes and biases they have to overcome. Therefore, they may require more support than male students. In turn, we should focus on making the STEM pipeline an equitable pathway for students. This would require educators, administrators, and institutions to allocate their resources to support the students who need them the most. In this paper, I focus on the obstacles that women face throughout the STEM pipeline, and investigate how we can create an equitable STEM pipeline for women pursuing STEM.

Microaggressions

Many female students feel discouraged to enter or continue their pathway in the STEM pipeline due to their experiences of microaggressions. Microaggressions are “brief, everyday exchanges that send denigrating messages to people of color because they belong to a racial group” (Grossman and Porche, 2014, p. 701). An example of a STEM microaggression related to race is described by a Latino student in Grossman and Porche’s study (2014) who experienced microaggressions from his White peers: “Oh, you’re Spanish and you’re doing math that good?”. This ambiguous message portrays the idea that the student’s mathematical abilities are somehow influenced by his race. Grossman and Porche’s study applies the concept of microaggressions to gender. A female student in their study provided an example of her interpretation of a microaggression: “I guess scientists, you can say, have power. I don’t know. And a lot of people don’t like the idea of women having power. Like women are supposed to be like at home or something. Or with the kids”(p.709). Microaggressions are usually not explicit discriminatory comments or actions; Majority of microaggressions are indirect behaviors that educators and even students do unconsciously.

Grossman and Porche (2014) interviewed high school students about gender-based microaggressions that had happened to them or a loved one in the STEM field. Researchers adapted Sue’s (2010) study of microaggressions to create themes based on the student experiences of microaggressions. This paper will focus on two key themes researchers found among microaggressions: microassaults and microinsults. Microassaults are beliefs about and experiences of discrimination (Grossman and Porche 2014, p. 709). Unfortunately, 45% of participants expressed that they or someone they know has experienced a microassault based on their gender (p. 709). One example of a microassault came from a male student, who recalled his mother experiencing a microassault in the STEM field: “Her boss gave a dude a job she earned. She did more work than him and he gave [the man] the job” (p.710). Next, Grossman and Porche (2014) observed students' experiences of microninsults. Microinsults are *perceived on others’* beliefs or assumptions. Researchers found that 57% of participants described accounts of microinsults based on gender. A female participant shared her perception of society views women in STEM:

"I do think it's true that a lot of times girls are less interested. And that might be because of like society, how they're like it might be like a cycle, you know? Like girls are told, 'Oh girls are less interested in science.' So they're like, 'Well, I'm less interested in science" (p. 711).

Gender-based microaggressions not only leave a deep-rooted effect on the victim, but also on students who have knowledge of the incident. This is shown in Moss-Racusin et al.'s study (2018) in which participants either read an article reporting explicit gender bias or no gender bias within STEM research. Female participants who read the biased article reported having less motivation to pursue STEM, a more negative stance towards STEM, and a "less sense of belonging" compared to their male counterparts. Conversely, women who read the unbiased article portrayed the same level of motivation to pursue STEM as their male counterparts (p. 655-656). This study shows how simply being aware of microassaults can influence how girls perceive STEM.

According to Sue (2010), ambiguous microaggressions can be even more hurtful than blatant discriminatory comments because it's not clear whether the insulter was intentional or simply uneducated (Grossman and Porche, 2014, p. 702). For that reason, microinsults that are directed at girls in STEM can leave powerful impressions on their academic capabilities. For example, Sadker and Sadker (1994) reported that "girls often receive less attention from their teacher, hear more comments about their appearance than about their academic skills, and often receive less and lower-quality feedback than boys" (Andrus, Jacobs, and Kurlioff, 2018, p. 47). By not receiving the same treatment as boys, girls feel less valued and less competent to pursue complex careers, such as those in STEM. It is clear that microaggressions leave an unfavorable impression of STEM on girls. However, it is also important to examine how girls are coping with these microaggressions.

Additionally, Grossman and Porche (2014) also collected responses on the coping mechanisms girls used to cope with the microaggressions that arose within their STEM education. 30% of participants expressed experiencing support for STEM success specific to their gender. Additionally, participants expressed confidence to overcome microaggressions by "ignoring others biased assumptions, challenging them, or proving them wrong" (p. 714). Girls also pointed out that the stereotypes they are facing now are not as bad as they were in the past.

Throughout interviews, many students described support from their family members or teachers for persisting in STEM. One student recounted a time her mother supported her pursuing STEM:

"She's a scientist . . . I asked her about different stuff, like what are some challenges I'm going to have to face if I want to get into that field. And she tells me that, of course, people might view women as inferior, but you just have to keep going with it and you have to prove it instead of just saying it" (p.715).

