

A Summer STEM Camp for High School Female Students

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Dr. Afrin Naz is an assistant professor at the Computer Science and Information Systems department at West Virginia University Institute of Technology. She is working with high school teachers to inspire the K-12 students to the STEM fields. In last four years Dr. Naz and her team launched six workshops for high school teachers. Currently her team is training the high school teachers to offer online materials to supplement their face-to-face classroom.

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Introduction

In the summer of 2015, a Summer STEM Camp was organized at West Virginia University Institute of Technology (WVU Tech) with the objective of inspiring female high school students' interest in STEM disciplines and encouraging them to choose STEM (science, technology, engineering, and mathematics) as their college major. Twenty-four (24) female high school students participated in the Summer STEM Camp. During the five-day camp, they learned about fundamental knowledge of science and engineering, were exposed to cutting-edge technologies, and conducted multiple mini-projects. They had extensive interactions with female college students, female professors, and female professionals (invited as guest speakers). They also met Ms. Carolyn Long (President of WVU Tech), Ms. Robin Anglin-Sizemore (Science Coordinator of Office of Secondary Learning, West Virginia Department of Education), and Ms. Millie Marshall (President of Toyota Motor Manufacturing West Virginia Inc., primary sponsor of the camp), who shared their personal stories about how females excel in STEM fields with the participants. The participating female high school students stayed on university campus during the Summer STEM Camp.



Figure 1: Participants of the Summer STEM Camp held in June 2015.

Relevant work

U.S. Census Bureau's 2011 American Community Survey¹ indicates that females are significantly underrepresented in STEM areas. Specifically, only 13 percent of engineers are women, and women constitute only a quarter of the workforce in computer and mathematical sciences. The female students' interest in STEM fields has been low due to issues encountered in K-12 education system¹⁰⁻¹². Recently, there have been academia and industry supported events to attract young girls to STEM fields using a variety of different methods²⁻⁹. One of these methods

is summer STEM camps, which can attract young girls to STEM fields through applied activities²⁻⁷. Several universities had successfully initiated annual STEM camp series for middle school and high school female students, such as “C-STEM Girl Camp” at University of California at Davis², “Summer Engineering Experience for Girls (SEE)” at Carnegie Mellon University³, and “Robocamp” at University of North Texas⁴.

Implementation of the summer STEM camp

The photo in Figure 1 was taken at the camp with all the camp participants. The main objective of this project is to inspire female high school students' interests in STEM disciplines and to encourage them to choose STEM as their college majors. The technical topics covered at the camp span computer science, electrical engineering, computer engineering, mechanical engineering, civil engineering, chemical engineering, chemistry, pharmacy and biology. Faculties of WVU Tech were the instructors at the Summer STEM Girls Camp. In addition to technical sessions, the Summer STEM Girls Camp also included a few special sessions.

"As a woman I can say we need some encouragement. Somebody to tell us we can do it, so we are putting these girls together," said Dr. Afrin Naz, an assistant professor of computer science and engineering and director of the new program. While more females have ventured into STEM programs over the past 10 years, Naz said females are still underrepresented. "That's the goal of this camp," she said. "Bring these girls while they are still young and have their future ahead of them."

Many of the camp's attendees shared that the all-girls format of the camp was a draw for them, as it allowed students to start the program on common ground with girls who hold similar interests. Plus, it gives administrators the chance to tailor the camp to girls. Students spent a few sessions, for example, designing and building high-heeled shoes from cardboard. The project culminated with a fashion show in which the girls had to prove their shoes would support them as they walked at least 20 feet. The shoe competition is to teach students the elements of engineering including the concept of architecture and design, while thinking about fashion, something any girl will like. As another example, in the chemistry lab, the girls made cosmetics for their own use.

In addition to their lessons in various engineering and science fields, the campers are also interacted with college students majoring in STEM, with female professors from the university, and professionals brought in as guest speakers in the hopes of encouraging them to follow their love of science and math later in life while choosing a career.

