



A Camp Invention® camper embraces her inner superhero

HOW EXPOSURE TO INNOVATION HELPS CLOSE THE GAPS IN STEM FIELDS

When children look for role models in STEM fields, not all of them can easily find those who look, sound or learn like them. While children certainly benefit from identifying a wide array of role models, it is essential that they see themselves reflected in some of their role models as well – and that is just one reason we need to fill the gaps that persist in STEM.

Consider, for example, that in 2015 women comprised just 24% 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% 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 stereotypes and demonstrate that everyone can thrive in STEM careers.



Two Camp Invention participants show off their DIY Orbot™ designs

The study found that by age 15 only 40% of those surveyed said they would consider a career in STEM and listed reasons including negative stereotyping and a lack of women role models in STEM careers for their decision.³

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/>

ADDRESSING THE CAUSES AND CONSEQUENCES OF STEM GAPS

Gaps in STEM and innovation not only harm women's economic prospects but also hinder progress in STEM fields where we need new and different ideas and solutions. Such imbalances can have especially serious consequences in health and medicine. For example, heart disease, the leading cause of death in the United States, has historically been misdiagnosed in women because symptoms differ between sexes. Despite the fact that women have a higher lifetime risk of a stroke and are less likely than men to survive their first heart attack, women continue to receive lower-quality medical care compared to their male counterparts. The reason for these disparities has to do with a lack of women physicians and clinical trial participants.⁴

The best way to eliminate each of these problems is to address the reasons why interest in math and sciences tends to dwindle as girls grow. One significant reason is the shortage of women role models in STEM fields. According to the 2017 Microsoft study of 11,500 women and girls 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 woman role model in a STEM field.⁵ Being introduced to mentors at a young age has been shown to improve a child's performance and sense of belonging in STEM – factors that improve both recruitment and retention rates for women in these fields.⁶ This technique is especially effective when the role models are similar to the child in interests, attitude and behavior.⁷ 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.

In addition to acknowledging the need for more women role models in STEM, we must also address the persistent stereotyping and other societal obstacles girls often face as they engage in these fields. According to Bauer, social expectations, traditional roles and enduring stereotypes are factors that can negatively impact the decision to pursue innovative career opportunities.⁸ 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.⁹ Stereotypes that assume women are naturally poor performers in math and science act as invisible obstacles, 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."¹⁰

Research has shown that many stereotypes begin to develop in children at around 4 years of age.¹¹ 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 STEM and innovation gaps by introducing STEM programs to girls in high school, it simply begins too late. Instead, educators and mentors must start providing girls with fun and inspiring introductions to the world of technology and engineering beginning in early childhood.



A Camp Invention Instructor helps her students build their inventions

4. 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/>

5. Trotman (2017, March 1).

6. 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

7. Ibid.

8. Trotman (2017, March 1).

9. Cheryan, Ziegler, Montoya, & Jiang (2017).

10. Gallucci, M. (2016, October 15). "Masculine culture" of STEM fields is partly to blame for gender gap: Study. Retrieved from <https://mashable.com/2016/10/15/stem-gender-gap-masculine-culture/#YEHffvXyMqt>

11. Martin, C. L., & Ruble, D. N. (2010, January 10). Patterns of gender development. *Annual Review of Psychology*, 61(1), 353-381. DOI: Retrieved from <https://doi.org/10.1146/annurev.psych.093008.100511>



A Camp Invention Instructor assists a camper with a creative STEM activity

INTRODUCING ROLE MODELS AND EARLY EDUCATION PROGRAMS TO SPARK INNOVATION

To effectively engage all children in early STEM learning, providing STEM education programs that will introduce them to relatable role models and mentors can make a significant impact. In fact, research has found that exposing girls to women inventors at a young age has the potential to reduce relevant gaps in technical-related STEM fields by half.¹² **Introducing young girls to successful women in educational settings cultivates a tangible bond between STEM role models and a 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 introducing girls to women role models in STEM not only buffered the effects of negative stereotyping, but also led to increased performance and interest in STEM fields overall.¹³ 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.¹⁴

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% more than their non-STEM counterparts, but the industry is growing significantly. STEM occupations are estimated to grow by 8.9% from 2014 to 2024 – a higher rate than comparative job sectors.¹⁵ Social stereotypes and fear of not being accepted should in no way discourage girls from pursuing this fulfilling, stable and lucrative career path. As research has shown, introducing all children to relatable STEM role models at an early age can make powerful, long-term impacts. By starting with developmentally appropriate programs and role-modeling, parents and teachers can eliminate harmful stereotypes and inspire every child to realize their own potential to shape the future of STEM.

FEARLESS WOMEN INSPIRING STEM EDUCATION



Radia Perlman, National Inventors Hall of Fame® Inductee and inventor of robust network routing and bridging, didn't let any obstacle deter her from following her dreams. A great piece of advice from Perlman to young innovators is to remember that "the more of a difference you can make, the more valuable you are!"



Frances Ligler, National Inventors Hall of Fame Inductee and inventor of portable optical biosensors, is the primary influence behind the popular Camp Invention® experience DIY Orbot™. This experience challenged campers to experiment and design courses for their very own sensor-based robot and learn how Ligler built her own path to success!



Carolyn Bertozzi, National Inventors Hall of Fame Inductee and inventor of bioorthogonal chemistry, isn't afraid to push boundaries. As children gain the skills and encouragement they need to recognize their potential and build their confidence at Camp Invention, Bertozzi urges them to not let anything get in the way of their drive to make discoveries. "If someone says I can't do something, I would like to understand the root of that, because in all likelihood, it's artificial or it's a challenge, and I can take it on," Bertozzi said.

12. Bell, A., Chetty, R., Jaravel, X., Petkova, N., & Van Reenen, J. (2017). Who becomes an inventor in America? The importance of exposure to innovation. DOI: 10.3386/w24062

13. Streamer, L., Park, L., & Young, A. (2014, September). Motivating women in STEM: The impact of gender roles and role models. Tulane University. DOI: Retrieved from <https://digital.library.tulane.edu/islandora/object/tulane%3A27945>

14. Ibid.

15. Economics & Statistics Administration. (2017, March 30). STEM jobs: 2017 update. Retrieved from <http://www.esa.doc.gov/reports/stem-jobs-2017-update>