Girl Scouts STEM Day

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Abstract

Girl Scouts STEM day is a program at Wentworth Institute of Technology to help 4th or 5th grade students explore STEM fields. The event is organized by the Society of Women Engineers (SWE). Members of Girl Scouts participate in STEM-related workshops and hear women leaders talk about their experiences. The event was first started at our university in 2014 with 30 students, and has grown to 89 students in 2018. In the past five years, over 270 girl scouts participated in the skills-based workshops and hands-on projects.

There were 5 different STEM workshops in this one day program: Computer Engineering, Electrical Engineering, Computer Science, Science, and Manufacturing Engineering. There was about forty five minutes for each workshop. The Computer and Electrical workshops are presented in this paper. Computer Engineering project was Autonomous Mobile Robot by Arduino while Electrical Engineering project was LED Dexterity Challenge. A survey was conducted to collect data right after students completed each workshop to evaluate the content of the workshop. 169 girl scouts members participated in the STEM program and took the survey in the past two years. The survey shows 95% students enjoyed Electrical Engineering workshop activity while 98% of the students enjoyed Computer Engineering. Students reflected that they would like to participate more STEM related activities in the future.

The program represents part of our university's ongoing efforts to interest young women in STEM and is part of the Girl Scouts' "fun with purpose" K-12 curriculum. That initiative introduces scouts of every age to STEM to inspire them to embrace and celebrate scientific discovery and, according to the Girl Scouts of America website, "help them see how they can actually improve the world."

Introduction/Background

Nowadays, more and more scientists, engineers and innovators are needed to contribute and succeed in the global competitive economic environment. As a result, this requires quality science, technology, engineering and mathematics (STEM) education. However, insufficient numbers of American students pursue education and training in the STEM fields. After noticing this challenge, STEM has become a great effort by many to increase STEM-related activities, which have the potential to promote collaborative learning and inquiry as well as to contribute to the development of the 21st century skills [1]. The US government initiated the "Educate to Innovate" program to increase student participation in all STEM-related activities. The long-term objective of these activities is to encourage more young women to choose an education in the STEM in the future [2].

Getting more students involved in the STEM education is a challenge. Attracting more female students into the STEM fields can be even harder. Statistics show that there is a big gender gap in the STEM fields in workplaces. It has been found that the women make up 46% of the workforce, but women have only 24% of jobs in STEM fields [3]. More women in STEM careers

have at least two primary benefits. First, STEM careers typically have higher salary, benefits, and career stability in the workforce [14]. Secondly, a more diverse workforce in STEM jobs will lead to more diversity in solutions and designs [15]. Possibly, these designs that are more influenced by women will be more holistic, sustainable, safe, and fit better with people and society.

Many institutions and organizations have realized this challenge and provided various activities to promote female students into the STEM fields [2]. In addition, different strategies were developed to recruit and retain students in the STEM education [4-5]. Creating quality, attractive STEM programs [6] and using peer influence to motivate high school girls into the STEM fields [7-8] appears to be effective ways to retain female students in STEM.

Since 2014 our university has organized a Girl Scouts STEM Day program targeted to help 4th or 5th grade students explore STEM fields. It started with 30 students, and the number of students increased to 89 in 2018. In the past five years, over 270 girl scouts participated in the skills-based workshops and hands-on projects.

There were five different STEM workshops in this one day program: Computer Engineering, Electrical Engineering, Computer Science, Science, and Manufacturing Engineering. The girl scouts explored a STEM workshop for forty five minutes and then rotated to a different workshop. These workshops were conducted by faculty from different departments. In each workshop, one faculty and several college student volunteers introduced and guided the activity. A group of 15-18 girl scouts would participate a workshop. Besides the faculty member, 3-5 college student volunteers helped. Many of the student volunteers were from the Society of Women Engineers (SWE) student chapter, and others were from the general student body. The student volunteers played a large role in the girl scouts experience with the activity. The student volunteers explained the activity and acted as role models. During and after the activity, the girl scouts usually asked many questions of the student volunteers.

This paper describes our experience of conducting the one day program to expose young girls to the STEM fields. This paper presents our study with the Computer and Electrical workshops, including preparation, implementation, survey data, observations, and findings.

