

Girls in Engineering, Math and Science (GEMS) Camp at the University of Incarnate Word

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Abstract

Girls in Engineering, Math and Science (GEMS) Camp was started by the University of Incarnate Word in 2015 as an effort to increase the number of female students in the Science, Technology, Engineering and Mathematics (STEM) fields, particularly in engineering, through active engagement and inspiration. In order to maximize the outreach to as many high school female students as possible regarding the GEMS camp and inspiring them towards choosing a STEM career, high school students in San Antonio were invited to the GEMS camp to participate in hands-on engineering activities. Students gained valuable experience through challenging activities that emphasized Civil and Electrical Engineering. The students presented their experiences, and the knowledge gained throughout the projects, by creating and delivering a group poster presentation at the end. The outcomes of the camp included student's increased ability to conceptualize engineering problems and an increased engagement in engineering by incorporating visualization tools in the classroom environment.

Keywords

STEM, Women, Engineering, Soft skills, Education

Introduction

Women are historically underrepresented in the STEM fields – specifically in the engineering fields. As late as 2013 on average, one woman for every four men earned an undergraduate engineering degree and less than one out of those four women were from a historically minority background¹⁻⁹. Girls in Engineering, Math and Science (GEMS) Camp was funded and organized by the Dean's Office of the School of Mathematics, Science and Engineering at the University of the Incarnate Word. The camp was designed for the female students who were sophomores or juniors at any San Antonio Independent School District high school, Incarnate Word High School or St. Anthony Catholic High School. The objectives of the camp were:

- To introduce the students to engineering fields.
- To inspire the students to become more skilled in communication, organization, and research that will help prepare them for future success in higher levels of schooling and in the workplace.

Ten female students from Fox Tech, Douglas MacArthur, Burbank, Edison, and St. Phillips Early College High Schools were invited to take part in the GEMS camp. The camp provided the students with the opportunities to study the basic concepts of electricity and magnetism through exciting hands-on robotics activities, to develop creativity and engineering problem-solving

skills through teamwork. Table 1 lists the activities that were designed based on learning objectives.

Table 1. GEMS Camp Overview

Activities	Learning Objectives
<ul style="list-style-type: none"> Choosing a Discipline – Personality Quiz. 	<ul style="list-style-type: none"> Combine the fun of a personality quiz with the usefulness of a career test. Understand different Engineering disciplines. Able to see which of the engineering traits most closely aligns with student’s personality.
<ul style="list-style-type: none"> Build a robot that can distinguish good batteries from “dead” batteries. Build a robot that will keep a pair of solar panels pointed toward a light. 	<ul style="list-style-type: none"> Learn the proper terminology for electrical components. Able to relate theory and practice. Demonstrate the ability to collect, analyze, and interpret data, and to form and support conclusions. Able to work and communicate effectively with team members, both orally and in writing. Learn to use the Digital Multimeter and NXT battery tester, measure the voltage of different size batteries. Distinguish between fresh and “dead” batteries. Build a gearing mechanism for a robotic gripper. Learn how a solar panel works and measure the electrical output from a solar panel. Build and program a robot to follow a light source.
<ul style="list-style-type: none"> Build a robot that will play a sound when it drives past a magnet. 	<ul style="list-style-type: none"> Learn basic concepts of magnetism. Able to relate theory and practice. Demonstrate the ability to collect, analyze, and interpret data, and to form and support conclusions. Able to work and communicate effectively with team members, both orally and in writing. Able to investigate the behavior of a magnet and learn to use a magnetic field sensor. Build a robot from a CAD drawing. Program a robot to detect a magnet.
<ul style="list-style-type: none"> Design and build an autonomous robot, an explorer, to locate the stranded rover on Mars. 	<ul style="list-style-type: none"> Understand the importance of engineering design process in designing and building a successful working robot. Bridge gap between the scientific theory and engineering application. Able to link the information gained through the previous experimental activities, i.e. theoretical analysis, data collection, to the practice. Able to work and communicate effectively with team members, both orally and in writing.
<ul style="list-style-type: none"> Construct a lightweight bridge that will hold as much weight as possible. 	<ul style="list-style-type: none"> Design, build, and test a model lightweight bridge that has the highest weight bearing capacity to satisfy the client requirements. Recognize that there is more than one solution to a problem. Able to evaluate different designs in building a lightweight bridge. Able to work and communicate effectively with team members, both orally and in writing. Demonstrate creativity and capability in real-world problem solving.

Conclusions

The Girls in Engineering, Math and Science camp was classified as a success. The outcomes of the summer camp included student’s increased ability to conceptualize engineering problems and an increased engagement in engineering by incorporating visualization tools in the classroom environment. A sample of survey results shown in Tables 2 and 3 clearly indicated that GEMS experience not only impacted their academic life but also changed their perspective on Engineering. A survey on hands-on activities indicated that students really enjoyed working with their group members in creating a working/moving robotic machine and building a bridge using their innovative design. Students also suggested that more time should be given for such hands-on activities and more material should be provided for bridge activity. More importantly, the graduating high school seniors were motivated and excited about starting their first year at a university in an engineering field.

Table 2 – A sample of GEMS Final Evaluation

For each of the following statements, use the given scale to indicate your level of agreement about how your participation in GEMS has impacted your academic life.				
Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
I plan to expand my GEMS experience, by telling my high school peers about my camp experience.	20%	80%	0%	0%
Because of my teammates and GEMS experience, my skills in writing, documentation, oral presentations have improved.	30%	70%	0%	0%
My GEMS experiences did not provide more information that will help me in my career choice.	10%	10%	50%	30%

Table 3 – A sample of Students’ responses to the open ended questions on GEMS

<p>1. What did you like the best about GEMS?</p> <ul style="list-style-type: none"> • The projects • Engineering camp day • I liked that it was hands on • That GEMS have actual female mentors in the science field to teach us • The experience allowed me to have a clear view of engineering
<p>2. Can you state a unique GEMS camp feature different than other usual summer camps?</p> <ul style="list-style-type: none"> • This is an all girls camp and it has more experiments • Hands on activities, we actually get to do fun stuff • Actual professors teaching on a college campus • Allows us to look into a male dominated career field. By keeping the camp restricted to only girls, they won’t feel pressured or inferior to boys who actually have STEM experience • It was super long which allowed us to not have to rush

Future GEMS Camp

The goals for 2017 GEMS camp is to increase participation through outreach programs, to invite a female speaker from industry to talk about her career path/research interests and discuss opportunities in Engineering. In addition, we will recruit current UIW female engineering

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students to volunteer at the camp as role models. Furthermore, we will implement more comprehensive evaluation methods in order to assess the camp participants' learning objectives.

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Mr. Coronado was the student assistant during the camp.