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

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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 1997 to 2002, he was a research assistant at the Department of Electrical and Computer Engineering in the University of Illinois at Urbana-Champaign. 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 interests include 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 Chapter of IEEE Fort Worth Section from 2006 to 2011.

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

(Research-to-Practice, Strand: Other)

Introduction

The major objective of the COVERAGE (Competition Of VEX Educational Robotics to Advance Girls Education) project is to increase female West Virginia middle school students' interest in Computer Science and STEM. As the original plan of the COVERAGE project, Girls Robotics Clubs would be organized in three counties of West Virginia, including Kanawha, Fayette, and Lincoln Counties, to prepare female middle school students for a regional robotics competition at the end of 2020. The Covid-19 pandemic started soon after the COVERAGE project was initiated. As a result, almost all the activities had to be changed to an online platform [1], over which the participating students program robots virtually. In Fall 2020 and Spring 2021, online instructions were offered every week via Microsoft Teams, intending to guide the participating middle school students to program virtual robots. All the Teams sessions are recorded and shared with all the participants, such that the middle school students could visit them anytime. In addition to online instructions, at least one hour was designated every week for the mentors (who are female undergraduate students) to work with the participating middle school students on the online assignments under the supervision of middle school teachers. An online competition was held on March 10, 2021 among nine teams of female middle school students. Although "online" is definitely not the optimal means for robotics activities, survey results indicate that the project is well received by the participating middle school students. Particularly, the participating middle school students appreciate the opportunities of working closely with female undergraduate students.

Related work

According to the data of National Center for Women and Information Technology, in 2016 57% of the Bachelor's degree recipients were women; however, only 19% of the Computer Science Bachelor's degree recipients were women [2]. Meanwhile, the data of West Virginia Department of Education indicate that female West Virginia K-12 students' interest and readiness in Computer Science are lower than the national average level.

The COVERAGE project is designed to increase female West Virginia middle school students' interest in Computer Science and STEM. As the original plan of the COVERAGE project, Girls Robotics Clubs would be organized in three counties of West Virginia, including Kanawha, Fayette, and Lincoln Counties, to prepare female middle school students for a regional robotics competition at the end of 2020. Robotics has been widely adopted across the nation in K-12 STEM education. To name a few examples, robotics outreach programs have been developed by Massachusetts Institute of Technology [3], University of Texas at El Paso [4], Tufts University [5], and Central Piedmont Community College of Charlotte [6]. As West Virginia is in the

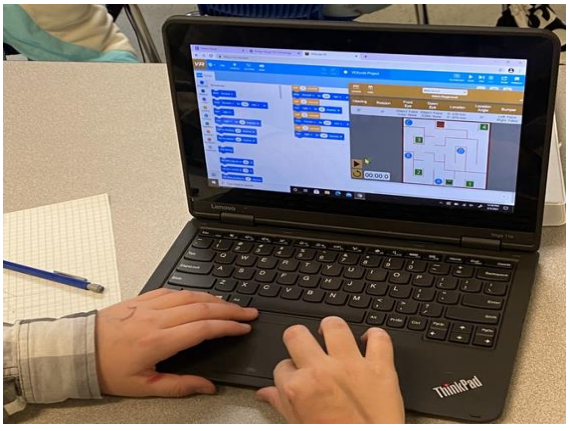
transition stage to move beyond relying on fossil fuel extraction as the primary source of revenue, improvement in education, particularly in STEM education, would be vital to the State's future. Employing robotics as a venue to inspire/motivate young female students' interest in STEM, if proved successful, might have the potential to change the socioeconomic outlook of West Virginia dramatically.

Establishing effective mentorship relationship between female undergraduate students and female middle school students constitutes the primary merit of this project. In this project, female undergraduate students of West Virginia University Institute of Technology with STEM majors serve as the mentors of female middle school students. As the mentors are just a few years ahead of the middle school students, it would be natural for the mentors to become the role models of middle school students. Research shows that mentees are most likely to compare themselves with someone they perceive as similar both demographically and in ability-related performance [2]. Thus, most of the mentors in this project are selected from first-generation undergraduate students with West Virginia background.