Workshop Implementation

Laboratory exercises play an important role in engineering education [9-11]. They provide the opportunity for students to work on modern machines, tools used in industry [12]. Therefore, in our workshops, we focused on hands on activity using modern machines and tools.

Electrical Engineering Workshop

The Electrical Engineering Workshop activity was called LED Dexterity Challenge. The activity had the girl scouts build and test a circuit that could test one's ability of hand-to-eye steadiness

and accuracy. The challenger that transversed the greatest length or wire without electrical contact was the winner. It took five steps to build the circuit on breadboard.

The flow of the activity was guided by the following steps that were given by the student volunteers.

Step 1: Insert the resistor on left edge of board, one hole down from the left corner.
Step 2: Place LED (Light Emitting Diode). The lead with the sticker should be in the same row as the resistor.
Step 3: Take the cap off the battery. Snap the battery into the battery clip which has two wire leads, one red and the other black. Put the black lead in the same row as the LED lead (without the sticker). Put the red lead in any hole to the right.
Step 4: Add the colored wire end in the same row as the red battery lead. Now touch the ring side of the wire to the resistor lead in the top left of the board. Your LED should light!
Step 5: Add a piece of bus wire to create the game. Place on end in the very top left hand hole on the board. Shape the bus wire into any shape you want, a Valentine heart? Loop the colored wire end through the bus wire. Secure the end of the bus wire in space anywhere on the top right of the board. Now test your skill!

