



HOW EXPOSURE TO INNOVATION MATTERS WITH CLOSING THE GENDER GAP IN STEM FIELDS

Women have been historically underrepresented in science, technology, engineering and mathematics (STEM) fields, and in 2015, they comprised a mere 24 percent of the STEM workforce.¹ Despite showing similar interest in STEM compared to their male peers in elementary school, when young girls grow up, a majority pursue careers in non-STEM fields. Combined, women earn less than 20 percent of computer science, engineering and physics undergraduate degrees nationwide.² What are the reasons for this significant drop in STEM interest by the time girls enter high school?

It was this same question researchers at Microsoft asked themselves in 2017, when the company teamed up with psychology professor Martin Bauer of the London School of Economics to discover at what age girls began to lose interest in STEM subjects, and the underlying reasons for the decline.

In order to encourage young women's innovative development and grow their much-needed presence in STEM industries, it is essential to provide exposure and support for them in early education. Educators and mentors must actively work toward dispelling gender stereotypes and demonstrate that women can and do thrive in STEM careers.



Two Camp Invention participants show off their DIY Orbot™ designs

The study found that by age 15 only 42 percent of those surveyed said they would consider a career in STEM and listed reasons including negative gender stereotyping and a lack of female role models in STEM careers for their decision.³

A Camp Invention® camper embraces her inner superhero

1. Noonan, R. (2017, November 13). Women in STEM: 2017 update. Retrieved from <https://www.commerce.gov/news/reports/2017/11/women-stem-2017-update>

2. Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin*, 143(1), 1.

3. Trotman, A. (2017, March 1). Why don't European girls like science or technology? Retrieved from <https://news.microsoft.com/europe/features/dont-european-girls-like-science-technology/>

THE INNOVATION GENDER GAP AND ITS ROOTS

The innovation gender gap is not only harming the economic prospects of women, but it's also negatively impacting STEM fields in need of diverse ideas and solutions. Though gender bias has received much of its national exposure in the form of unequal payment practices – on average, full-time working women are paid 80 cents for every dollar paid to a man doing the same job – this imbalance can have even more serious consequences when it comes to health and medicine.⁴ For example, heart disease, the leading cause of death in the United States, has historically been misdiagnosed in women because symptoms differ between the sexes. Despite the fact that women have both a higher lifetime risk of a stroke and are less likely to survive their first heart attack than men, women continue to receive lower-quality medical care compared to their male counterparts. The reason for this inequality has to do with a lack of female physicians and representation during clinical trials.⁵

The best way to eliminate both gender bias and the lack of female representation in the STEM workforce is to address the reasons why interest in the math and sciences dwindles as girls grow older. Significant among these is the absence of female role models in STEM fields. According to the 2017 Microsoft study of the 11,500 women between ages 11 and 30, one of the key reasons why girls chose not to follow a career in STEM was because they lacked a female role model.⁶ Being introduced to mentors at a young age has been shown to improve performance and a sense of belonging in STEM – factors that improve both recruitment and retention rates for women in the field.⁷ This technique is especially effective when the role models are similar to the child in interests, attitude and behavior.⁸ However, given the relatively limited number of women in STEM fields (as compared to their male counterparts), it can sometimes be difficult to find an adequate number of mentors to inspire and influence the vocational decisions of school-aged girls.

GENDER ROLES AND STEREOTYPES IN STEM

In addition to a scarcity of female STEM role models, another major deterrent arises from fears of stereotyping and discrimination in engineering and computer science. According to Bauer, conformity to social expectations, gender stereotypes and gender roles are factors that negatively impact the decision to pursue innovative career opportunities.⁹ Further research conducted by Sapna Cheryan, a psychology professor from the University of Washington, has shown that the prevalence of “masculine culture” in many STEM workplaces has contributed to a lower sense of belonging among women and has caused women to avoid situations in which they feel like an outsider.¹⁰ Stereotypes that assume women are naturally poor performers in math and science act as invisible barriers, and according to Cheryan, these “assumptions about the STEM fields signal to women that they might not belong or feel accepted in these career fields.”¹¹

Research has shown that gender-related stereotypes begin to develop in children at around 4 years of age.¹² These presumptions are especially harmful to young girls who very early on in their education begin to question their aptitude in math and science. Though there exists a national push to close the innovation gender gap by introducing high school STEM programming to young women in this age group, it simply begins too late. Instead, educators and mentors must start providing girls with playful introductions to the world of technology and engineering beginning in early childhood.