Online robotics activities and online robotics competition

The major objective of the COVERAGE project is to increase female West Virginia middle school students' interest in Computer Science and STEM. As the original plan of the COVERAGE project, Girls Robotics Clubs would be organized in three counties of West Virginia, including Kanawha, Fayette, and Lincoln Counties, to prepare female middle school students for a regional robotics competition at the end of 2020. The Covid-19 pandemic started soon after the COVERAGE project was initiated. As a result, almost all the activities had to be changed to an online platform, over which the participating students program robots virtually. Only in one of the three participating counties, which is Fayette County, did middle school students have limited opportunities to program real robots, as demonstrated by two photos in Figure 1. The specific online implementation of COVERAGE project is detailed in this section.

(a) Three female students with their robots



(b) One student programming her robots

Figure 1: Demonstration of the robotics activities in Fayette County in early 2020.

Since March 2020, the VEX simulator over vr.vex.com has been the main platform for the participating middle school students to program robots virtually. At each participating middle school, one teacher serves as the coordinator of the COVERAGE project, and he/she has a real VEX IQ robot. When a middle school student verifies her codes over the vr.vex.com platform, she could ask the teacher to test her codes using the real robot. In Fall 2020 and Spring 2021, online instructions were offered every week via Microsoft Teams, intending to guide the participating middle school students to program virtual robots. A range of exercises/challenges are provided at vr.vex.com; eight of them are shown in Figure 2. Every week, certain exercises/challenges are addressed by our online Teams session. All the Teams sessions are recorded and shared with all the participants, such that the middle school students could visit them anytime. A list of videos of our online sessions is displayed in Figure 3. In addition to online instructions, at least one hour was designated every week for the mentors (who are female undergraduate students) to work with the participating middle school students on the online assignments under the supervision of middle school teachers.