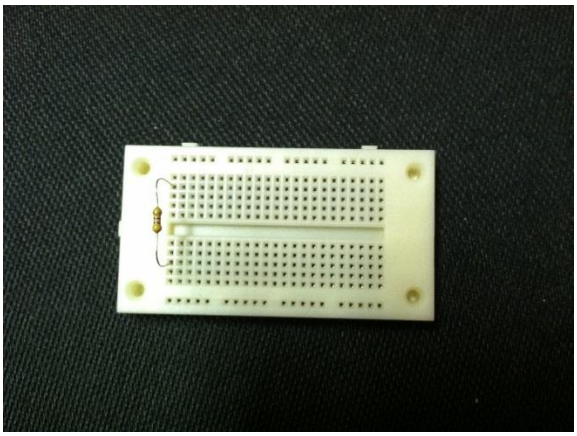

Figure 1 LED Dexterity Challenge Step 1

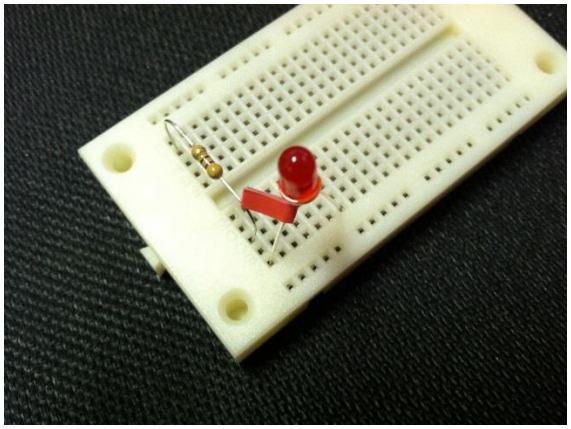

Figure 2 LED Dexterity Challenge Step 2

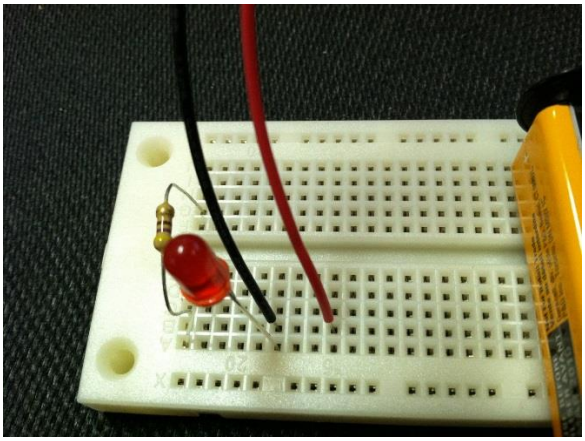

Figure 3 LED Dexterity Challenge Step 3

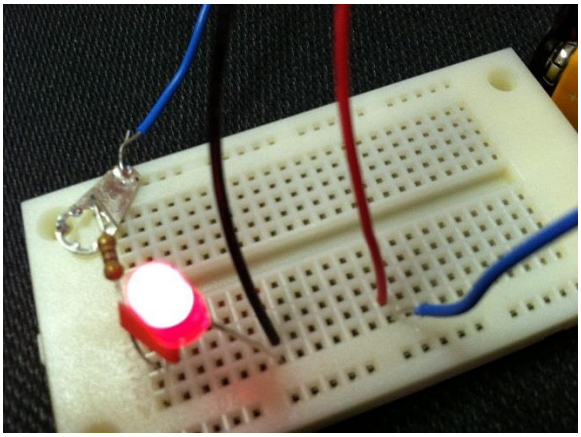

Figure 4 LED Dexterity Challenge Step 4

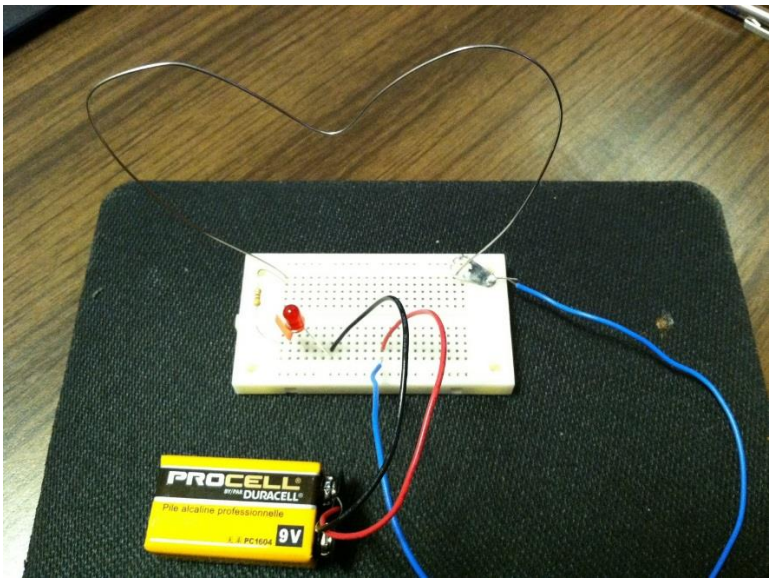

Figure 5 LED Dexterity Challenge Step 5

Computer Engineering Workshop

The objective of Computer Engineering Workshop was to expose students to microcontroller circuits, motor control, computer programming, and robotic vehicles. An autonomous vehicle assembly kit based on Arduino was utilized for this activity. The procedure for the girl scouts was to place the wires on the breadboard connecting 5 volt power, ground, the two motors, and the two sensors with the Arduino microcontroller. The student volunteers used diagrams to guide this process of wiring. Figure 6 is the autonomous vehicle with hardware connection.

The girl scouts were then shown how to compile and download a base C program to the Arduino microcontroller. The base C program had been developed by one of the student volunteers. Once the C program was successfully complied and downloaded, the girl scouts were instructed to take

the assembled Arduino Autonomous Vehicle to the testing ring (80 cm diameter black circle surrounded by white). If wired correctly by the girl scouts, the vehicle would go forward over black until the front sensors detected the white edge. Then the vehicle would turn. However, with the base C program the vehicle only turned about 10 degrees, so would almost immediately hit the line again.

The function of turning was then explained, and how a timer delay value in the code determined how big the rotation would be. The next challenge for the girl scouts was to change the C program so that the vehicle rotated about 90 degrees when the sensor detected the white edge. The scouts modified the timer value in the C code, complied, tested on the ring, and repeated the process until the rotation was about 90 degrees. The trial and error experimentation and control of the vehicle allowed development of insight and confidence [12].

