Smithsonian | SCIENCE *for the classroom*

Gender Equity in STEM Education

How Educators Can Help Girls Succeed in All STEM Subjects

"Boys are just better at science."

"Girls can't do math!"

"You don't look like a scientist."

Common statements such as these are just one type of social cue that reflects deeply embedded ideas in society, reinforcing the underlying notion that girls and boys are inherently different when it comes to science, technology, engineering, and math (STEM) aptitude. The misconceptions that boys have superior STEM abilities to girls was historically commonly accepted. Fortunately, extensive research over the past 30 years has provided strong evidence that girls and boys are similar in STEM abilities (O'Dea et al., 2018). Unfortunately, differences in participation and achievement persist (Funk and Parker, 2018).

When teachers, parents, or other influential people believe these stereotypes, it often leads to treating girls and boys differently and thereby perpetuating ideas that are untrue—that girls cannot be good at math, that they do not look like scientists, or that they will not be interested in engineering. This continues to influence and harm girls' representation in STEM fields in different ways. It becomes a self-fulfilling prophecy: even when girls—those who identify as girls as well as those who perceive others to identify them as girls—are

Credit: Smithsonian Science Education Center

born with similar abilities to boys, they can be influenced by their environment in ways that impede their performance, interest, and confidence in STEM (Sundem and Candy, 2013). This significantly contributes to the "STEM leaky pipeline," a continuing tradition in which girls flee certain STEM fields, such as engineering and technology.

Explaining Girls' Underrepresentation in STEM

Although women have been historically underrepresented across STEM fields, the tide has recently turned. Due to changes over the past few decades, women now comprise half or more of all undergraduate degree recipients in biological/health sciences, psychology, and most social sciences (NSF, 2019). However, differences persist in math-intensive STEM fields, including economics, engineering, mathematics, and physics. Research shows that cognitive ability is not responsible for these differences in girls' achievement and participation. The explanations can be attributed to other phenomena, such as gender-related stereotypes and biases, girls' ability beliefs about themselves, and preferences and interests (Wang and Degol, 2016). Research in each of these areas has converged on sociocultural—not biological—differences that account for each of these explanations. Girls' beliefs, feelings, and values about their abilities in STEM fields are derived from environmental cues that falsely tell them that (1) boys are better at STEM, (2) they don't belong in STEM, and (3) STEM doesn't align with other values that have been developed socially through their gender identity. These social influences drive the differential achievement between girls and boys.

Credit: Smithsonian Science Education Center

The writers of the Next Generation Science Standards (NGSS)* know about these problems (NGSS Lead States, 2013). NGSS specifically highlights girls as one of seven nondominant group identities in STEM due to girls' persistent underrepresentation in certain STEM fields. As outlined in NGSS Appendix D "All Standards, All Students," there are ways science education decisionmakers—including teachers, parents, and curriculum writers—can ensure that NGSS is accessible to girls. Appendix D goes further to comment on how NGSS pedagogy can be thoughtfully constructed to support girls, including how sociocultural influences and psychological factors contribute to the gender gap, what behaviors promote these problems in school settings, and how to enact mindful strategies to prevent and counter them.

This white paper comments on how NGSS pedagogy can be thoughtfully constructed by educators to support girls in STEM by enacting

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three mindful strategies that address each of these social influences:

1. Countering sociocultural influences and psychological factors, such as stereotype threat, which contribute to the gender gap
2. Fostering a sense of belonging
3. Practicing mindful inclusion

"Boys Are Better at STEM": Countering Stereotypes and Stereotype Threat

Countering the first problem—that girls are taught to believe that they cannot be as successful as boys in STEM, which influences their abilities and self-beliefs within STEM—requires breaking down stereotypes. Girls grow up believing they can't succeed in STEM because of cues from their parents, teachers, peers, and others that tell them they are not expected to do well. In the classroom, teachers treat boys and girls differently when they hold implicit or unconscious biases. These stereotypes can even be communicated to students through objects and posters in the classroom. Research on stereotype threat (a concern about others' perception that one will not do well because they belong to a negatively stereotyped group, which disrupts and undermines performance in a negatively stereotyped field) has shown that girls' fears about confirming the stereotype that girls can't do well in math negatively influences how they perform in math (Beilock, 2008).