Students also participated in a weeklong project where they were asked to give a PowerPoint presentation on what they learned during the camp. The competition served to boost teamwork skills and bring the concepts and lessons students learned together in a cohesive way.

Moreover, parents were invited to attend a picnic and the girls' presentations on the last day of the camp. A range of information related to STEM majors (such as job opportunities and availability of scholarships) was provided to the parents and the parents are expected to play a more constructive role when their daughters choose college majors.

Agenda of the Summer STEM Camp is shown in Table I. It includes various types of sessions, which are detailed in the following.

Table I: Agenda of the Summer STEM Camp

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
9 AM – 12 PM		Computer engineering	Chemical engineering	Pharmacy	Tour Toyota plant & Meet president	Mechanical engineering
12 PM – 1 PM		Lunch	Lunch	Lunch	Lunch	Lunch
1 PM – 2 PM		Computer science	Computer science	Meet president	Outdoor activities	Electrical engineering
2 PM – 5 PM	Registration	Civil engineering	Biology	Chemistry		Project presentation
5 PM – 6 PM	Dinner	Dinner	Dinner	Dinner	Pizza dinner, movie, and games	Picnic, parent session
6 PM – 8 PM	Orientation	Invited speaker	Invited speaker	Invited speaker		
8 PM – 10 PM		Games	Shoe design contest	Games		

Technical sessions

The camp included five engineering and four science sessions where each session provided hands on experiences.

a) Computer engineering session

Instructor: Kimberlyn Gray, Ph.D.

Topic: Robotics

In the computer engineering session, the participants used a graphical user interface to program real-life robotic solutions and learn to use touch, sound and light sensors to program a robot to react to its environment.

b) Computer science session

Instructor: Afrin Naz, Ph.D.

Topic: Building a Simple Website

In this session, the participants worked in a group to learn how to develop a simple website.

c) Civil engineering session

Instructor: Horng-Jyh Yang, Ph.D.

Topic: Soil Magic

Soil is a fundamental construction material in civil engineering. It can support the huge mass of a building or bring it crashing to the ground. In this session, the participants examined soil samples with their hands and tried to determine what these soils will do under different conditions.

d) Mechanical engineering session

Instructor: Shahed Mustafa, M. Sc.

Topic: Gears

The gear is one of the most commonly-used mechanical components in the world. Gears transmit motion between rotating shafts by meshing with one another, and in this mechanical engineering session, students learned the fundamental operations and parameters of realistic gears.

e) Biology session

Instructor: Lisa Ferrara, Ph.D.

Topic: Detecting a virus using the ELISA test

The Enzyme-Linked Immunosorbent Assay (ELISA) is a test used to screen for the presence of a viral antigen in blood. An antigen is a very large molecule, usually a protein that an antibody combines with during the human body's fight against a disease. In this session, the participants did set up and performed this assay using simulated patient serum, antibodies, enzyme-linked anti-antibodies, reagents, microtiter plates, transfer pipettes and micropipettes.

f) Pharmacy session

Instructor: Susan M. Gardner, Ph.D.

Topic: Experiencing Pharmacy

This session welcomed special guest faculty members of the University of Charleston, who introduced the participants to the fascinating pharmaceutical world.

g) Chemistry session

Instructor: Hasan El Rifai, Ph.D.

Topic: Renewable Energy Technologies

Renewable energy is among the hottest topics on the face of earth today. This session was an introduction to the chemical processes and technologies driving renewable energy. The participants gain first-hand experience of the various kinds of energy sources in the merging renewable energy sector and learned how places around the world are developing alternatives to fossil-fuel-based energy.

h) Chemical engineering session

Instructor: Gifty Osei-Prempeh, Ph.D.

Topic: Battery and Fuel Cell Technologies

There is a major need for alternative sources of fuel to power our homes, cars and everything in between. Batteries and fuel cells use electrochemical reactions to generate electricity. For these cells to work, they need fuels such as hydrogen and oxygen. In this session, the participants were introduced to the reactions involved in generating electricity in these cells and even built a simple battery.

i) Electrical engineering session

Instructor: Kenan Hatipoglu, Ph.D.

