

## **Board 172: Redefining the Role of Women in Engineering through SWE-Led Middle School Outreach Program (Work in Progress)**

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# **Redefining the Role of Women in Engineering through SWE-Led Middle School Outreach Program (Work in Progress)**

## **Abstract**

Research shows that women constitute half the workforce in the U.S.; however, women only occupy about a quarter of science, technology, engineering, and mathematics (STEM) jobs. In the last twenty years, many educators and researchers have worked to develop strategies and programs to increase the participation of women in STEM careers. Research shows that strategic intervention at the middle school-level can have great impacts on female students' perspectives of careers in STEM fields. At Rowan University, the Society of Women Engineers: Engineers in Training (SWEET) Program, a program led by engineering faculty and the students of the university's chapter of the Society of Women Engineers (SWE), was established to help redefine the role of women in STEM fields. Through a series of workshops, the SWEET Program exposed middle school-aged girls to the exciting and meaningful career possibilities in engineering from the perspectives of faculty, current students, and women in the industry.

Through the SWEET Program, workshop participants learned about what engineers do, what impact engineers can have on society, and what types of engineering work they could do in their future careers. Participants took part in two hands-on engineering projects during each workshop day, ranging from hydraulic bridges to polymer bouncy balls to magnetic-levitation trains. Workshop participants completed pre- and post-workshop surveys in order for the workshop leaders to gauge the background knowledge of the participants in engineering fields, as well as to determine what the participants learned during the workshop, what they enjoyed most about the workshop, and to gauge their interest in pursuing an education in engineering. During its pilot programming from summer 2021 to 2022, the SWEET Program hosted nine workshop days across four workshop periods with 123 total workshop participants in grades 6, 7, and 8. Based on the preliminary survey data collected, 94% of participants said they wished they learned more about topics such as engineering in their middle-school curriculum, and 95% of participants said the workshop content sparked their interest into the field of engineering. About 74% of participants said that after participating in the SWEET Program, they feel motivated to look further into pursuing engineering as a choice of study.

## **Introduction**

Women occupy only 24% of science, technology, engineering, and mathematics (STEM) jobs, though research data shows that women constitute nearly half of the workforce in the United States [1-2]. Additionally, data shows that only 13% of engineers in the workforce are women [1-2]. In the last twenty years, there have been many efforts by educators and researchers to increase the participation of women in STEM careers. Research shows that strategic intervention at the middle school-level can have great impacts on female students' perspectives of careers in STEM fields, as this time period is known to result in a decrease in girls' self-esteem as they enter adolescence [3]. Studies show that 66% of fourth grade girls report that they enjoy their

science and mathematics classes; however, by the time they reach college, only 18% of engineering majors are female [4]. This can be attributed to a number of influencing factors, such as those from social media, negative stereotypes regarding engineers and scientists, and the lack of role models and mentors [3-4].

Though there have been great strides over the past twenty years in increasing the recruitment and retention of women in the fields of engineering and technology, women remain under-represented in these areas. Many young women think that the fields of engineering and technology are difficult, complex fields that are more attainable for their male counterparts. Researchers and educators have worked to develop programs and strategies to help combat such negative gender stereotypes in the fields of engineering and technology, while preparing young girls to undertake careers in engineering. Studies have shown that female students, in particular, are attracted to careers with communal and altruistic goals, showing that female students are most interested in the social relevance of the work, exploring career opportunities of engineering fields that link communal goals with engineering practice [5-8]. Studies have also shown that outreach camps and programs that strive to provide an outlet for like-minded students to interact with each other are a great tool for introducing young students to careers in the STEM fields [9]. Traditional workshop goals include teaching participants certain skills. Research into workshops that can achieve these goals in a fun, engaging way, while fostering an environment of intellectual growth and empowerment, shows great impact on young students [9].

### Program Development

At Rowan University, the Society of Women Engineers: Engineers in Training (SWEET) Program, a program led by engineering faculty and the students of the university’s chapter of the Society of Women Engineers (SWE), was established to help redefine the role of women in STEM fields. The SWEET Program, piloted from summer 2021 to 2022, developed a series of one-day workshops with the aim of exposing workshop participants to a series of engineering activities and career paths. Through the SWEET Program, middle school-aged girls were exposed to the exciting and meaningful career possibilities in engineering from the perspectives of faculty, current students, and women in the industry. Workshop participants participated in innovative, hands-on activities which exposed them to careers in the

*Table 1: SWEET One-Day Workshop Itinerary*

Time	Activity
8:30 AM	Sign-In/Team Assignments
9:00 AM	Introductions/Team Icebreaker Activity
9:30 AM	Overview of Engineering Disciplines Presentation
10:00 AM	Activity 1
11:00 AM	Lunch/Engineering Facilities Tour
12:00 PM	Q&A with SWE Professional Members
12:30 PM	Activity 2
1:45 PM	Wrap-Up/Thank You
2:00 PM	Sign-Out/End of Workshop

fields of engineering and technology and encouraged them to pursue degrees in STEM fields. Table 1 presents an overview of the SWEET workshop itinerary. During the workshops, participants learned from current engineering students about what engineers do, what impact engineers can have on society, and what types of engineering work they could do in their future careers. Participants took part in two hands-on engineering projects during each workshop day, ranging from hydraulic bridges to polymer bouncy balls to magnetic-levitation trains to water filtration systems. Participants also heard from practicing engineers invested in exposing the next generation of female students to the fields of engineering and technology.