To mitigate the effects of stereotypes and stereotype threat, teachers can do several things.

- They can provide positive stereotypes of girls in STEM by providing information about successful women in these fields.
- They can be mindful of how their classrooms look so as not to create a masculine space.
- For students who might face initial difficulties in a STEM subject, teachers can introduce the class to STEM professionals who faced and overcame struggles in their own careers.
- Teachers can also promote a growth mindset—the belief that when faced with failure at a task, such minor setbacks are a part of the learning process that can guide changes in strategies to overcoming obstacles (Good, Aronson, and Inzlicht, 2003).

It is important to teach girls (and boys) that there is no norm for STEM success. Educators can do this by both depicting math-intensive STEM fields in atypical ways and fostering student approaches to obstacles in ways that allow them to discover that learning and succeeding at STEM is part of the normal process for themselves and others.

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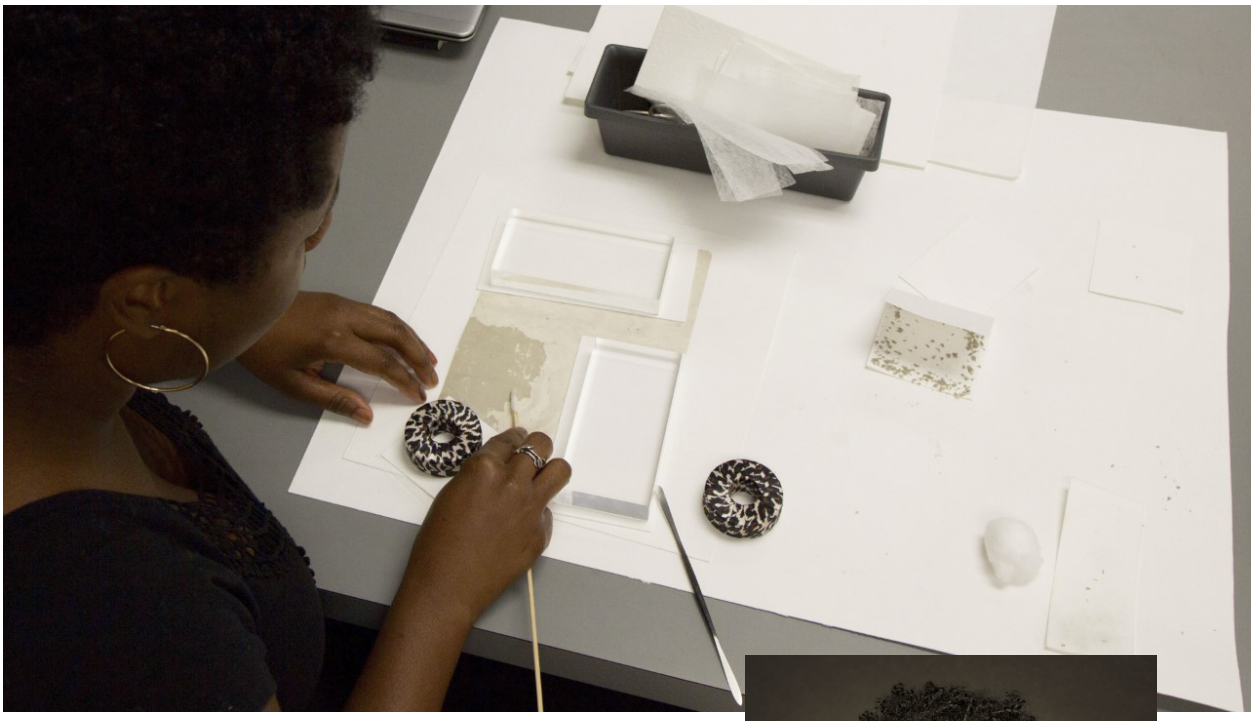
"Girls Don't Belong in STEM": Fostering a Sense of Belonging

The second problem—that girls do not see themselves as similar to most STEM professionals, which influences their sense of belonging—can be counteracted by finding ways to help girls relate to STEM professionals. Even when girls succeed in STEM subjects, they can feel like they don't belong when confronted with depictions of predominantly male scientists, programmers, and engineers. Many of these spaces have historically been defined in ways that implicitly tell women they don't belong.

