



Competition Of VEX Educational Robotics to Advance Girls Education (COVERAGE)

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Dr. Afrin Naz is an associate 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 six years Dr. Naz and her team launched more than twenty five 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.

Dr. Mingyu Lu, West Virginia University Institute of Technology

Mingyu Lu received the B.S. and M.S. degrees in electrical engineering from Tsinghua University, Beijing, China, in 1995 and 1997 respectively, and the Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign in 2002. From 2002 to 2005, he was a postdoctoral research associate at the Electromagnetics Laboratory in the University of Illinois at Urbana-Champaign. He was an assistant professor with the Department of Electrical Engineering, the University of Texas at Arlington from 2005 to 2012. He joined the Department of Electrical and Computer Engineering, West Virginia University Institute of Technology in 2012, and he is currently a professor. His current research interest includes wireless power transmission, radar systems, microwave remote sensing, antenna design, and computational electromagnetics. He was the recipient of the first prize award in the student paper competition of the IEEE International Antennas and Propagation Symposium, Boston, MA in 2001. He served as the chair of Antennas and Propagation Society of IEEE Fort Worth Chapter from 2006 to 2011. He is currently serving as the treasurer of IEEE West Virginia Section.

Chase Broyles, West Virginia University Institute of Technology

Chase Broyles is from Princeton, WV and is currently a Computer Science student at West Virginia University Institute of Technology expecting to graduate in Spring of 2020. He has been working with high school computer science curriculum and is an advocate for Computer Science classes in all West Virginia schools. Recently, he has been working with middle school students in an after-school program focusing on exposure to STEM topics and experiences.

Ms. Isabel Barrio Sanchez, West Virginia University Institute of Technology

Isabel Barrio Sánchez is a college student at West Virginia University Institute of Technology. She is currently a Junior pursuing a Mathematics major and Computer Science and Economics minors. She has been working as a middle school and high school mentor for three years. Alongside the Computer Science department at WVU Tech and Dr. Afrin Naz, she has developed and implemented several programs to increase West Virginia's girls' interest in STEM disciplines. She is currently working on the curriculum for STEM projects that will be implemented in Spring 2020 at several middle schools in Southern West Virginia.

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(Research-to-Practice)

Strand: Other

Introduction

Approximately, half of West Virginia high school graduates are female. Meanwhile according to ACT college readiness data, as low as 14% of the female high school graduates in West Virginia are college ready for STEM. Apparently, female students in West Virginia need assistance to become competent and confident in STEM disciplines. Competition Of VEX Educational Robotics to Advance Girls Education (COVERAGE) is a project aiming to inspire and support female middle school and high school students to pursue STEM careers in West Virginia, funded by the Greater Kanawha Valley Foundation. Specifically, in the fall semester of 2019 and spring semester of 2020, West Virginia University Institute of Technology assisted teachers to organize Girls Robotics Clubs in Kanawha County, Fayette County, and Lincoln County. Through attending the robotics clubs, female middle school and high school students are expected to become more knowledgeable and interested in STEM disciplines. All the activities at the robotics clubs are oriented toward a regional robotics competition, which will be held in fall 2020 at the Coliseum & Convention Center in Charleston, West Virginia. It will be West Virginia's first girls-only VEX robotics competition. Around 16 girls-only teams will participate in the competition. Judges will include faculty members of West Virginia University Institute of Technology as well as professionals from local companies/organizations. Winners of the regional robotics competition are anticipated to be highly competitive at the national VEX robotics competition (according to Guinness World Records, the VEX robotics world championship in April 2018 was the largest robotics competition in the world¹). We are expecting that the contribution of this innovative project will be the middle and high school girls' increased interest in STEM disciplines.

The primary merit of this project is establishing mentorship relationship between female university students and female K-12 students. Specifically, 6 female undergraduate students of West Virginia University Institute of Technology with STEM majors serve as the mentors of female middle school and high school students. The mentors started their university study recently; in other words, they are just a couple of years ahead of the female middle school and high school students. As a result, it would be natural for them to become the role models of middle school and high school students. The mentors work closely with female middle school and high school students in the robotics clubs on monthly basis. The mentors also help female middle school and high school students with their math and science coursework. In addition to monthly in-person meetings, virtual meetings are held in which the mentors post videos online for middle school or high school students.

For this education research project, we are working with two research questions as provided below.

Research question 1: “Does being mentored by undergraduate female students increase the students in the middle school and high schools’ interest in STEM disciplines?”.

Research question 2: “Does increasing the parents’ STEM awareness imposes positive impacts on their daughter’s joining STEM program at college/university?”

Relevant Work

U.S. Census Bureau’s 2011 American Community Survey² 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. Female students’ interest in STEM fields has been low due to issues encountered in K-12 education system¹¹⁻¹³. There have been numerous efforts with the objective of attracting young girls to STEM fields using a variety of methods³⁻¹⁰. One of the effective methods is STEM clubs/camps³⁻⁸. Several universities had successfully initiated annual STEM camp series for female middle school and high school students, such as “C-STEM Girl Camp” at University of California at Davis², “Summer Engineering Experience for Girls (SEE)” at Carnegie Mellon University⁴, and “Robocamp” at University of North Texas⁵.