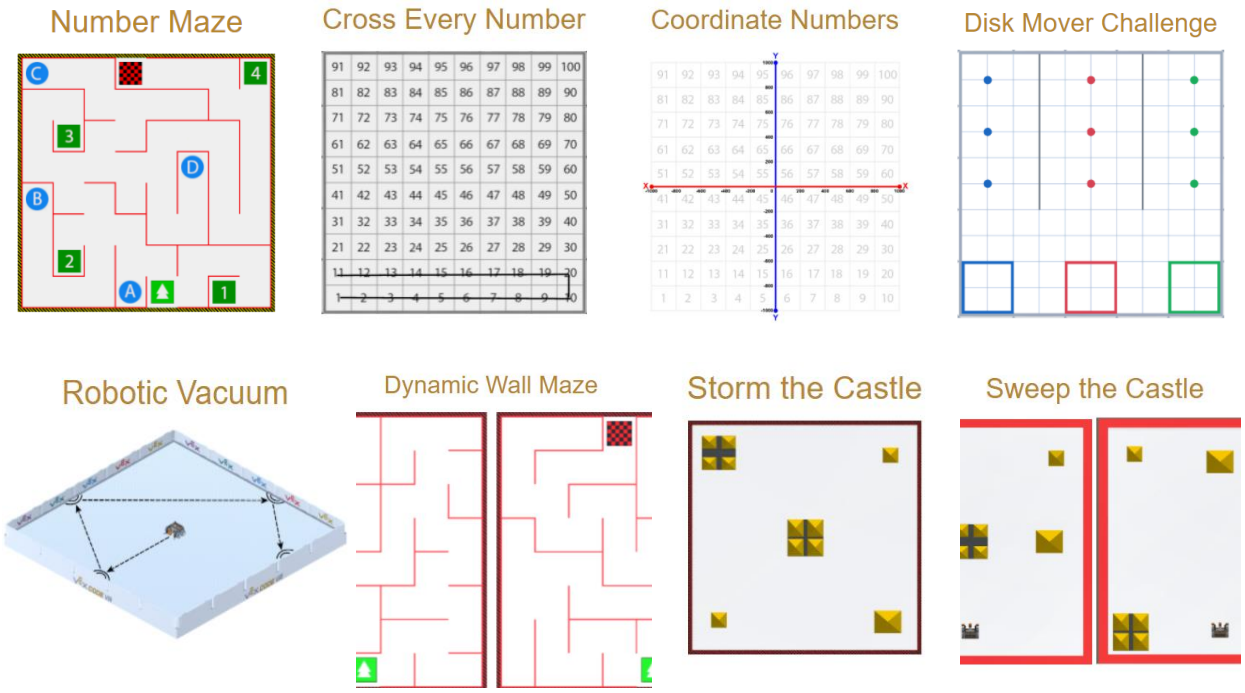


Figure 2: Eight different challenges from vr.vex.com website.

An online competition was held among the middle school students on March 10, 2021. The Coral Cleanup challenge, one of the challenges over vr.vex.com website, was selected as the topic of the online competition. In Coral Cleanup challenge, a robot is programmed to navigate an enclosed area to avoid obstacles and collect as much trash as possible. Nine teams participated in the online competition. Each team was given one week to develop a code for the Coral Cleanup challenge, by applying what they learned in this project including loops and sensors. Each team submitted their code before the online competition. On the competition day, each team's code was executed, and the weight of trash collected by the robot was recorded as the score. When one team's code was executed, it was watched and discussed by all the teams. Diverse strategies were demonstrated at the competition, and all the teams learned from each

other. One team from Oak Hill Middle School collected the largest amount of trash and thus won the first place of the online competition. Several photos and snapshots taken at the competition were shown in Figure 4.

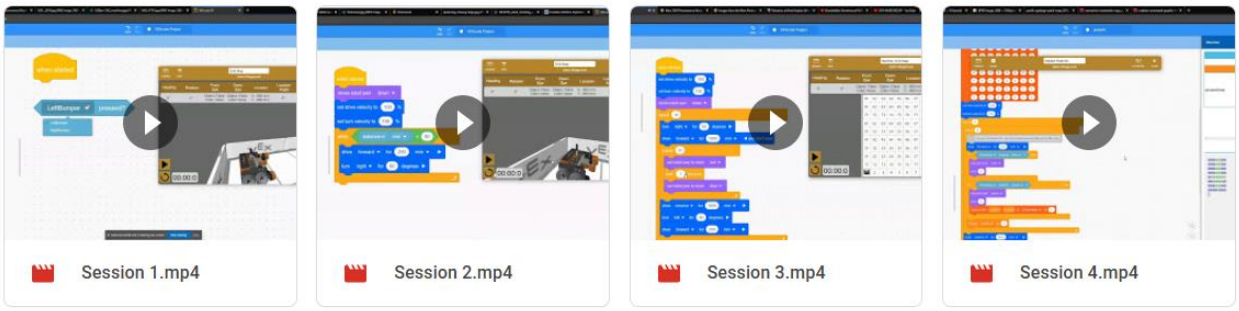
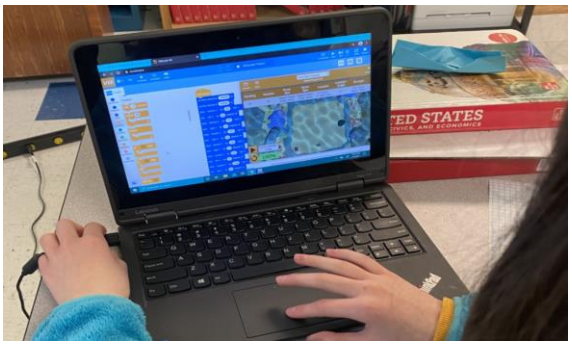
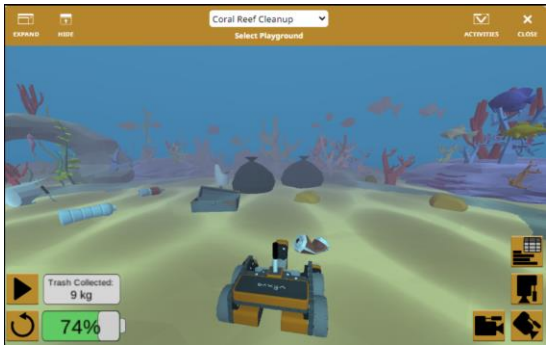