Topic: Basic Electrical Circuit Operation

This session covered basic electrical circuit operation to measure the current and power flow of a system and simulate the basic wave form. After attending this session, the participants had a rough idea how a complicated circuit system (such as computer) works. This session is for everyone – the participants did not need highly sophisticated knowledge or skills to play with electrical circuits.



Figure 2: The participants in technical sessions

Special sessions

In addition to these technical sessions, the camp also included several special sessions tailored for girls to gear towards STEM.

a) Meet the president session

In the camp, the girls had the great opportunity to meet two female presidents who are blazing a path for women in their fields, – Carolyn Long, President of WVU Tech and the new WVU campus in Beckley, and Millie Marshall, President of Toyota Motor Manufacturing West Virginia. In two separate sessions, these pioneer women shared their experiences and demonstrate the many opportunities for women in the workplace.



Figure 3: In “Meet the President Session” the participants are with (a) WVU Tech president Ms. Long and (b) Toyota Motor Manufacturing West Virginia president Ms. Marshall

b) Academy speaker series

The STEM Summer camp for Girls invited female speakers from STEM to meet with students and share their stories from the classroom and the field. These inspiring women, all of whom have found success in STEM professions, provided advice on pursuing STEM fields and discussed the ways female students can support one another in their efforts to study and work in these important professions. On the first night our speaker was Ms. Robin Anglin-Sizemore, Science Coordinator, Office of Middle/Secondary Learning West Virginia Department of Education (WVDE). She shared her own life story to inspire these girls. On other nights we had women academia and industry representatives.

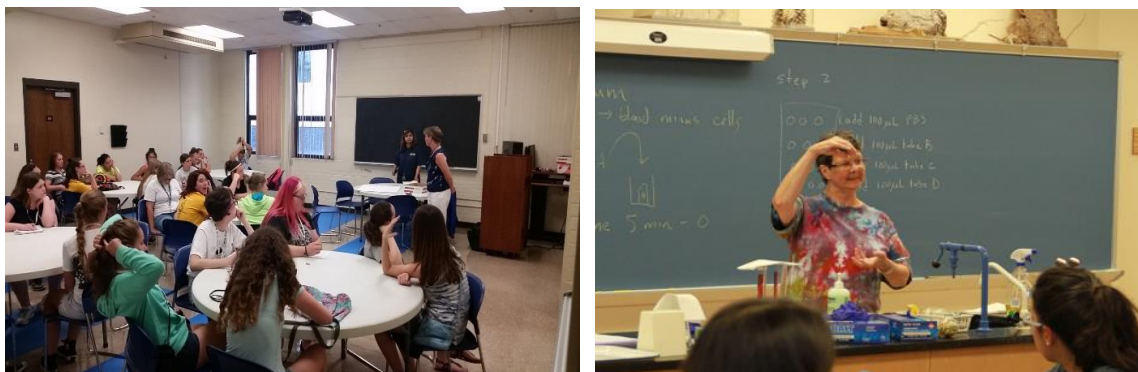


Figure 4: In “Academy Speaker Series” the participants are with (a) WVDE Science coordinator Ms. Anglin-Sizemore and (b) Female scientist Dr. Ferrara

c) A day trip to remember

On the fourth day of the camp, the participants embarked on a day-long field trip. In the morning, the group traveled to Buffalo, West Virginia to tour the Toyota Motor Manufacturing West Virginia plant where the company makes engines and transmissions. On a wonderful session led by Toyota WV president Ms. Millie Marshall, Toyota gathered their female employees where they talked about the opportunities and challenges of being a women in a male dominated field. They also shared their personal stories about how females excel in STEM fields. After the tour, the group traveled to the state’s capital city of Charleston where they enjoyed a delicious lunch at a Japanese hibachi-style steak house and visited the city’s iconic Clay Center for the Arts & Sciences of West Virginia.



