EmpowerHER: Development of an Inclusive Summer STEM Workshop for Middle School Girls (Work in Progress)

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Introduction

Increasing girls' interest in STEM fields at an early age is critical to helping them envision themselves pursuing careers in science, technology, engineering, and mathematics [1], [2]. Research shows that effective strategies for encouraging girls' interest in STEM include access to hands-on, engaging STEM activities and real-world experiences, as well as exposure to female role models in STEM fields [1], [2].

The EmpowerHER Girls STEM Workshop is an initiative designed to address the gender gap [1] in STEM by engaging middle school girls in structured, hands-on learning experiences. Middle school represents a pivotal period when academic interests and future career aspirations begin to take shape [3–5]. The workshop aims to create a supportive, interactive environment in which participants can explore STEM disciplines, develop foundational skills, build confidence through projects, and be inspired by mentorship from STEM professionals. While similar programs exist worldwide [6–10], this workshop is distinctive in that it is one of the few summer STEM programs specifically for middle school girls in the South-Central Pennsylvania region. As such, it fills an important gap in targeted STEM outreach. The program also emphasizes partnerships with local community organizations and industry professionals, who lead sessions that highlight STEM opportunities available within the region.

The 2025 workshop marked the first in a planned series of five annual workshops hosted by the York College of Pennsylvania, an undergraduate institution, running through 2029 and supported by Constellation's E2 Energy to Educate grant program. Feedback and experiences from each offering will be used to refine the program and expand future workshops into additional STEM areas. By fostering early interest in STEM, the workshop seeks to contribute to increased female participation in STEM fields and aligns with broader efforts to strengthen diversity in industries essential to innovation and global problem-solving [1].

This Work-in-Progress paper documents the design, implementation, and preliminary assessment of the EmpowerHER Girls STEM Workshop held in July 2025. It describes the program structure, outlines assessment methods, and reports early outcomes based on participant and parent surveys, with the goal of sharing insights to inform similar pre-college engineering initiatives.

Program Overview

The workshop targeted middle school girls (rising 7th-, 8th-, and 9th-grade students). The goals of the program were informed by best practices in pre-college engineering education [1], [2], [7], [10] and included increasing awareness of STEM fields, strengthening confidence in STEM-related skills, and exposing participants to diverse STEM pathways and role models. Specific objectives of the workshop were to:

- *Increase Awareness and Interest in STEM Fields:* The workshop introduced participants to a variety of STEM fields, from coding and robotics to engineering and science experiments. By exposing participants to real-world applications of STEM, the workshop highlighted how these fields play pivotal roles in addressing everyday problems and global challenges.
- *Build Confidence and Foster a Growth Mindset:* STEM subjects often require persistence, creativity, and problem-solving [2]. Through the workshop's collaborative and supportive environment, participants were encouraged to approach challenges with a growth mindset and to recognize that setbacks are part of the learning process.
- *Provide Access to Female Role Models and Mentors:* A key aspect of the workshop was connecting participants with women who work in STEM fields. These mentors shared their experiences, offered guidance, and served as role models, demonstrating that a successful and fulfilling career in STEM is within reach.
- *Encourage Continued Engagement with STEM:* At the end of the workshop, participants received take-home STEM kits (Arduino-based), enabling them to continue exploring STEM subjects independently. The intent was to foster long-term interest in STEM that extends beyond the duration of the workshop.

In 2025, the inaugural year, students from 13 schools in two states, Pennsylvania and Maryland, from the area surrounding the York College of Pennsylvania participated in the workshop. A total of 24 students registered for the workshop, and 22 attended on the first day. 19 students were present for the full duration of the event and participated in all activities. Three participants were homeschooled. Among the registered students, nine were entering the 7th grade, seven were entering the 8th grade, and eight were entering the 9th grade. Approximately 25% of participants identified as members of visible minority; socio-economic background information was not collected.

Six undergraduate engineering faculty members were involved in the 2025 workshop. Five were men, three of whom were a visible minority, and one was a woman who was also a visible minority. In addition, three activities were led by industry professionals and community partners. Two of these leaders were men with one of the men being a visible minority. Two third-year female undergraduates, one computer science major and one electrical engineering major who is a visible minority, volunteered throughout the workshop, assisting with activities and serving as near-peer role models and informal mentors.

