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# Board 243: CS Frontiers: Module 4—A Software Engineering Curriculum for High School Females

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# CS Frontiers: Module 4 - A Software Engineering Curriculum for High School Females


## Abstract

Computer Science (CS) Frontiers is a 4-module curriculum, 9 weeks each, designed to bring the frontiers of computing to high school girls for exploration and development. Our prior work has showcased the work in developing and piloting our first three modules, Distributed Computing, Artificial Intelligence (AI), and the Internet of Things (IoT). During the summer of 2022, we piloted the completed curricula, including the new Software Engineering module, with 56 high school camp attendees. This poster reports on the newly developed software engineering module, the experiences of 7 teachers and 11 students using the module, and our plans for improving this module prior to its release in formal high school classrooms. Initial survey and interview data indicate that teachers became comfortable with facilitating the open-endedness of the final projects and that students appreciated the connections to socially relevant topics and the ability of their projects to help with real-world problems such as flood prevention and wheelchair accessibility. The CS Frontiers curriculum has been added to course offerings in Tennessee and adoption through the North Carolina Department of Public Instruction is currently underway. Teachers from Tennessee, North Carolina, Massachusetts, and New York have piloted the materials. Together with researchers, we are working to package the course and curricula for widespread adoption as additional support to students as they try out computing courses in their high school pathways. Our aim is to increase the interest and career awareness of CS for high school girls so they may have an equitable footing to choose CS as a potential major or career.


## Introduction

After previously piloting three innovative computer science modules developed specifically for high school audiences, we drew from our prior findings to develop and implement the fourth module, Software Engineering (SE) [1] [2]. For our module design framework, we used project-based learning and expansive framing in order to situate software engineering in a meaningful context for the desired audience [3] [4] [5] .

## Module Description

The SE module challenges students to address a local or community problem. The module follows an entrepreneurship approach, modeled after the successful Engineering Projects in Community Service (EPICS) engineering design process, where students research an issue in their own community and design a program to help people solve it [6]. Through these activities, students learn many valuable lessons including the role of community service in society, the significant impact that their engineering skills can have on their community, and that assisting others leads to their own substantial growth. The module teaches design, planning, code versioning, collaboration, and aspects of human-computer interaction (HCI) and usability. The final product serves as a capstone project for the course. Industry volunteers and local relevant stakeholders are recruited to serve as role models, to share about their work and experiences through informative presentations and/or provide feedback during periodic whole-group showcases.

## Pilot Study

*Teacher Professional Development*

During the four-day teacher professional development (PD), we reviewed the curriculum materials and online format used for the camp. Teachers then worked in groups using the Teach Learn Observe (TLO) method to prepare to lead the different camps. Each group of teachers led another group in a lesson related to the camp they were scheduled to lead. Six teachers facilitated at least one section of the AI or IoT, and all seven teachers facilitated a SE camp. Participant demographics for the teacher professional development are shown in Table 1.

Table 1. Participant demographics from teacher professional development

| Race / Ethnicity | | African American/Hispanic | Caucasian/South Asian | **Total** |
|---|---|---|---|---|
| Week 1 | Male | 1 | 1 | **2** |
| | Female | 2 | 3 | **5** |
| **Total** | | **3** | **4** | **7** |

*Summer Camps*

Since we decided to embed software engineering within the contexts of our other two modules, the design of the SE summer camp was based on the prerequisite IoT or AI summer camps, resulting in a two-week program for our summer campers. The camps were hosted virtually over the summer and taught by our CSF teachers previously trained in the module during the professional development. Demographics for the high school student campers who participated in the final week for the software engineering module are listed in Table 2 below.

Table 2. Camper demographics for each week of the software engineering camp.

| Race / Ethnicity | | Southeast Asian/Indian | East Asian/Pacific Islander/Asian Other | **Total** |
|---|---|---|---|---|
| Week 1 | Male | 2 | - | **2** |
| Week 2 | Male | 5 | 1 | **6** |
| | Female | 1 | 1 | **2** |
| **Total** | | **8** | **2** | **10** |

## Results and Discussion

*student artifacts*

Figure 1 (left) shows the start screen of a flood awareness app a student developed during the SE camp. The purpose of this app is to notify users of the possibility of flooding in their area. First, the user inputs a city name into the text box at the bottom of the screen. Next the user asks if the user has grass or a black top surrounding their home. Finally, the program tells the user of the chances of their area being flooded, what can cause flooding in their area, and where the most recent flooding has occurred. Figure 1 (right), is the simulation screen of a remote control wheelchair app a group of students developed during the camp. The purpose of this app is to

allow wheelchair users to control their movements in a simulated space on their electronic devices. First, users would connect the program to an app on their electronic device. Next, they would move to where they wanted to go in the simulation space. Then, their wheelchair would move to that location.