A Camp Invention Instructor helps her students build their inventions

4. The National Women's Law Center. (n.d.). Equal pay & the wage gap. Retrieved from <https://nwlcc.org/issue/equal-pay-and-the-wage-gap/>

5. American Heart Association. (n.d.). Path to parity. Retrieved from <https://www.goredforwomen.org/fight-heart-disease-women-go-red-women-official-site/path-to-parity-2/>

6. Trotman (2017, March 1).

7. Drury, B. J., Siy, J. O., & Cheryan, S. (2011). When do female role models benefit women? The importance of differentiating recruitment from retention in STEM. *Psychological Inquiry*, 22, 265. DOI: 10.1080/1047840X.2011.620935

8. Ibid.

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A Camp Invention Instructor assists a camper with the Mod My Mini Mansion™ activity

INTRODUCING ROLE MODELS AND EARLY EDUCATION PROGRAMMING TO SPARK INNOVATION

In order to integrate early STEM education programming that will properly engage young girls, there are certain practices that must be emphasized. One of the most effective involves the introduction of relevant role models and mentors. Research from [the Equality of Opportunity Project](#) found that exposing girls to female inventors at a young age has the potential to reduce the gender gap in technical-related STEM fields by half.¹³ **Introducing young girls to successful women within an educational setting cultivates a tangible bond between STEM role models and a young girl's growing opinions about how she would fit into such fields.**

This strategy has been reinforced by research conducted at Tulane University, which found that exposing young girls to female role models in STEM not only buffered the effects of negative stereotyping, but also led to increased performance and interest in STEM fields overall.¹⁴ Because the women in the study were able to connect to a figure who embodied sought-after outcomes, attitudes

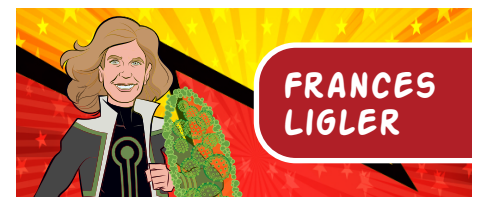
toward STEM as a potential career path began to shift, and levels of perceived belonging and acceptance increased.¹⁵

Educators and parents should take advantage of classroom and out-of-school environments that promote STEM as a viable career path. Not only do these jobs earn on average 29 percent more than their non-STEM counterparts, but the industry is growing significantly; and STEM occupations are estimated to grow by 8.9 percent from 2014 to 2024 – a higher rate than comparative job sectors.¹⁶ Gender stereotypes and fear of not being accepted should in no way discourage girls from avoiding this fulfilling, stable and lucrative career path. By introducing female STEM role models at an early age, research has shown that this exposure can have powerful, long-term impacts. By starting with developmentally appropriate programs and role-modeling, parents and teachers can inspire females to be future leaders in innovation and eliminate STEM stereotypes once and for all.

FEARLESS FEMALES INSPIRING STEM EDUCATION



Radia Perlman, National Inventors Hall of Fame® (NIHF) Inductee and inventor of robust network routing and bridging, didn't let the typical stereotype of girls in STEM deter her from following her dreams. A great piece of advice from Perlman to young female innovators is that "the more of a difference you can make, the more valuable you are!"



Frances Ligler, NIHF Inductee and inventor of portable optical biosensors, was inducted in 2017 for her work with sensors. She is also the primary influence behind the Camp Invention® 2018 activity DIY Orbot™. In this module, campers experiment and design courses for their very own sensor-based robot and learn how Frances built her own path to success!



Carolyn Bertozzi, NIHF Inductee and inventor of biorthogonal chemistry, isn't afraid to push boundaries. At Camp Invention, young girls are exposed to the tools and encouragement they need to recognize and build confidence! Bertozzi's advice for young innovators is to not let rejection get in the way of discovery. "If you can't do it because somebody said so, let's go talk to that person and ask them why does it have to be that way," Bertozzi said.

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