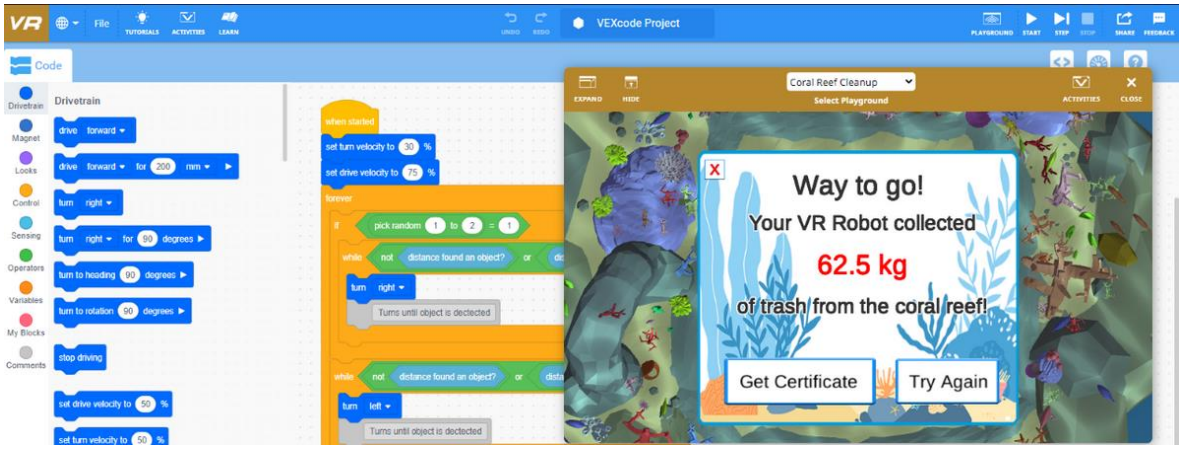
Figure 3: List of videos of our weekly online sessions.



(a) Students participating in the competition



(b) A snapshot taken during the competition



(c) A snapshot showing the score of one team

Figure 4: The online competition on March 10, 2021.

Results

Although "online" is definitely not the optimal means for robotics activities, the online implementation of the COVERAGE project achieves excellent outcomes, as demonstrated by some results in this section.

The middle school students who participated in the COVERAGE project were asked to complete an online survey after the online competition, for the project organizers to assess the effectiveness of the project. Some of the survey results are presented in Table I. For each survey question, the participants were asked to respond with a rating on a scale of 1 to 5, with "1" standing for "strongly disagree" and "5" standing for "strongly agree." The survey results unequivocally indicate that the project is well received by the participating students.

Table I: Some survey results collected after the project; the percentage data in the table are the "percentage of participants."

↓ Survey question Rating →	1	2	3	4	5
Working with robotics increased my interest in STEM	0	0	5%	25%	70%
I liked the flexibility of working online which allowed me to work around my schedule	0	10%	15%	25%	50%
Working with college student mentor helped me with the project	0	5%	15%	25%	55%
Working with my mentor inspired me to go to college	0	5%	20%	15%	60%

After the online competition, several participating middle school students and their mentors (who are female undergraduate students) were interviewed regarding their experience in this COVERAGE project. Almost all the people who were interviewed concur that the mentorship is mutually beneficial, although the mentorship occurred online rather than in person. The middle school students felt inspired and encouraged by their mentors, and meanwhile, the mentors felt that their efforts on supporting younger students are appreciated. Some comments collected from the interviews are cited below.

Below are some comments from the participating middle school students.