Workshop Structure and Activities

The 2025 workshop was structured as a three-day program, with each day organized around a variety of STEM topics such as basic engineering concepts, technology, applied sciences, and environmental sustainability, and a sequence of interactive activities. Each activity session was approximately two hours long. Across all three days, activities were intentionally designed to be hands-on, collaborative, and engaging, supporting confidence development while broadening participants' awareness of STEM applications.

Day 1 focused on foundational engineering concepts and design thinking. The day started with a session led by Young Thinkers of York, a community partner organization, where participants

first assembled LEGO-Mindstorm robots. Then each student group used a touchscreen tablet to remotely connect to a robot and programmed it to move a specific distance. In another session, students completed a manufacturing challenge that introduced them to the concepts of LEAN manufacturing and how to streamline processes and eliminate waste. This session was facilitated by an industry professional who is an engineering manager at MANTEC, a local engineering company. The day ended with a session conducted by a Civil Engineering faculty member where participants constructed bridges using K'nex building pieces to explore structural design, forces, and problem-solving. The Day 1 activities emphasized teamwork, creativity, and iterative design while introducing core engineering principles.

Day 2 emphasized technology and applied sciences. In the first session, participants worked with Arduino microcontrollers and sensors to explore basic programming and data collection. They learned how embedded computing systems interface with sensors and actuators. This session was run by two Electrical and Computer Engineering faculty members. Another session, led by a Mechanical Engineering faculty member, focused on the concepts of physical forces and interactions. Students worked in teams to assemble two toy cars and then build a long track or rail for the cars to travel along. They also constructed a sling-style launcher system to propel the cars and observe how different forces affect motion. Additionally, a hands-on vermicomposting session, led by community partner York County Solid Waste Authority (YCSWA), demonstrated how worms recycle food waste into compost and how this relates to environmental sustainability. A significant activity for the day was a tour of the college campus, including different engineering and science labs and facilities.

Day 3 highlighted sustainability and advanced STEM applications. Participants engaged in renewable energy engineering activities where they used solar panels and a Vernier LabQuest for data collection and analysis. They learned how to transfer the collected data to a computer and generate graphs in Excel for data analysis. In another session, students observed physics demonstrations using a Van de Graaff generator, which illustrated electricity and magnetism concepts.

Drone technology was a central focus of the workshop, with activities on safe and effective drone operation integrated across all three days. In the classroom, students learned about different types of drones, their applications, FAA regulations and airspace rules, safe operating practices, and ethical considerations. They were introduced to how drones work, weather considerations, flight-path planning, and related aviation technologies. Each participant also passed The Recreational UAS Safety Test (TRUST) [11] and was given a copy of their certificate. For hands-on learning, students practiced controls, navigation, and maneuvers using RealFlight drone simulators before participating in outdoor flight sessions with beginner-friendly drones. During these sessions, they learned to safely take off, hover, fly patterns, and land drones.

Assessment Methods

To evaluate program impact, we employed a mixed-methods assessment approach. Participants completed pre- and post-workshop surveys designed to measure changes in STEM awareness, confidence, and interest. Survey items included Likert-scale questions assessing attitudes toward

STEM subjects, self-confidence in STEM-related tasks, and perceptions of future STEM engagement. In addition, post-workshop surveys were distributed to parents and community partners to capture perceptions of program effectiveness, assess observed impacts on participants, and gauge interest in continued involvement. Open-ended questions were included to allow respondents to provide qualitative feedback and suggestions for improvement. Survey items were adapted from existing instruments on STEM interest and self-efficacy for pre-college populations [12, 13] and then tailored to the workshop context. To support content validity, clarity and appropriateness the draft surveys were also reviewed by three engineering faculty members. Given the modest sample sizes in this initial implementation, the authors report descriptive statistics only; internal consistency metrics (e.g., Cronbach's alpha [14]) will be examined in future iterations as additional data are collected.

