A Simple Hands-on Project for the Conference of "Girls will be Women in STEAM"

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Abstract

In this paper, a simple hands-on project is introduced for the Annual Conference of "*Girls will be Women in STEAM*". The "*Girls will be Women in STEAM*" is a one-day conference held by the Real I.M.P.A.C.T Center (**I**ntelligent and **M**otivated **P**eople **A**ctivity **C**hanging the **T**imes) at the Hutchings College & Career Academy (in Macon, GA). This conference was created especially for the girls from 3rd grade to 8th grade. In order to encourage and motivate more girls to be interested in STEM and may benefit their engineering career in future, we participated the program and provided a simple hands-on project on solar cell at the conference in 2017 and 2018. In this project, we introduced the basic concept of solar cell and its principle and how to wire a simple electric circuit on breadboard to light up LEDs by utilizing solar energy. We had a total of 44 girls who joined the 3 sessions of 2017 and a total of 24 girls in the 3 sessions of 2018. Feedback was collected at the end of each session from the girls for assessment. There was 35 feedback from 44 girls in 2017 and 24 feedback from 25 girls in 2018. In the question of "*How do you like the solar cell project?*" rated from 1 (the lowest point) to 5 (the highest point), 32 out of the 35 feedback gave 4 and 5 points in 2017 and 21 out of the 24 rated 4 and 5 points in 2018. The surveys show that this kind of simple hand-on project can effectively attract young girls and promote their interests in STEM disciplines from young age.

Keywords

Engineering, Girls, Hands-on project, Solar cell, STEM

Introduction

The "*Girls will be Women in STEAM*" is an annual one-day conference held by the Real I.M.P.A.C.T Center (**I**ntelligent and **M**otivated **P**eople **A**ctivity **C**hanging the **T**imes) at the Hutchings College & Career Academy (in Macon, GA). This conference was created especially for the girls from 3rd grade to 8th grade since 2016. During the past three years, the conference held almost 200 girls each year and exposed them to the projects related to **S**cience, **T**echnology, **E**ngineering, **A**rt, and **M**ath (**STEAM**) education and career. In this one-day conference the girls were divided into two groups, 3rd - 5th and 6th - 8th depending on their grade levels. On that day, the girls went through three different projects led by STEAM professionals to gain some hand-on experience on science, technology, engineering, art, and math skills, and to discover some joy in STEAM career. The girls learned some information about robots, program coding, Agi-Science, papermaking, and other topics from different workshop sessions.

According to the report of "*Women in STEM: 2017 Update*" released by Office of the Chief Economist (OCE) of the U.S. Department of Commerce, women are filled 24 percent of STEM jobs and just held only 14 percent of engineer jobs [1]. Women with STEM jobs earned 35%

more in salary than comparable women in non-STEM jobs. In order to encourage and motivate more girls to join the electrical engineering and STEM group, we participated the STEAM program and designed a simple solar-cell-based hands-on project for the conference of 2017 and 2018, by referring some prior experience of K-12 STEM education [2]-[7]. In this project, we introduced the basic concept of solar cell and its principle and how to wire a simple electric circuit on breadboard to light up LEDs by utilizing solar energy. We had a total of 44 girls in 2017 and a total of 24 girls in 2018 who attended all 3 sessions of this project for assessment.

Overview of the Hands-on Project

The design of this solar cell hands-on project was supported by "*Research that Reaches Out*" under the "*Quality Enhancement Plan (QEP)*" program at the Mercer University in Macon GA. The main goal of "*Research that Reaches Out*" is to enhance student learning through service-focused research and to foster a culture of civic engagement through scholarship and service. Two undergraduate students worked with me as volunteer to assist planning the lecture and preparing the materials and parts of this project. Our "customers" were the girls from 3rd – 8th grades and they may not have any knowledge/experience in building an electrical circuit, even a simple one. So, we designed an easy-understanding procedure to keep them in pace and following the procedure. At the beginning of this project, we started with a game that have the girl hand in hand to form a circle to indicate the concept of power flow and how an electrical circuit works as a warmup. After that, we introduced how to wire a simple circuit by using electric parts and solar cell on a breadboard. Finally, we went outside and tested the solar cell circuits under the sunlight. The followings are the major material of the project – "*Knowledge about Solar Power Energy*":

1. **Electrical Components:** breadboard, 2 solar cells and several LEDs (in Red, Yellow and Green colors)

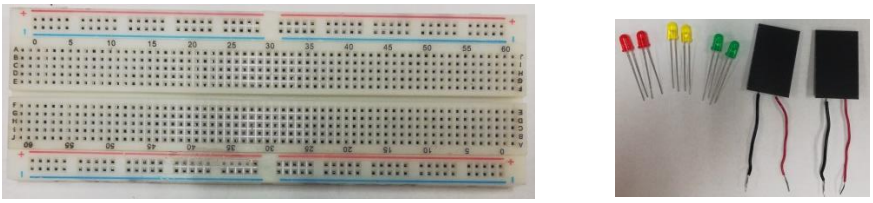

Figure 1: Electrical parts needed in the project

2. **Procedure of Test**:
   (1) Connect one solar cell with **one LED at a time** for different color and find out which color is the brightest;
   (2) Connect two solar cells **in series to** each other as one power source. And use the power source to light up three series-connected LEDs at the same time;
   (3) Connect two solar cells **in parallel to** each other as one power source. And use the power source to light up three parallel- connected LEDs at the same time.
   (Notice that: the girls may choose the color they like to finish the tests.)