This project is based upon our prior efforts to serve female middle school and high school students. Recently, Lincoln County Schools and Kanawha County Schools were awarded grants by Robotics Education and Competition Foundation. In 2018, West Virginia University Institute of Technology received funding from the National Center for Women & Information Technology. Both grants above aim to promote educational activities related to robotics in West Virginia middle schools and high schools. In this project, all of our prior efforts are integrated into one framework.

Implementation

In the fall semester of 2019 and spring semester of 2020, West Virginia University Institute of Technology assisted teachers to organize Girls Robotics Clubs in Kanawha County, Fayette County, and Lincoln County, which prepare female middle school and high school students for a regional robotics competition. The regional robotics competition will be held in fall 2020, and it will be West Virginia’s first girls-only VEX robotics competition. Through attending the robotics clubs and competition, female middle school and high school students are expected to become more knowledgeable and interested in STEM disciplines.

The specific implementation plan has the following four tasks. The progress of these four tasks is

reported one by one below.

Task 1: Summer training workshop

This project involves three school districts: Fayette County Schools, Lincoln County Schools, and Kanawha County Schools. In August 2019, a training workshop was organized on the campus of West Virginia University Institute of Technology for middle school and high school teachers. Six undergraduate students of West Virginia University Institute of Technology also attended the workshop. At the workshop, the participants learned the basis knowledge and skills of VEX robotics.

Task 2: Girls Robotics Clubs

After learning the basis knowledge and skills of VEX robotics at the summer workshop, the participating teachers organized Girls Robotics Clubs at their schools in the fall semester of 2019.



(a)



(b)



(c)



(d)

Figure 1: Illustration of activities at the Girls Robotics Clubs.

Thanks to the sponsorship of Greater Kanawha Valley Foundation, “girls-only robotics clubs/classes” are initiated at the following schools.

Stonewall Jackson Middle School, Kanawha County

John Adams Middle School, Kanawha County
Lincoln County High School, Lincoln County
Oak Hill High School, Fayette County
Oak Hill Middle School, Fayette County

At the above schools, the number of female middle/high school students involved ranges from 5 to 25. Six female undergraduate students of West Virginia University Institute of Technology serve as the mentors of female middle and high school students. Some of the activities at the Girls Robotics Clubs are demonstrated by four photos in Figure 1. Figure 1(a) shows two mentors, Isabel and Beatriz, giving presentation to Stonewall Jackson Middle School students. The photo in Figure 1(b) was taken when a middle school student was explaining her program to her mentor Tommi. A snapshot of a Middle School teacher working with her students is shown in Figure 1(c). In the photo of Figure 1(d), two High School students are working with their robots in the field.

Task 3: Regional robotics competition

A regional robotics competition has been scheduled to be held on fall 2020 at Coliseum & Convention Center in Charleston. It will be West Virginia's first girls-only VEX robotics competition. Around 16 teams will participate in the competition. Winners of the regional robotics competition are anticipated to be highly competitive at the national VEX robotics competition. We have also developed a website for the competition (<https://stemcenter.wvutec.edu/coverage>).

Task 4: "Family STEM Night"

We have organized two "Family STEM Nights." The first one was held on October 23, 2019 at the Oak Hill High School of Fayette County. The speakers included a female engineer from Toyota Manufacturing West Virginia and two female undergraduate students of West Virginia University Institute of Technology. The second one was held on October 26, 2019 at Charleston. The speakers included Naveed Zaman (Dean of the College of Natural Sciences and Mathematics, West Virginia State University), Lesley Rosier-Tabor (Executive Director of the West Virginia State Board of Registration for Professional Engineers), Tammy Kassic (robotics instructor at South Charleston High School), and Mildra Benye (engineering student of West Virginia University Institute of Technology). At the "Family STEM Nights," middle school and high school students shared their experience of the Girls Robotics Clubs with their peers and parents. The photo in Figure 2 was taken at the "Family STEM Night" on October 26, 2019.



Figure 2: A photo taken at the “Family STEM Night” on October 26, 2019.

Preliminary results

This project has the following three outcomes.

- Outcome 1: Female middle school and high school students who participate in this project demonstrate increased interest in choosing STEM careers.
- Outcome 2: Female middle school and high school students who participate in this project demonstrate interest in joining STEM program at college/university.
- Outcome 3: Female middle school and high school students’ parents become more knowledgeable about STEM and increasing the parents’ STEM awareness imposes positive impacts on the students.

To measure this project’s efficacy at achieving the expected success, we have designed various instruments to collect data throughout this project, as elucidated below. Female middle school and high school students’ intention to pursue STEM careers is being assessed using Social Cognitive Career Theory. The model of Social Cognitive Career Theory accounts for the development and influence of students’ self-efficacy, expected outcomes, and interests in STEM professions. Parents respond to surveys before this project and after they attend the “Family STEM Night.” Success will be indicated by positive changes in parents’ conceptions toward STEM across time.