- *So the robot may hesitate a little bit, but when I ran it through, it picked up about thirty kg. I'll keep working on the robot but I will turn this one in just in case my mom decides to pick me up as well from school. Thank you for giving me this amazing opportunity and not giving up on letting me in! I will keep coding through the website and come up with different cycles of code! Once again, thank you for the opportunity! I've never done anything like this and it really means a lot!*
- *With dance, school, homework, and around-the-house chores, I felt like I wasn't gonna be able to join any kind of program outside of my busy schedule. I felt like whatever I was gonna be able to would only be dance-related. This program has proved me wrong and I*

would love to do another program like this. It has shown me that you don't have to be available seven days a week just to code something great. I didn't think that this program would be anything like this and it stunned me! With the virus going on, I thought to myself, "Man, is this really worth it?" And by surprise, it was!

- *I had a lot of fun, and I really enjoyed meeting new friends and learning new things. It felt nice to work hard and win.*
- *The programming was very interesting, and I enjoyed socializing with other people, and learning new coding to program the robot. The competition was kind of worrying, and, of course, I was nervous, however we won after that programming experience, and I am very excited and happy about it!*
- *Before doing the Robotics competition I had never really considered doing coding before, when I heard about the program I figured I'd give it a try. Coding turned out to be SO MUCH FUN, and it's an experience I never would have even thought to have tried had it not been for this opportunity. The competition was especially fun, and I got to see what it would be like to try different techniques and code as a job. I'm so proud that our team placed first because we all tried really hard. I'm so thankful for this experience!*
- *I enjoyed coding and learning how to code, I'm so happy I won second place. I've had a lot of fun competing with the other players.*

Below are some comments from the mentors.

- *As an engineer myself, I know the struggle women have to go through to succeed in this male-dominated field. From people not considering you smart enough, to your fellow classmates not including you in conversations because they are not talking about a "girly" topic that might interest you. This is why when I was given the chance to try to motivate Middle School girls to study STEM-related majors, I felt that I could be useful. And honestly, I liked this experience much more than I imagined: I found a group of promising students who have been willing to work for themselves, to prove that they are more than worth it; sacrificing their free time and showing me how smart and capable they are. They have considerably improved their knowledge about coding, and some of them have even mentioned wanting to work on this program even after the lectures are done. It has been an honor to form part of this program, and besides what I have been able to teach them, I have also learned a lot from this experience, so I am really grateful.*
- *Mentoring these girls was refreshing as I am used to working with men in my classes. It was inspiring to see so many girls that were interested in technology and might develop a passion for it. One girl researched my major in computer engineering and wanted to study it herself. I found myself wanting these girls to become successful and I am glad to know many of them will be.*
- *Before the program I was a little worried about how the students would like the program and with me helping them. Instead of them being shy and uninterested, they were excited and open to asking questions! They made the program really fun as I was able to watch them have unique ways of solving problems and collaborate with each other. I am honestly jealous that they get to participate in these activities! I never had any opportunities like this in*

middle or high school! I also think that their interest in STEM will carry over into high school as they were very interested in what coding looked like at a higher level.

Conclusions

The COVERAGE project is designed to increase female West Virginia middle school students' interest in Computer Science and STEM. As the original plan of the COVERAGE project, Girls Robotics Clubs would be organized in three counties of West Virginia to prepare female middle school students for a regional robotics competition at the end of 2020. Due to the Covid-19 pandemic, almost all the activities had to be changed to an online platform over which the participating students program robots virtually. In Fall 2020 and Spring 2021, online instructions were offered every week via Microsoft Teams, intending to guide the participating middle school students to program virtual robots. In addition to online instructions, at least one hour was designated every week for the mentors (who are female undergraduate students) to work with the participating middle school students on the online assignments under the supervision of middle school teachers. An online competition was held on March 10, 2021 among nine teams of female middle school students. Although "online" is definitely not the optimal means for robotics activities, our survey results indicate that the project is well received by the participating middle school students. Particularly, the participating middle school students appreciate the opportunities of working closely with female undergraduate students.

Acknowledgment

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References

[1] vr.vex.com
[2] www.ncwit.org/resources
[3] www.ll.mit.edu/outreach/first-lego-league
[4] www.utep.edu/engineering/academic-programs/k12-outreach/robotics.html
[5] ceeo.tufts.edu/outreach/workshopsKids.htm
[6] www.cpcc.edu/stars/projects-1/lego-robotics-outreach-program