Thesis Project Portfolio

Empowering Girls in STEM: Developing an Intervention that Promotes Interest in STEM Topics

(Technical Report)

Gender Bias in Adolescence: Barriers to Girls in STEM and Initiatives to Overcome It

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Genevieve Purcell

Spring, 2025

Department of Computer Science

Table of Contents

Sociotechnical Synthesis

In light of the underrepresentation of women in scientific, technical, engineering, and mathematical fields, educators, policymakers, and advocates promote the involvement of women in both academics and the workforce to close the STEM gender gap. The effects of these efforts continue to be enforced today, with an increase of equal opportunities in STEM education, as well sexual harassment and discrimination policies. However, despite an increase in opportunities, the increase in women working in engineering occupations has been slight and numbers have decreased for women holding computer occupations. This raises a troubling paradox: while interest in STEM is rising, girls' confidence in STEM abilities is decreasing, thus revealing gender bias as a persistent barrier to increasing representation of girls and women in STEM. I explore this dilemma in both my technical project and STS research paper.

One method to mitigate the negative effects of gender bias is through initiatives targeting women and girls with the purpose of increasing interest and confidence in STEM fields. In my experience, I have seen the overall positive association with STEM disciplines such clubs have created through personal participation in my formative years. In October of 2023, I jumped at the opportunity to co-create and co-lead Mentoring Girls in Computing (MGIC) at the University of Virginia, a volunteer-based, women-led organization that offers introductory coding lessons to its middle school participants and fosters positive relationships with girls at a Charlottesville middle school. MGIC follows the CS1 curriculum exploring the fundamentals of programming through an active learning lens. The activities utilized evolved from Hour of Code lessons, to Python programming, and finally to the current endeavor of using LEGO Education to introduce the girls to a variety of engineering topics outside of computer science. As for the makeup of the club, MGIC has two primary components: the planning session, where members create the

curriculum and activities, and the teaching session, where members visit the middle school in person. Student engagement and informal, testimonial feedback from middle school participants indicate that the club is both fun and educational, with a school participation rate of 27%. Additionally, open and comfortable discussions between students and MGIC members suggest a success in forming positive relationships with the girls. In the future, MGIC plans to conduct surveys to gain insight on the increased and continued interest in STEM subjects as a result of the club, as well as expand its reach to other schools and organizations.

My work with the introductory coding club and personal experience as a woman pursuing a STEM education left me wondering if the specific aspects I observed which mitigate gender bias are common in existing research and personal testimonies. Thus, in my STS research paper, I conducted a meta-review and analyzed interviews to answer the question: how does gender bias in adolescence impact the participation of women in technological and engineering fields, and what factors play a role in mitigating the barriers that discourage girls from pursuing futures in STEM? Various studies revealed that gender bias starts as early as 5-7 years of age, with stereotypes reinforced by peers, parents, teachers, and the media. The most common source of this gender bias is male peers and teachers' behaviors instill these biases, reaffirming the importance of the classroom in forming conceptions of gender in formative years. Furthermore, though there is a perceived notion that boys are better at STEM subjects than girls, this was not reflected in actual performance, suggesting that confidence, not capability, is the major barrier for girls with interest in STEM topics. An analysis of different interventions revealed that long-term, identity building programs are most effective at increasing and retaining interest. However, defining and measuring intervention success remains inconsistent, as there is a lack of effort to collect data post-initiative. I then examined secondary interviews and personal anecdotes to see if

the lived experiences of women reflect these findings. Common themes for the encouragement of STEM interest unveiled in the interviews were positive role models, family and peer support, and early exposure. Furthermore, there was a trend of male family members acting as catalysts for STEM interest, indicating that men can and should be role models for girls and women. The most cited reasons for leaving STEM were hostile environments, heavy workload, lack of representation, and cultural expectations. In conclusion, it is essential to emphasize early, sustained exposure to STEM through mentorship and gender-inclusive programs. We should invest in inclusive, data-informed initiatives in adolescence, and true progress requires intentional, intersectional, and systemic change.