According to the feedback we have collected, most of the participating female students find robotics interesting, and most the participating female students respond that they become more knowledgeable about STEM. It is estimated that more than 100 parents have been engaged directly or indirectly through this project. Over the surveys, numerous parents said that they gained knowledge about STEM disciplines, available scholarship programs, and prospective STEM jobs in West Virginia. The parents also find it tremendously beneficial that their daughters are mentored by female university students, especially by first-generation female university students.

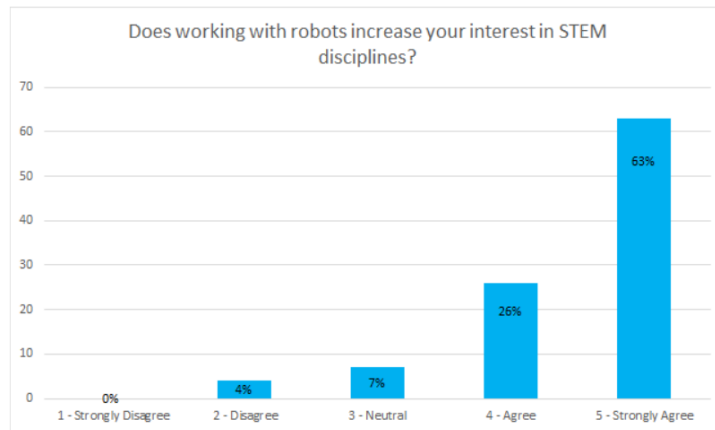


Figure 3: Survey answers from the participants

In figure 3 we are demonstrating our results. The participants responses for survey question “Does working with robots increase your interest in STEM disciplines?” are demonstrated in diagram (a). As can be seen from the diagram 63% of these young women answered, “strongly agree” and 26% answered “agree”.

As can be seen from figure 4 all parents agreed when we asked them “Does being mentored by undergraduate female students imposes positive impacts on your daughter’s joining STEM?”

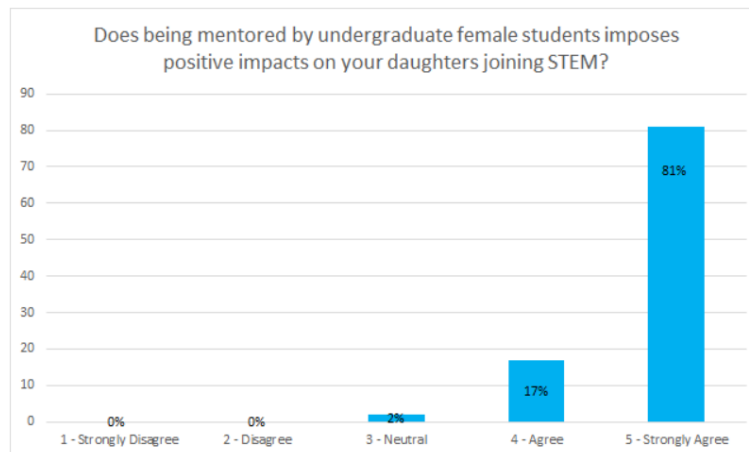


Figure 4: Survey answers from the parents

We are particularly proud that this project attracts tremendous attention from the community, which is evidenced by a large number of volunteers. Our volunteers range from a 63-year old grandma to the President of West Virginia’s largest manufacturing plant. More than 50 female

pioneers of our state will attend the upcoming competition in March and inspire the female middle school and high school students.



Figure 5: Another photo taken at the “Family STEM Night” on October 26, 2019.

A specific story is presented below, which demonstrates how female middle school students are inspired in this project. Mildra Benye is an undergraduate student at West Virginia University Institute of Technology with major in Civil Engineering. In this project, Mildra serves as a mentor of female middle school students. On October 26, 2019, a “Family STEM Night” was held at Charleston, West Virginia. Mildra was one of the speakers at the “Family STEM Night.” After her presentation, she spent almost 30 minutes on answering questions from the audience. At least 6 questions came from Cierah, who is an African American female student at Stonewall Jackson Middle School, Kanawha County. Cierah was simply amazed by Mildra and said "I have never met anyone as cool and smart as Mildra. I want to be like her when I grow up." A picture of Mildra interacting with middle school students is shown in Figure 5.

Conclusion

This ongoing project serves female middle school and high school students of Kanawha County, Fayette County, and Lincoln County. In the fall semester of 2019 and spring semester of 2020, West Virginia University Institute of Technology assisted teachers of these three counties to organize Girls Robotics Clubs. All the activities at the robotics clubs are oriented toward a regional robotics competition, which will be held in fall 2020 at the Coliseum & Convention Center in Charleston, West Virginia. It will be West Virginia’s first girls-only VEX robotics competition. Around 16 girls-only teams will participate in the competition. Through attending this ongoing project, female middle school and high school students are expected to become more knowledgeable and interested in STEM disciplines. According to collected data and our experience the girls developed interest in STEM education because of higher career opportunities

and also due to STEM being a scientific fun such as VEX robotics. We are endeavoring to involve more middle schools and high schools in this project.

Acknowledgment

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