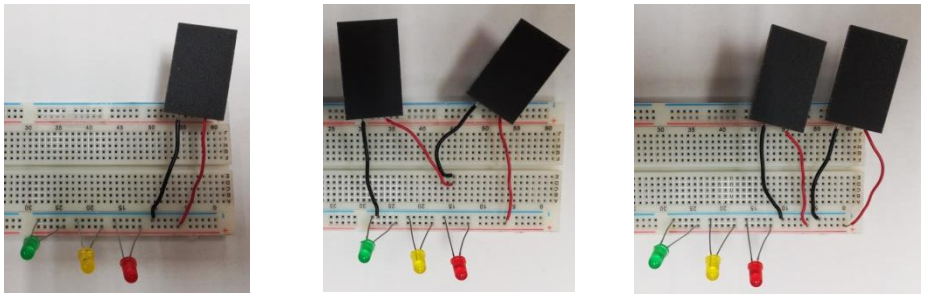

Figure 2: Sample wiring of three different testing circuit on breadboard

3. **Outcomes:** Upon successful completion of these tests, the girls are expected to:
   (1) know the loop concept of electrical circuit;
   (2) know how to wire a circuit on a breadboard;
   (3) know how to determine the polarity of LEDs;
   (4) know what is the difference between series- and parallel- connections;
   (5) know how solar cells transfer solar energy into electric format. The power produced by the solar cells depends on how much solar energy delivered into solar cell, which is different when the cell is exposed to the sunlight and hidden in shade.

Evaluation and Assessment

We had a total of 44 girls in 2017 and 24 girls in 2018. Feedback was collected from the girls at the end of each session for the project assessment. Finally, we received effective data from 35 girls in 2017 and 24 girls in 2018. The questions of survey and data summary are listed in Table 1 and 2, respectively.

Table 1: List of Questions on the Girls' Survey

(1) How do you like the Solar cell project? Please rated from 1-5. ("1" for "I don't like it" and "5" for "I like it very much") 1 2 3 4 5
(2) If you have chance, would you talk with other people about the experience of solar cell? Please circle the answer. Yes, because it is awesome. No, it is boring. Others. _____
(3) Are you going to recommend the project to your friends? Please circle the answer. Yes. No. Others. _____
(4) Comments to the instructors:

Table 2: Results of Girls' Survey

	Question 1 (Rated from 1 to 5)					Question 2			Question 3		
	1	2	3	4	5	Yes	No	Others	Yes	No	Others
Results (2017)	0	1	2	10	22	31	2	2	27	5	3

Percent	0	3%	6%	28%	63%	88%	6%	6%	77%	14%	9%
Results (2018)	0	1	2	12	9	19	2	3	19	4	1
Percent	0	4%	8%	50%	38%	80%	8%	12%	80%	16%	4%

In addition, some samples of the comment from the girls are listed below:

(1) In 2017:
- "*I really enjoyed it! I thought we were going to keep it because it was cool. Thanks.*"
- "*The instructions were understandable. Thank you very much. I learned a lot.*"
- "*Thank you for your awesome project.*"
- "*The instructors demonstrate a very good example. I can understand very well.*"
- "*I love how she taught. I love the solar system stuff what she taught because it was fun.*"
- "*Thanks so much for teaching about solar engineering! I thoroughly enjoyed my experience!*"

……

(2) In 2018:
- "*Thank you to take the time to show me how to do this. I am really interested in solar power now.*"
- "*You did a great job with inspiring us what to do!*"
- "*Lessons were very interesting and fun. I enjoyed it very much.*"
- "*You have done a great job. I loved the analogy for "friends"! It helped me understand circuits.*"
- "*You were very descriptive. Thanks you for that.*"
- "*I appreciate your work. Thank you for teaching me something new.*"

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As shown in Figure 3, to the question of "*How do you like the solar cell project?*", 89.8% of participants rated this project at level-4 and level-5 overall. The data show that this project attracts the majority of girls in the solar cell hands-on experience. And we met our goal to make our project funny, interesting and knowledgeable. Also, it proves that our project procedure was understandable to the girls from 3rd to 8th grades.

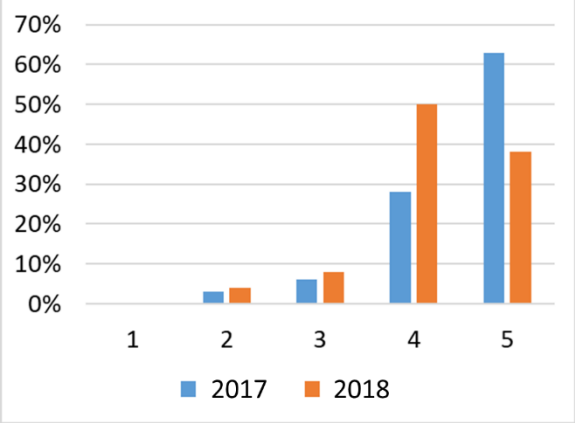

Figure 3: Rating of this project from girls

Conclusions

The outreach of demonstrating the basic concept of electrical circuit and solar energy to the girls in their 3rd-8th grade was deemed successfully based on the evaluation. To the girls, it provided a

valuable opportunity to gain some experience of electrical engineering and STEM disciplines at first hand. Many girls showed great enthusiasm towards electrical and solar power engineering. The undergraduate volunteers also said that it was joyful to share their professional knowledge with little kids and they were glad to reach out from the university to service the community. Based on the success of this outreach activity with little girls in the conference, more simple hand-on projects should be proposed and designed for the girls to motivate their interest and encourage their anticipation in engineering and STEM disciplines in future.

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