Results and Discussion

Twenty-one students completed the pre-workshop survey. Over 65% of respondents agreed or strongly agreed that they are good at math, would consider a career involving math or science, are interested in how machines work, are curious about electronics, and enjoy imagining new products. Fewer than 50% expressed interest in a career as an engineer or technologist. More than 70% reported confidence in applying STEM knowledge to solve problems, participating in STEM activities, and generating ideas for new products or inventions. Additionally, over 70% indicated they know adults working as mathematicians, scientists, engineers, or technologists.

The post-workshop survey, conducted one month later, had five respondents. All rated the range of activities, teaching quality, workshop pace, collaborative learning with peers of the same gender, and overall workshop quality as "Excellent" or "Very Good". All respondents also reported using the Arduino kits provided, and all expressed strong confidence in applying STEM knowledge, engaging in STEM activities, and developing new ideas or inventions. Furthermore, all agreed that people like them can succeed in learning STEM, pursue STEM careers, and create new products. Some comments about what they liked best about the workshop were:

> *"I liked actually getting to be on a college campus and being challenged with new skills and concepts."*
> *"I liked the hands-on activities included in the workshop."*
> *"I liked the drone flying the most."*

Nine parents completed a post-workshop survey. All reported that their daughters enjoyed the workshop, gained confidence, and have used or plan to use the Arduino kit provided. All respondents also agreed or strongly agreed that STEM learning is important, that their daughters enjoy and perform well in STEM subjects, and that their daughters would succeed in STEM careers. Parents additionally shared comments highlighting their favorite aspects of the workshop, including:

> *"There were a wide range of engaging activities that provided her the basis for continuing to grow and learn."*
> *"Engaging staff that had her interested the entire time! Very unique opportunities like drones that aren't accessible in other classes. Great experience."*
> *"It's designed for girls only and gives them space to explore STEM without boys."*

Two community partners also provided feedback that they found the students were engaged during the activities and that they had positive experiences leading their respective sessions.

Pre-workshop survey results indicated that many participants entered the workshop with generally positive attitudes toward math and science but expressed uncertainty regarding engineering careers and their own abilities to apply STEM knowledge in real-world contexts. Confidence levels varied, particularly for tasks involving design, invention, and problem-solving. Post-workshop participant survey responses demonstrated positive shifts across multiple dimensions. Participants rated the overall workshop experience and range of activities highly and reported increased confidence in engaging with STEM activities. Many participants indicated stronger agreement with statements related to their ability to succeed in STEM subjects and to create new products or inventions in the future. The consistent positive responses indicate early promise for this targeted intervention in fostering girls' engagement in STEM.

Parent survey responses further reinforced these findings. Parents overwhelmingly agreed that the workshop increased their child's interest in STEM and supported confidence development. Qualitative feedback highlighted the value of hands-on experiences, exposure to mentors, and a supportive learning environment. Several parents expressed interest in future offerings and expanded programming.

We recognize that the current sample size and duration of the workshop are limited and view this as an opportunity for continued data collection and growth of the study. We plan to continue to gather data for the next four workshops to obtain a larger sample size and a better understanding of whether outcomes are achieved. To increase the participation rate of the post workshop surveys, particularly among the participants, we plan to offer an incentive for those who complete the survey such as a raffle for a STEM kit. These initial findings provide early evidence that the workshop positively influenced participants' STEM confidence and interest, while also demonstrating strong parent and community support. We also plan to conduct a one-year post-workshop survey to assess whether participants continue engaging with STEM activities and show interest in further workshops.

Conclusion

This Work-in-Progress paper described the design, implementation, and preliminary assessment of a summer STEM workshop for middle school girls. Participants responded particularly positively to hands-on, collaborative activities that connected STEM concepts to real-world applications. The inclusion of mentors and community partners was perceived as valuable by both participants and parents. Future iterations of the workshop will focus on expanding the program into a five-day format to allow deeper engagement with a range of STEM activities that extend beyond traditional engineering fields. This expanded structure will also allow for more structured mentoring opportunities with female alumni and industry professionals. Ongoing data collection and future iterations of the workshop will further inform best practices in pre-college engineering education and contribute to efforts aimed at broadening participation in STEM.

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