Figure 5: In “Day to remember” the participants are at (a) Toyota WV plant, (b) Japanese restaurant, (c) and (d) Clay center

d) The shoe design competition

Designed from the start as a means of demonstrating the application of STEM fields to everyday life (including fashion), the camp took a unique approach to helping students process the program’s educational offerings. For instance, attendees participated in a competition where they worked with a budget to purchase materials like construction paper, glue and tape to build a pair of shoes. The participants had to consider engineering design elements to account for pressures and weight distribution in the shoes, and had to test their designs on a 20-foot runway.



Figure 6: (a) Girls are working on completing their pair of shoes. (b) The winners of the shoe contest

Over a period of the first two days of the camp, the girls worked to learn the biomechanics of the human foot and where pressure points lie. Armed with that information, the girls were asked to create a shoe that would be comfortable, practical and fashionable. Looking down the runway, 12 teams competed for the best shoe, wearing their newly-made projects while walking a 20 foot distance in front of judges, who are female engineers. The shoes were judged on a variety of criteria including appearance, fit, cost to build, and structural integrity. Girls were able to choose between a flat or high-heeled shoe. Some were decorated with pom-poms or pipe cleaners, and one pair of shoes featured LED lights. Taking first place at the competition were Destiny Lusk and Maria Plaza.



Figure 7: (a) Girls are walking on a 20-foot runway as part of the judging for the shoe contest, (b) A contestant was able to smile after her shoes collapsed as soon as she stood up and (c) A pair of shoes was designed and constructed mainly out of construction paper

e) Student presentation

In order to improve the presentation, leadership and team work skills of the participants the camp included a special option, the “group project” presentation. On the first day of the camp, the girls were grouped (four girls per group) to work together on a week-long group project. At the end of the week, each group displayed a presentation about their experience, including what

they learned about the role of women in STEM professions. In order to include the parents, the presentations were made during our fun family picnic, where camp judges awarded prizes to the best presenters. The slogan for the first prize winner group was “We became sisters from strangers”.



Figure 8: (a) Girls are presenting their group project and (b) The winners of the project competition

By including the competition element, the students were paying more attention in each class. They're making connections between these fields and how one field can have an impact on another. They were also better able to articulate what they like and dislike in each field because they have to think about what they are learning in an analytical way.

f) Parent session

One of the highlight of our camp was inclusion of parents. In West Virginia still majority of the students are first generation college students. The "Parents Session" was held on the last day of the camp. Both high school students and their parents attended the Parents Session to enable family-oriented discussions. A range of information related to STEM majors (such as job market and STEM scholarships) was provided to the parents. Through the Parents Session, parents are expected to be more knowledgeable about available STEM jobs, and in turn, would play a more constructive role when their children choose college majors.



Figure 9: (a) Parents in the audience and (b) Another view of parents

g) Evening activities

Each evening, the girls participated in a variety of fun activities. They played games designed to challenge their problem-solving skills, test their ability to work in a team and help you get to know one another. They also had attended a movie and pizza night.

Assessment

In the following section we provided data collected from our four sets of surveys, description of media coverage and then comments from the participants and the camp administrators.

a) Survey results

Assessment was conducted primarily via a series of surveys before and after the camp, to the participating high school girls as well as their parents. Surveys collected after the camp reveal that the camp was well received by the participating girls and their parents. The idea of having a girl only camp was also well received. As an example, one girl said she had originally planned to attend a co-ed STEM Camp, but changed her mind when she heard about this camp for girls. “In engineering and science fields you’re always going to be outnumbered by guys, so I liked how it focused more on the impact that women can have and the job opportunities women have,” she commented.