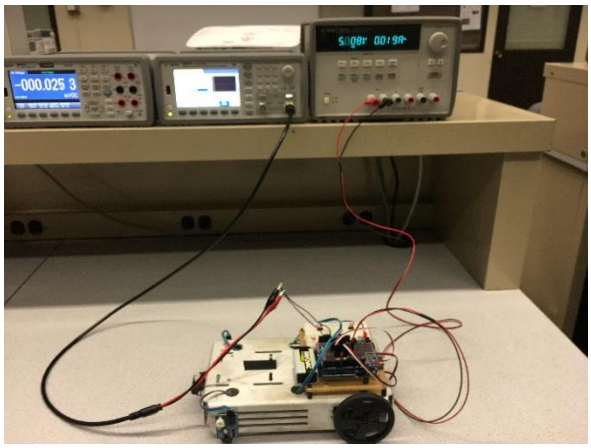

Figure 6. Hardware connection of autonomous vehicle

Survey Questions

A survey was conducted to collect data right after students completed the workshop to evaluate the content of the workshop. 169 female students participated in the Girl Scouts STEM Day Electrical and Computer Engineering workshops in the past two years and all of them took the surveys. Following are the questions we asked students in the survey:

Table 1: Survey Questions

Computer Workshop	**Electrical Workshop**
1. Did you learn something new during this activity? (a) I learned a lot (b) I learned some (c) I did not learn anything (d) I was confused 2. Did you enjoy the activity?	1. Did you learn something new during this activity? (a) I learned a lot (b) I learned some (c) I did not learn anything (d) I was confused 2. Did you enjoy the activity?

(a) I really liked it (b) I liked it (c) It was OK (d) I did not like it (e) It was boring	(a) I really liked it (b) I liked it (c) It was OK (d) I did not like it (e) It was boring

Survey Results

The survey results are shown in Figure 9-12.

Computer Engineering Workshop

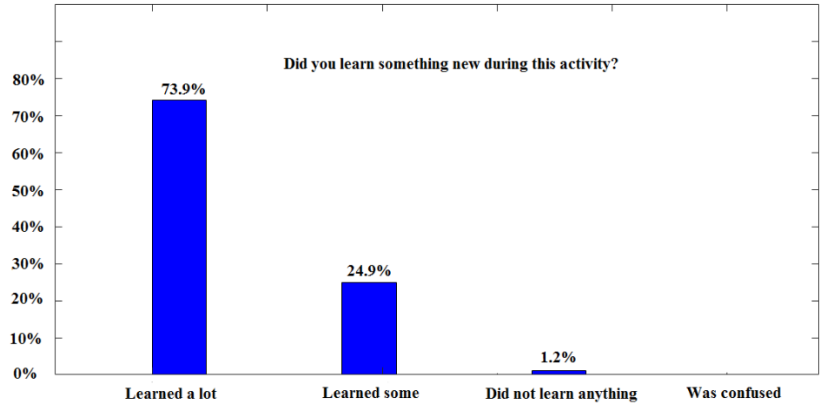

Figure 9: Survey results for "Did you learn something new during this activity?"

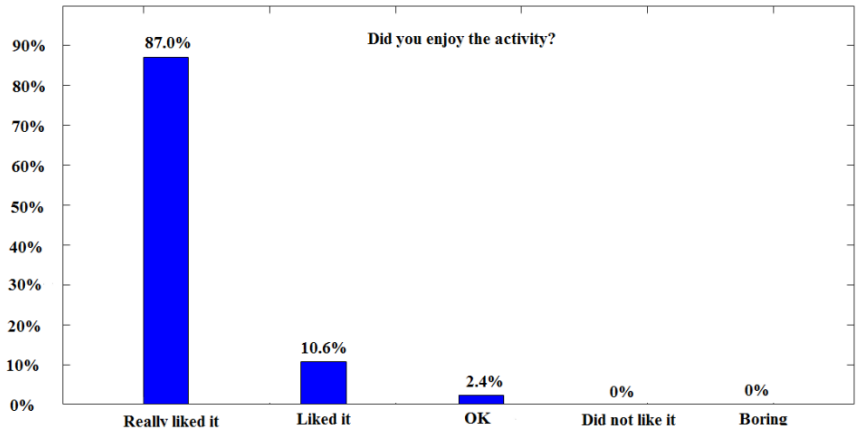

Figure 10: Survey results for "Did you enjoy the activity?"