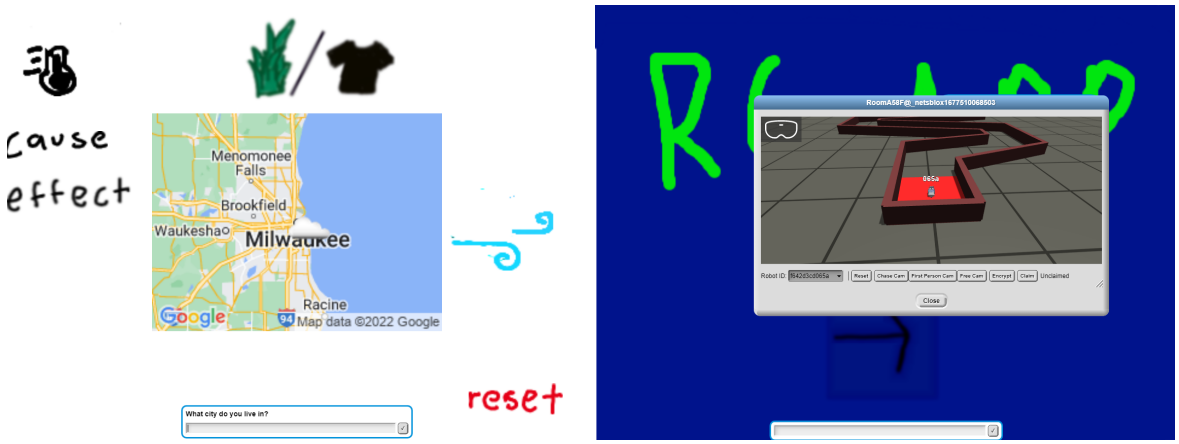


Figure 1. Example student artifacts created during the software engineering camp.

*Survey Results*

On the last day of camp students completed a survey about their camp experiences and if they would like to continue learning about different methods to help their community [2]. The questions in the survey were both Likert value and open-ended questions. Likert value questions were on a five point scale, with five being the highest possible agreement. In Table 3, we show the percentage of students that agreed with selected questions from this survey. For both Q1 and Q2, all students selected either "Strongly Agree" or "Agree", suggesting that students' perceptions about the use of programming changed during the camp and they enjoyed learning about software engineering. These responses also indicate that all students are interested in continuing to learn how to use software engineering to solve problems in their communities, one of the main goals of our curriculum.

Table 3. Student agreement from post-survey

| Question | Agreement | Strongly Agree | Agree |
|---|---|---|---|
| Q1 This camp expanded my views regarding how we can use programming | 100% | 9 | 1 |
| Q.2 I would like to learn more about or use ideas that I have learned in this camp | 100% | 8 | 2 |

*Student Feedback*

At the end of the survey mentioned previously, students were asked "What other feedback, comments, or suggestions do you have after your experience with the CS Frontiers Camp?" Overall, the responses were positive except for one student who responded: "*I'd just like a little more time to work on things.*" There was limited time each day to work on activities because the

camp was only a week long. We believe in a full classroom implementation of the course this would not be a large issue since students would have more time overall to work on activities. The positive feedback discussed students enjoying the camp activities and learning more about programming. One student commented: "*I had a good experience with CS Frontier Camp and the camp also helped me improve my coding skills."* Another said: *"... the camp was exciting and each minute we [were always] doing something fun or engaging."* One of the female participants said: *"I really enjoyed this camp and it was a great learning opportunity."* This comment gives us insight into how girls may feel about the materials. In summary, the students enjoyed their experiences during the camp and enjoyed themselves. This is especially crucial when engaging young women in computing, another goal of this curriculum.

*Teacher Feedback*

At the end of each camp day, teachers completed a survey about their general observations of students interacting with the material. Overall, the feedback was spirited and also gave us insight into teachers' perceptions of the SE module. Two teachers discussed student behavior while working in groups, saying, "Students worked well together. [The communication] was excellent. Everyone was engaged and excited" and "The students really jumped in and did a great job working together." One teacher shared a fear they had about the camp, "I was worried about how to manage the scrum/sprint model since I've never done it, but it made a lot of sense when we started to do it with the students, so tackling my fear of working that way was a success." Based on teacher feedback, we believe that students engaged with the SE concepts taught throughout the camp and wanted to continue creating and improving their projects.

## Conclusion and Future Work

In summer 2022, we piloted the final module of our CS Frontiers curriculum, software engineering, in a series of virtual summer camp opportunities. Our program was successful in its goal to appeal to our female participants and all participants were able to create community-based projects on topics that were relevant and meaningful to them. Our curriculum is currently being implemented in Tennessee as an elective high school course and is in the pipeline to be implemented in North Carolina classrooms. In the meantime, we are offering professional development webinars throughout spring 2023, to help teach more educators about our curriculum in an attempt to achieve wider adoption of CS Frontiers.

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