In the post workshop survey we asked the participants the following question “I think what we are studying about science and math in STEM Girls camp is useful for me to know” with following seven answer options (a) Strongly Disagree, (b) Disagree, (c) Somewhat Disagree, (d) Neither agree or Disagree, (e) Somewhat Agree, (f) Agree and (g) Strongly Agree. While fourteen girls have selected “Strongly Agree” option, six girls selected “Agree”, two girls selected “Somewhat Agree” and two girls selected “Neither agree nor Disagree” option. Although comparison between the pre-camp and post-camp survey data reveals increase in the participating girls’ interest in taking STEM as their college major, the percentage increase was not high (it was only 8%). As we were very surprised with this low number, after thorough analysis we have identified a possible reason. We were happy to find this reason as that pointed out one limitation of our effort while providing an opportunity to fix the problem in our future plans. As the participants were selected through advertisements we end up with girls who are already interested in STEM field. The high percentage score in “I am interested in STEM” question in pre workshop survey proves our hypothesis. As most of them already selected the “Strongly Agree” option in their interest in STEM field in pre workshop survey there was not enough room to increase the percentage in the post workshop survey. In our future plan we decided to continue with two camps. The first camp will be same as our 2015 effort. However as our second option instead of selecting girls through advertisement, we will work with all girls in selected counties to specifically include those girls who are currently not interested in STEM. We already have contacted the superintendent of two counties with high poverty level.

In finding the ways to inspire student in STEM fields, a critical but often overlooked factor is parents¹³. In this project our efforts included some parent engagements. A specially designed "Parents Session" was held on the last day of the camp where range of information related to STEM majors (such as job market and STEM scholarships) was provided. We believe that

parents being more knowledgeable about available STEM jobs would play a more constructive role when their children choose college majors. Two sets of survey (pre and post workshop) were conducted from the parents of the participating girls. Comparing our pre and post workshop survey we see an improvement in the confidence of awareness in of prospective STEM job positions and salaries in USA from 62% to 86%. Our collected data also reveals that only 26% of the parents of the participants are in STEM fields.

b) Media coverage

The Summer STEM Camp drew considerable publicity in state of West Virginia. Numerous articles/stories were reported by local TV and newspapers.

In their broadcast WOWK TV 13, said “This summer program encourages girls to join STEM workforce. For five days, 24 girls from around the tri-state region learned about electrical engineering, computer science, robotics, biology and chemical engineering. They had the opportunities to speak with women in those fields and complete hands-on tasks, like creating shoes out of paper.” During her interview with WOWK TV 13, a ninth grader Bianca Grey said, "There are so many things we can do with our life. Instead of just being in nursing, you have more options."

On their fall 2015 issue, WV focus magazine featured an article on the girls' camp titled “Girls Only”. While describing a class in our camp they mentioned “If you glanced in the room you might be surprised to learn this is a computer coding class. These students don't look at all like Mark Zuckerberg. They're younger, for one thing—high school age. And they're all girls.” They also reported “The idea here, and throughout the camp, is to give the girls just enough of a taste of STEM subjects to make them hungry for more. With this camp, the administrators at WVU Tech are trying to show girls that STEM fields could be right for them. All the girls here have already demonstrated an interest in math, science, or technology, but this is a way to show them how much fun those fields can be outside the classroom.”

On the article titled “WVU Tech Launches Inaugural STEM Summer Academy for Girls” WV Executive interviewed WVU Tech president and quoted her remark “No matter what these girls ultimately decide to do, our goal is to give them an opportunity to explore some of the fields that will be changing business and industry in West Virginia in the decades to come. They'll leave here knowing they're capable of chasing down any career – not in spite of the fact that they're women, but because they're women,”

West Virginia Public Broadcasting said “Camp looks to boost women in the workforce”. They also reported “In addition to their lessons in various engineering and science fields, the campers are also interacting with college students majoring in STEM, with female professors from the university, and professionals brought in as guest speakers in the hopes of encouraging them to follow their love of science and math later in life while choosing a career.”

c) Comments from the girls and the camp administrators

“As a girl, we need something special,” said Dr. Afrin Naz, the director of the camp. “We need some kind of encouragement; somebody has to tell us that we can do it. We have this

common misconception that science and engineering is only for boys and it's time to break those misconceptions."

"There's still a large gap in the number of women that are in engineering. We're not seeing as many women go into engineering and stay in engineering," said Assistant Professor of Chemical Engineering Dr. Kimberlyn Gray. "One of the things that a lot of research has shown when people have looked into why is that people are more likely to go into things where they have role models and mentors that have already done those kinds of things."

