Robotics-Based Creative Expression for Middle/High School Female Students

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Introduction

Innovation in computing require talents from diverse backgrounds. Given the lack of female participation in computer science, we propose to integrate artistic practice, such as choreography design and video production, into educational Robotics. Our goal is to create computing experience that can relate to and engage female students, and to encourage them to use computer science as a tool for self-expression.

Problem and Motivation

In [1], researchers try to answer the question of why so few women participate in the field of science and engineering. According to their study, there exists a strong implicit association of male with science and female with arts. This inspires us to consider integrating artistic practice into computer science education as a way to attract female students into computer science. Given the success of educational Robotics, we asked ourselves a question: can we introduce artistic practice into robotics and teach young girls to use the combination of the two to express themselves? We find a micro:bit- based [2] robot [3] that can perform various body movements. The research questions are:
1) Does this method increase girls' interest in computer science?
2) Does this method help them learn basic computer science concepts in an effective way?

Our Approach

Figure 1:A screenshot from a short film created by a student group: two robots perform synchronized dance on a stage

We created a three-day teaching curriculum for middle/high school students and visited four schools in February and March 2020. These visits mostly are 1 to 1.5 hour after-school sessions, but there was also one school that offered us three one-hour time periods in the morning.

- Day 1: covered basic programming statements to create robot motions, introduced communications between two robots and touched upon if-else statements.
- Day 2: reviewed if- else and taught loops. Then we asked students to team up to program their robots to explore a maze.
- Day 3: reinforce the concept of loops and taught the students how to control each joint of the robot so that they can design and implement choreography. Then we let students team up, decorate their robots and choose a stage design, and then have each team program their robots and create a short film to show an idea or conduct a performance.

Our Approach (cont'd)

In February and March 2020, we visited four schools including two middle schools and two high schools.

- School A has a Hispanic student population of 83%,
- School B has a Black student population of 54%,
- School C and D have a White student population of about 60% each.

There were some challenges we faced during the outreach programs.

- Unable to complete all outreach programs due to surge of COVID-19 in March 2020.
- Data impacted by cancellation of outreach programs

We gave students a pre-teaching and a post- teaching survey. We collected 23 complete sets of pre- and post-teaching surveys, from 10 males and 13 females. These survey questions fall into three categories: demographic questions, questions about whether a student understands basic programming concepts, such as variables, if-else and loops, and questions about their interest in computer science and perception about programming.

Figure 2:Two robot buddies exploring the maze

Figure 3:Two programmed robots interacting with each other.

Results

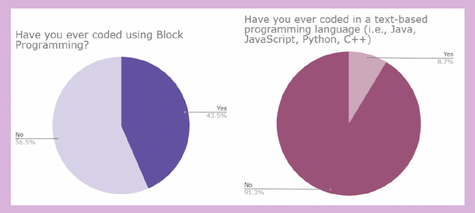


Figure 4:students' previous programming experience.

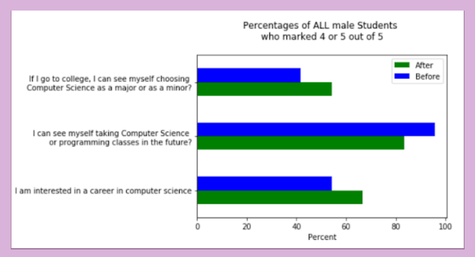


Figure 5:percentage of all **male** students who marked 4 or 5 out of 5 for questions related to their interest in CS courses/majors/careers

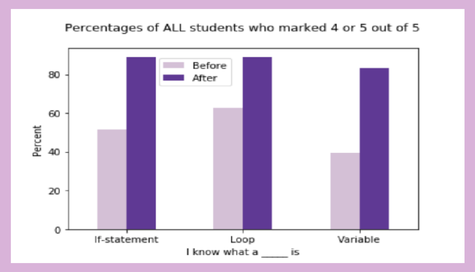


Figure 6:percentage of all students who marked 4 or 5 out of 5 for questions related to their understanding of basic programming concepts.

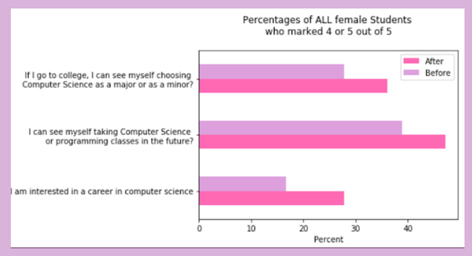


Figure 7:percentage of all **female** students who marked 4 or 5 out of 5 for questions related to their interest in CS courses/majors/careers

- Figure 4 shows students' previous experience with block programming as well as text-based programming.
- Figure 5 below shows that, after the teaching sessions, students demonstrate a significant increase in their understanding of basic programming concepts.
- Figure 6 and 7 show that, before the teaching sessions, male students show a stronger interest in a career in CS and in taking a CS/programming course in the future. But after the sessions, the female students show a more significant increase of interests in all three areas, taking a CS/programming course in the future (21.6% vs. -13%), choosing a CS major/minor in college (30% vs. 24%) and a career in CS (66.5% vs. 23%). These graphs show that the curriculum that we designed and implemented increases female middle/high school students' interest in CS and effectively taught them basic concepts of programming.

We also asked students to write down five words best describing programming before and after the teaching sessions. Table 1 shows the results. It shows a positive change of female students' attitude toward programming.

Results(cont'd)

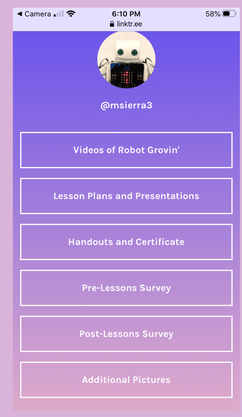
WordBefore	Frequency	WordAfter	Frequency
fun	11	fun	11
interesting	6	interesting	5
hard	4	exciting	4
boring	4	entertaining	4
confusing	3	amazing	3

Table 1:top 5 words that **female** student used to describe programming before and after teaching sessions

Conclusion

- We created a 3-day after-school curriculum based on the integration of artistic practice and robotics and applied it in four different schools, two of which have very diverse student populations. We have shared the teaching materials online.
- Our study shows that our method increases middle/high school female students' interest in computer science and leads to a positive change of female students' attitude toward programming and perception about a future career in computer science.

Figure 8:Scan QR Code for shared materials



References

[1] Catherine Hill, Andresse St. Rose, and Christianne Corbett. *Why So Few? Women in Science, Technology, Engineering, and Mathematics.*

[2] https://microbit.org/.

[3] https://plen.jp.

[4] National science board (2010). science and engineering indicators 2010 (nsb 10-01). arlington, va: National science foundation.

[5] Gahgene Gweon, Jane Ngai, and Jenica Rangos. Exposing middle school girls to programming via creative tools. *Human-Computer Interaction - INTERACT 2005 Lecture Notes in Computer Science*, page 431–442, 2005.

[6] Amanda Sullivan and Marina Umashi Bers. Vex robotics competitions: Gender differences in student attitudes and experiences. *Journal of Information Technology Education: Research*, 18:097–112, 2019.