**Program Evaluation**

The overall objectives of the SWEET Program were to: 1) increase students’ self-efficacy and motivation related to STEM contents relative to their participation in the workshop activities, 2) increase student awareness of the excitement and innovation in STEM fields through participation in the workshop activities, and 3) increase enrollment in STEM-related courses and activities through participation in the workshop activities. To help address the program objectives, pre- and post-workshop surveys were developed and implemented within each workshop. Pre-workshop survey questions are presented in Table 2.

*Table 2: SWEET Pre-Workshop Survey Questions*

Question Number	Question Asked	Possible Answers
1	Have you ever heard of Engineering?	No, Yes, and I’m not sure
2	In your own words, how would you describe what an engineer does?	Open-Ended
3	On a scale of 1-5, how much do you know about Engineering?	Answer (1-5) 1 being nothing and 5 being a lot
4	Have you ever thought about studying Engineering?	Yes, No, and I’m not sure
5	On a scale of 1-5, how interested are you in learning about Engineering?	Answer (1-5) 1 being not interested 5 being very interested
6	Have you ever learned about Engineering in your classes/school before?	Yes, No, and I’m not sure
7	What are some qualities that you think would make a good engineering student?	Open-Ended
8	Which of the following engineering disciplines have you heard of?	Open-Ended

Workshop participants were given time to complete the pre-workshop survey prior to the start of the workshop in order for the workshop leaders to gauge the background knowledge of the participants in engineering fields and what career paths engineers can take. A post-workshop

survey was given to the participants at the conclusion of the workshop in order to determine what the participants learned during the workshop, what they enjoyed most about the workshop, and to gauge their interest in pursuing an education in engineering. Post-workshop survey questions are presented in Table 3.

*Table 3: SWEET Post-Workshop Survey Questions*

<b>Question Number</b>	<b>Question Asked</b>	<b>Possible Answers</b>
9	Based on your previous knowledge of engineering, was the content of today's presentations expected, or were you surprised by what you learned?	Answer (1-5) 1 being not surprised 5 being very surprised
10	How interesting did you find the first activity you did today?	Answer (1-5) 1 being not interesting 5 being very interesting
11	How interesting did you find the second activity you did today?	Answer (1-5) 1 being not interesting 5 being very interesting
12	Which part of today's presentations was most interesting to you?	Open-Ended
13	Was speaking and hearing from the female engineering professionals helpful to you?	Answer (1-5) 1 being not helpful 5 being very helpful
14	Would you like to learn more about topics such as engineering in your everyday school curriculum?	Answer (1-5) 1 being not interested 5 being very interested
15	Did the content of the presentation spark your interest into the field of engineering?	Answer (1-5) 1 being not interested 5 being very interested
16	How motivated do you feel to look further into going into the engineering field for a choice of study?	Answer (1-5) 1 being not motivated 5 being very motivated
17	Based on the content of the presentation, do you think being an engineer would be a fun job?	Yes, Maybe, or No
18	What is something new you learned from the presentation?	Open-Ended
19	In your opinion, how could the activities or presentations be made more interesting to you?	Open-Ended

### **Evaluation Results**

During its pilot year from summer 2021 to 2022, the SWEET Program hosted nine workshop days across four workshop periods with 123 total workshop participants in grades 6, 7, and 8. Participants came from twelve counties in New Jersey, Pennsylvania, and Delaware. Figure 1