"There are so many things we can do with our life. Instead of just being in nursing, you have more options," said Bianca Grey, who is going into 9th grade.

Fourteen-year-old Piper Martin is going into the ninth grade at Charleston's George Washington High School, but she already has her eye on college. She attended the camp to explore new fields and get a feel for what life in college is like. "Usually in school you get sort of a brief introduction to careers, but I like learning more in depth about all the careers, especially in biology, because that's where I want to go," she said. "Knowing that it's really sterile in a lab and that you have to be careful when you're doing experiments is helpful. It gives me a picture of what I'll be doing."

Counselor Kaylah Bovard, 21, of Waldorf, Md, said the camp has been "amazing." "There's such a different dynamic when there's no boys involved because they're getting here and there's no competition. They get to meet new people that all kind of started from the same place, whereas in STEM field, boys have grown up liking cars ... there's just a different atmosphere type-thing." She also said that her role is to show the girls that despite the lack of woman working in STEM fields, it's a viable career option. "If you really are enjoying this and you really are great at math or science or you even just have a passion for it, you can succeed in this field," Bovard said.

"I've actually never thought of engineering before," Cline said. "I like the camp because there are a lot of really great people here. It's a fun time being with people who are on the same wavelength."

"I was worried the camp was going to be too girly," says Rhane Napier, a 17-yearold from Ohio who attended to the camp. She says at home, she mainly hangs out with guys because they're the people at school who share her interests. When she decided to go to an all-girls summer camp she was worried she wouldn't get along with the other campers. She was worried she wouldn't like the stuff they had to do, because she doesn't like the stuff most girls like. "But it's not like that," she says. "You can take the assignments any way you want." She pulls out a sketch she's made for the high-heel competition. The shoe looks like a cat—a whole new play on the term "kitten heels"—proving a feat of engineering doesn't have to be masculine to be impressive.

As a counselor, WVU Tech biology student Taylor Miltenberger said the camp was an opportunity to connect with young students headed down the path she's taking. Miltenberger, a first-generation college student, was able to share her experiences with students who will be in

her shoes in just a few short years. “I didn’t have this kind of opportunity when I went to school – it was always just pick what you like and you don’t always know until you’re in it whether you really enjoy a field. Students can picture themselves in these careers here because of the activities we’ve been going over with them. They get to see what a biologist or an engineer really does and they can connect with that,” she said.

“I feel like [role models] are hard to find in my community” Buckhannon Upshur High School senior Laura Dean said. “A lot of people in my school, I don’t think they’re really into engineering. So, I can’t really point out to my community and say I want to be like her.”

Too few women are actually in engineering, science, technology and math, said Teagan Waugh, 15, of Princeton, adding that she eventually wants to study for a cure to all mental illnesses, specifically schizophrenia and multiple personality disorders. “There should be more girls in it; girl power!” At the initial introduction, Waugh introduced herself as “Fabulous,” pointing to her name tag that read: “Hi, My name is ‘Fabulous,’” laughing it off. Waugh attended the co-ed camp last year, but said that she has been able to relax around a group of girls. “I can sit and talk with (girls) for like, an hour, about how to correctly code a computer to make a webpage...” Waugh said. “Girls sometimes think ‘Oh, I can’t be friends with that girl because that guy’s cute,’ or something else to pull away their focus because sometimes, guys who go to STEM camp are actually pretty cute.” She also added “It isn’t that guys are less intelligent than girls, or the other way around; it’s that we all have different viewpoints.”

“It really brings out the different creative ways that everybody looks at something,” said Tiffeni Cline, 14, of Pipestem, who is interested in forensic science.

Conclusion

In June 2015, a Summer STEM Camp was organized at West Virginia University Institute of Technology, with Toyota Motor Manufacturing West Virginia Inc. as the primary sponsor. The main objective of the Summer STEM Camp is to inspire female high school students’ interest in STEM (science, technology, engineering, and mathematics) disciplines and encourage them to choose STEM as their college majors. In this paper we describe our experience in launching the first girls STEM camp in the state of West Virginia.

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