To counteract this, teachers can introduce students to female STEM professionals—whether in person or through textbooks, readings, and activities—through portrayals of women in STEM as well as positive and diverse portrayals of women in STEM. Teachers can provide examples of successful STEM professionals who students can connect with by identifying similarities with these role models. Teachers can also focus on inclusive identities by depicting scientists and



Credit: Shannon Brogdon-Grantham

Shannon Brogdon-Grantham, profiled in *Smithsonian Science Stories: Art in Science*, is a photograph and paper conservator at the Smithsonian Museum Conservation Institute. Her work includes preventative care of photos and paper objects in the Smithsonian collection, which requires extensive knowledge of chemistry and physics as well as art and history.

Credit: Shannon Brogdon-Grantham

engineers as a diverse cohort that lacks a defined look. In other words, STEM professionals are not depicted as boys or girls but rather as *scientists, engineers, investigators,* and *problem-solvers.*

"STEM Doesn't Align with Girls' Values": Practicing Mindful Inclusion

The third problem—that girls do not view STEM fields as aligned with their communal, altruistic, collaborative, or creative values—calls for rotating perspectives and broadening the scope of STEM learning activities to target these values. Historically, boys and men have been taught to value money, power, achievement, challenge, and risk-taking—values associated with math-intensive STEM fields (Dasgupta and Stout, 2014). These same fields have been misrepresented as fields that don't align with communal goals, hindering girls' continued interest and pursuit of careers in these fields.

These misrepresentations can be counteracted in the classroom by connecting STEM fields with communal values and allowing students to participate firsthand in STEM in ways that emphasize these values. Students should collaborate to explain phenomena and solve problems. They should see scientists and engineers collaborating and learn that STEM professionals work together on common goals. Math-intensive STEM subjects should be connected to solving real-world problems, such as providing energy to people's homes or protecting people from earthquakes. Aligned

with these values, several NGSS performance expectations explicitly include values such as helping others (e.g., 5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and the environment), while science and engineering practices emphasize skills such as collaboration (e.g., collaboratively develop and/or revise a model, communicate information, or design ideas and/or solutions with others). Students can also experience creativity in science and engineering through learning about interdisciplinary fields such as art and history conservation. Curriculum materials are an important means for turning such standards like NGSS into pedagogy that is inclusive, and attractive, to girls.

Supporting Teachers through Curriculum

No educator can be expected to tackle all influences that contribute to the gender gap.

Luckily, mindfully created, evidence-based professional development and curriculum materials that contain built-in strategies to promote girls' continued achievement and interest in math-intensive STEM fields can help equip teachers with the right tools. Many of these solutions are surprisingly simple:

- Conscientious depiction of STEM professionals that demonstrate women's participation, diversity, creativity, and non-stereotypical environments
- Connection between math-intensive STEM fields and real-world problems these fields can help solve
- Collaborative activities, with group roles that allow students to rotate through different responsibilities while working together to answer questions and find solutions

By using thoughtfully crafted curriculum materials, teachers can easily implement effective strategies to promote girls' continued participation in STEM.

Credit: From left to right, Chad Baker/DigitalVision/Thinkstock; Stockbyte/Thinkstock; Juniperimages/PHOTOS.com; Smithsonian Institution, National Museum of African Art, Eliot Elisofon Photographic Archives; Comstock/Stockbyte/Thinkstock; RomanMilert/Hemera/Thinkstock

Asking students to engineer solutions to problems, like Smithsonian Science for the Classroom's *How Can We Provide Freshwater to Those in Need?* (Grade 5), emphasizes how math-intensive STEM professions contribute to making the world a better place.

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How Smithsonian Science for the Classroom Curriculum Supports Girls in STEM

The Smithsonian Science Education Center has developed a curriculum series that provides teachers the tools to support all students in STEM. The Smithsonian Science for the Classroom curriculum was built by Smithsonian science curriculum developers from the ground up to be inclusive of all nondominant science student groups, including girls. Each module has been carefully developed to use inclusive language, provide multiple and diverse perspectives, demonstrate representation, and show atypical STEM careers to spark the interests of all students, even those who may think they are not math or science people. Its accompanying literacy series, Smithsonian Science Stories, provides all students with the opportunity to connect STEM to history, art, and culture at the point of use. It helps students understand how even the "hard sciences" can lead to improving the lives of all.

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