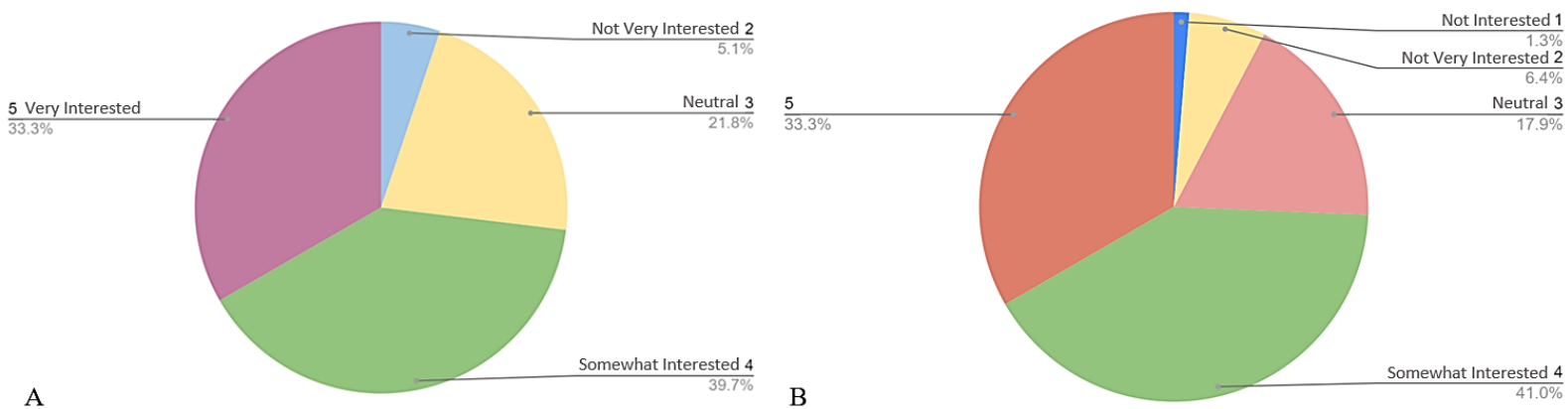
shows SWEET workshop mentors demonstrating hands-on engineering activities during the workshops. The first three workshop periods which took place in August 2021, November 2021, and March 2022 were hosted as virtual workshops through the video conferencing platform Zoom. The fourth and final workshop period took place in May 2022 and was hosted as an in-person workshop at Rowan University’s main campus in Glassboro, New Jersey.

Both pre- and post-workshop surveys were comprised of about ten questions with either prompted or open-ended responses available. Eighty-two percent of the workshop participants completed both the pre- and post-workshop surveys. Survey results were analyzed by the



**Fig. 1:** SWEET Workshop Mentors Demonstrating Hands-On Activities

workshop leaders to help evaluate whether the program achieved its overall goals. Overall, survey responses showed promising outcomes for the pilot year of the SWEET Program. Survey results showed that workshop participants enjoyed the hands-on activities they participated in during each workshop period, and 94% of participants said they wished they learned more about topics such as engineering in their middle-school curriculum. Ninety-five percent of participants said the workshop content sparked their interest into the field of engineering (*Fig. 2a*). Seventy-four percent of participants said that after attending the SWEET workshop, they feel motivated to look further into pursuing engineering as a choice of study (*Fig. 2b*). Workshop participants stated that after attending the workshop, they were given a better understanding of the many types of engineering, the different career paths for engineers, the qualities needed to be a successful engineer, and how engineers can help mitigate societal problems.



**Fig. 2:** Overall Results of SWEET Post-Workshop Survey Questions (a) 15: Did the content of the presentation spark your interest into the field of engineering? and (b) 16: How motivated do you feel to look further into going into the engineering field for a choice of study?

The results of the post-workshop surveys administered to the workshop participants showed the overall success of the workshops in exposing middle school-aged participants to the many fields of engineering, the different career paths available for engineers, and the qualities that make for a successful engineer. The results of the survey also helped the workshop leaders identify some areas of improvement for future SWEET workshops. Fifty-two percent of workshop participants stated that they would not change anything about the workshop program and hands-on activities. The other half of the participants noted a few things that could improve the overall workshop experience. Some participants noted that more time to complete the activities would have helped them better understand the materials and engineering principles. Other participants stated that more breaks in between the activities would have given them time to digest the material taught before moving to the next activity. The feedback gained from the survey results will be instrumental in adapting the program for future workshops.

During its pilot year, the SWEET Program was very well received. One 6<sup>th</sup>-grade student from Gloucester County, New Jersey was so excited to learn more about engineering after attending the first SWEET workshop in August 2021, she came back and attending every SWEET workshop hosted through summer 2022. Additionally, one grandmother of a participant in the May 2022 workshop reported, “My granddaughter attended your SWEET Workshop today. I had to let you know how much she enjoyed it. She talked about it all the way home and then repeated everything to her mom. She has been talking about becoming an engineer for several years now. The one volunteer who worked for NASA during her career really impressed her as she is interested in mechanical engineering, especially robotics. She said all the engineering student teachers were wonderful. Congrats on a job well done!”

### **Program Continuation**

The overall success of the first year of the SWEET Program is very promising for the workshop leaders and engineering students involved. In future SWEET workshops, the team looks forward to hosting additional in-person workshops at Rowan University. The workshop team plans to incorporate the feedback obtained from the post-workshop survey results to adapt future workshops to make a bigger impact on workshop participants. The workshop team also plans to reach out to past workshop participants with a follow-up survey to gauge continued interest in pursuing studies in the field of engineering.

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