Having a support system within the STEM field appears to be a significant factor in overcoming microaggressions. Else-Quest, Shibley, and Linn's research (2010) found that female students could perform just as well as male students if they had good support systems and "female role models" (Ybarra, 2016, p 99). While high-school girls gave contradicting responses, it seems that providing girls with support to make it through the STEM pipeline and overcoming challenges such as microaggressions is a vital factor in their success. In summary, while microaggressions can affect female student's outlooks and persistence in STEM, having a support system can help the overcome these barriers.

Implicit Biases

Another problem driving females away from the STEM field is implicit bias. Similar to microinsults, implicit bias is a bias one may hold unconsciously, even though they may not explicitly believe it (Hill, n.d.). An example of how our implicit biases can lead to microinsults is shown in a study conducted by Newall et al. (2018). In this study, adult participants were assigned the task of teaching a STEM lesson, either biology or physics, to an 8-year-old student. The adults first gave a practice lesson to researchers without knowing the gender of the student beforehand. Then, they were given one of four student profiles: a “stereotypical” boy or girl, or an “ambiguous” boy or girl. Once they received the profile of the child, they were asked to predict how much the child would enjoy the lesson, and how well the child would understand the subject. Then, they carried out the final lesson to the child.

Results showed that if the adult was given the profile of a “stereotypical” boy, the amount of scientific information they taught remained the same as the practice lesson. However, if the adults were given the profile of a “stereotypical” girl, the amount of scientific information they delivered decreased between the practice lesson and the final lesson. Furthermore, while participants predicted girls and boys would perform about the same in biology, they also predicted the boy students would perform better in physics than the girls. Finally, participants speculated that the “ambiguous” boy and girl would have the same level of enjoyment of the science lesson, but the “stereotypical” girl would enjoy the lesson much less than the “stereotypical” boy (p. 32-35). This study demonstrates implicit bias because participants did not directly tell their girl students that they won’t enjoy or understand this lesson as well as the boy students. Instead, they held back information given to female students. This microinsult is one of many that constantly happens in science education.

Some may argue that the participants may have altered their delivery of the lesson because they believe female students learn differently than male students. It could be thought that female students find different teaching strategies more engaging than others, and therefore are more likely to enjoy and retain information in a different way than boys. While girl students may find different material more interesting than boys, they do not learn or obtain information any differently. A study that compared male and female student’s preferences on teaching strategies found that both male and female students prefer hands-on lessons, in-class activities, and opportunities to display their knowledge in innovative ways (Andrus, Jacobs,and Kurlioff, 2018, p. 48). While some may believe that the adults in the study left out information to try and engage the female students, that is not an effective strategy to do so. To properly ensure all students receive a proper education, educators need to find ways to create a classroom that engages and supports all students through teaching methods that students are passionate about.

Existing Solutions

The problem of gender bias in STEM education is an issue that cannot be solved directly. There is no way of controlling what people think or knowing what biases they hold. However, we can do our best to join together and support girls who want to pursue a career in the STEM field. For example, the organization Million Women Mentors encourages females to enter the STEM field. The chief academic and diversity officer Talmesha Richards, has many ideas to try and "close the gender gap". These ideas include providing female students with female mentors in the field, inquiring why female students are not participating in STEM, and engaging students early on in the STEM pipeline (DeNisco, 2016).

Another strategy mentioned by Melissa Moritz, the deputy director of STEM initiatives at the U.S. Department of Education, is to expand the teaching strategies used for STEM. Oftentimes, STEM subjects are taught by giving students key terms and vocabulary words to memorize. While understanding this knowledge is helpful, Moritz argues for a more hands-on approach; "We need to teach in a way so students are doing STEM, not just absorbing it" (DeNisco, 2016). This hands-on approach to STEM seems to be an effective way to help students fully understand the material. A final strategy presented by Andrus, Jacobs, and Kurlioff (2018) informs teachers that they should keep a "gender conscious classroom" in order to provide their students with an equal education (p. 49). To do this, teachers must first discuss the unfortunate harassment and stereotypes that underrepresented groups, such as women, endure throughout their careers. To ensure the teachers are implementing a gender-conscious classroom, researchers mention teachers should give out surveys periodically on what is going well in the class and what students want to see more of (p. 49). This way, all students feel like they have a voice in their education and feel confident pursuing STEM.

Additionally, researchers encourage educators to create class activities that require all students to participate. This way, students are aware of the challenges they may face, but feel supported enough to overcome them. Andrus, Jacobs, and Kurlioff (2018) provide an example of how teachers can implement this in their classrooms:

"[…] in a physics classroom with a lab component, teachers can assign student groups and require that students rotate through different roles (e.g., note taker, supply organizer, construction lead, and calculations lead). The same rotation practice may be applied when students are doing history projects, or enacting plays in English. By providing the opportunity for each student to participate in a different role, the teacher can help ensure that students, both boys and girls, who are quieter, less confident of their abilities in the subject, less socially engaged with their peers, or otherwise typically marginalized in group work have chances to participate” (p. 49).