Electrical Engineering Workshop

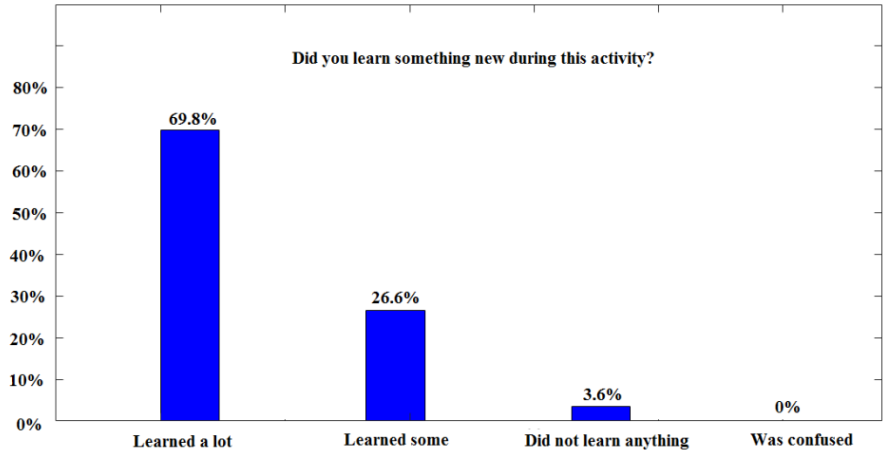

Figure 11: Survey results for "Did you learn something new during this activity?"

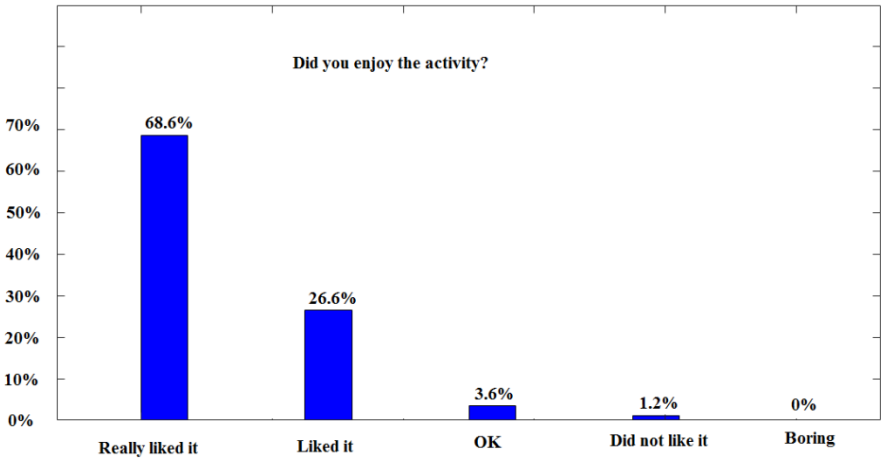

Figure 12: Survey results for "Did you enjoy the activity?"

The survey results indicate that many girl scouts enjoyed the Computer and Electrical Engineering workshops. 98.8% of the scouts learned some/a lot of Computer Engineering, while 96.4% of the scouts learned some/a lot of Electrical Engineering. Scouts also reflected that they enjoyed the experience very much. 97.6% of the scouts really liked/liked Computer Engineering workshop while 95.2% of the scouts really liked/liked Electrical Engineering workshop. Students also found the workshops increased their interest in STEM courses.

Conclusions

Girl Scouts STEM Day program was motivated to expose young girls to STEM fields, boost interests and give them more hands-on experience. It could also fulfill our long-term objective of recruiting more female students into the STEM-related educational pathways and careers [13].

Computer and Electrical workshops were presented in this paper. The survey results encouraged us that the workshops were interesting to the students and proper topics were selected. It also indicated that students enjoyed hands-on activities.

The experience gained from Girl Scouts STEM Day program will help organize similar workshops in the future. We believe these experiences would also benefit other educators and researchers with the common goal of increasing the number of female professionals in the STEM fields.

After completing Girl Scouts STEM Day grogram, students reflected that the workshops were interesting and they enjoyed STEM fields. Our future direction would be to track the number of students who enroll in STEM fields for college after they finish Girl Scouts STEM activies.

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