These strategies are not changing the mindset of those who are biased; Providing female students with mentors who are women in STEM provides a support system that will encourage persistence in STEM, as well as serve as a coping strategy for microassaults and implicit biases. Additionally, STEM educators can engage all students in their classes by creating interactive activities to capture students’ attention and motivate them to continue their STEM education. However, these existing strategies may be difficult to implement in every community. Some schools may not have the resources to provide professional support that Richards recommends, or have the budget and time to create a hands-on curriculum for students. These obstacles may make it difficult for schools to actually implement these solutions into their classrooms.

Proposed Solution

While each of the existing strategies are effective in supporting female students in STEM, they can only do so much individually. My proposed solution is to create an outreach program to support female students in STEM. As well as aiding in creating inclusive STEM classrooms, this program would have three outcomes. The first outcome is to create an afterschool program for all levels of education that would enhance STEM engagement, increase STEM persistence, and create a peer-support system for female students. For example, elementary students would be taught a small lesson on a STEM idea followed by a hands-on activity that further engages them on the topic. At the middle school and high school levels, the program would host study sessions for STEM classes, provide opportunities and guidance to create science projects, and go on field trips to science museums and STEM companies. These activities would not only capture girl's engagement and strengthen their STEM skills, but also provide a support system that is crucial to their success. Additionally, this program would work to expand students' ideas of gender norms, so as they continue through the STEM pipeline, they are not discouraged by their male peers. The second outcome for this program is to provide high-school girls with opportunities to professionally develop their STEM skills. This would consist of providing students with a female mentor in the STEM field to create a professional-support system, opportunities to obtain STEM internships, and shadow professionals in the field to see what it is like to work in the science industry. Furthermore, the program would also create a partnership between the middle school students and elementary students. Middle school students would gain leadership skills by tutoring elementary students in STEM subjects, as well as leading interactive activities to engage elementary students in STEM. Finally, the third outcome for this program is to educate teachers and administrators on how they can promote female participation in STEM. This would include hosting workshops on how to create a gender-conscious classroom, ideas on how to create action-based lessons on a budget, and provide assessment tools such as surveys to ensure female students feel they are receiving a valuable STEM education. My hope for this program is to give assurance to both female students and educators that all students can receive fully-developed STEM skills that would empower girls to pursue a career in STEM.

Conclusion

Female students of all ages struggle with numerous barriers to achieve a well-rounded STEM education; they must fight against microaggressions, implicit biases, and more. By creating a program specifically for female students that provides support from both peers and professionals, students will feel more confident when facing these hardships, enhance their STEM skills, and gain leadership skills. Furthermore, by providing workshops and resources for educators on how to create a gender-conscious classroom that provides engaging hands-on activities, female students will become more involved and hopefully continue their persistence in the STEM pipeline. This longstanding solution provides the resources needed for both students and educators to allow girls to be successful in STEM.

References

1. Andrus, Shannon, Jacobs, Charlotte and Kuriloff, Peter. "Miles to Go." Phi Delta Kappan, vol. 100, no. 2, 2018, pp. 46- 50, http://search.ebscohost.com/login.aspx? direct=true&db=a9h&AN=132002606&site=ehost-live, doi:10.1177/0031721718803570.
2. DeNisco, Alison. "Fueling Female STEM Participation." District Administration, vol. 52, no. 6, 2016, pp. 30, http://search.ebscohost.com/login.aspx? direct=true&db=a9h&AN=115711240&site=ehost-live
3. European Institute for Gender Equality. (2019). Gender Norms. Retrieved from https://eige.europa.eu/thesaurus/terms/1194
4. Grossman, Jennifer M., and Michelle V. Porche. "Perceived Gender and Racial/ Ethnic Barriers to STEM Success." Urban Education, vol. 49, no. 6, 2014, pp. 698-727, http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=97380102&site=ehost-live, doi:10.1177/0042085913481364.
5. Hill, Catherine. "Why so Few? Women in Science, Technology, Engineering, and Mathematics.", https://www.aauw.org/research/why-so-few/.
6. Laurence, B. K. (2015, April 10). Form a Nonprofit in Eight Steps. Retrieved from https://www.nolo.com/legal-encyclopedia/form-nonprofit-eight-steps 29484.html
7. Moss-Racusin, Corinne, et al. "Gender Bias Produces Gender Gaps in STEM Engagement." Sex Roles, vol. 79, no. 11, 2018, pp. 651-670. CrossRef, https://search.proquest.com/docview/2001505285, doi:10.1007/s11199-018-0902-z.
8. Newall, Carol, et al. "Science Education: Adult Biases because of the Child's Gender and Gender Stereotypicality." Contemporary Educational Psychology, vol. 55, 2018, pp. 30-41. CrossRef, https://www.sciencedirect.com/science/article/pii/S0361476X17305 209, doi:10.1016/j.cedpsych.2018.08.003.