

Engagement in Practice:CodeIT Day - Creating a One Day Experience to Increase Diversity Among Youth Interested in STEM

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Background

Computer science and other STEM related fields continue to expand and grow as society becomes more and more technologically advanced. The Bureau of Labor Statistics suggests that employment in computer occupations alone is expected to increase 12.5 % from 2014 to 2024; that is an estimation of 500,000 new jobs¹. The Bureau also reported that 99% of STEM employment in all occupation types required a post-secondary degree. It is important that students are exposed and introduced to STEM content early on in the educational "pipeline" to ensure that they are interested in pursuing STEM-related degrees at the collegiate level. It is important to note that while STEM exposure early on in the pipeline is important, it does not ensure that all students, in particular underrepresented minorities, will end up in a STEM related field. It is essential to take into account sociocultural factors that might affect and alter the journey through the pipeline for minority students²; some of these factors might include unequal access to STEM opportunities and classes, as well as the White male stereotypical depiction of scientists and engineers. This was a large part of the motivation behind the original CodeIT Day. CodeIT Day was initially established by the Human Centered Computing (HCC) Lab at Clemson University in South Carolina in April 2013 as a means to combat the inaccurate portrayal of computer scientists and engineers as well as offer an opportunity to insert middle and high school students into the STEM pipeline. CodeIT Day is a one day interactive hands on experience in which students explore different computer science concepts via a host of different technologies, led by a team of multi-racial, male and female, undergraduate and graduate volunteers who are currently pursuing degrees in computer science and related areas. Clemson's CodeIT Day initially started as a 10 hour+ daylong workshop with students arriving as early as 7:30 am for breakfast and check-in and concluding around 6:00 pm with live demonstrations and presentations and refreshments.

Five years later CodeIT Day has moved to the University of Florida along with the former HCC Lab; which is now named the Human Experience Research (HXR) Lab. The purpose and structure of CodeIT Day is still very much the same; the main goal is to help increase the pipeline of middle school kids interested in STEM disciplines by increasing their exposure to STEM via the introduction of computer science concepts and persons already involved in the STEM field. Changes, such as a shortened length of the workshop day to better accommodate families, have been implemented, but CodeIT Day still aims to showcase and encourage the introducing, diversifying and retaining of students in STEM fields. In the past, CodeIT Day did not involve an

evaluation portion but now that the event is back with hopes to grow, we have implemented data collection to better evaluate the program. This paper will discuss the 2018 implementation of CodeIT Day, hosted by students at the University of Florida; some of which were apart of the original cohort who took part in CodeIT Day instances at Clemson University. It will discuss the new technology utilized, lesson plans, participant recruitment, the workshop structure as well as results from surveys and participant focus groups. The paper will conclude with lessons learned from the workshop and future plans with the CodeIT Day model.

Project Design and Execution

The planning of CodeIT Day 2018 followed a similar structure as previous CodeIT Days. The planning committee got together to set a date, create the student applications and create a recruitment plan for students and volunteers. During this process, a team member was also working on the curriculum for students.

Recruitment

Although students of all backgrounds are welcomed to apply and are accepted to the workshop, due to the lack of underrepresented minorities in the STEM fields, it has always been a mission of CodeIT Day to intentionally recruit students of color and female students of the targeted grade level(s) each year. CodeIT Day 2018 was geared specifically for fifth and sixth grade students. In an effort to garner interest from students in the area, emails and flyers were sent to principals and counselors at local middle schools, the university-affiliated K-12 school and to other organizations that had partnerships with those in charge of organizing the workshop. One such partnership was with an area predominantly African American charter school for grades K-6. Another partnership that was used to recruit participants was a local community center located in the eastern part of Gainesville, which had a minority rich population. Through these recruitment efforts, we were able to recruit 16 participants for CodeIT Day 2018. The target number of participants was 20, however we only received 18 applications and 2 students did not show up the day of the event. The group consisted of 11 fifth graders and 5 sixth graders. 37.5% of the participants were girls and most identified as Black/African-American (31.25%) or White (31.25%).

Graduate and undergraduate students at the university were recruited by word of mouth as volunteers for CodeIT Day. All volunteers had some connection with the HXR Lab. The CodeIT Day team consisted of 13 faculty/staff, graduate and undergraduate volunteers. Most of the volunteers were female (84.62 %), graduate students (76.92%) and were Black or African American (76.92%). There were 2 main teachers who led the 2 classrooms and the other aids assisted in the classroom for additional support to students.

Lesson Plans and Technology

For CodeIT Day 2018, it was decided by the planning committee to continue with the paired programming approach used in previous years, in which two students work together when

programming; however it was decided to use this approach with a new piece of technology. The staff wanted to give students the ability to explore both hardware/engineering (through building) and programming during the workshop.

The technology utilized during this year's workshop were the Kano Computing kits which featured a tablet sized touch screen. The kits feature a Raspberry Pi 3 processing board, an HD screen, a rechargeable battery and keyboard, sound sensor, speaker, and a host of cables for students to assemble on their own, with the assistance of an easy to follow book and instructors. The Kano kits were appropriately balanced; it allowed students the challenge of constructing their kits, while also allotting enough time left over to spend learning how to code. Once assembled, students were able to work together in their pre-assigned pairs to follow along step by step with the content created by a CodeIT day team member.

The curriculum introduced the students to the different programming categories and parts that could be added (i.e. text and speaker) on Kano's integrated development environment, Kano World. The categories included events, control, logic, math, variables, color, lists and draw. Each of the nine categories and their sub-functions were introduced to the students individually and then were combined into several coding examples for students to follow along with. Throughout the curriculum, the pairs were given opportunities to test their knowledge of the coding concepts by altering, on their own, different aspects of the coding examples that had already been completed. After each of the nine categories were highlighted by the instructors and practiced by the students, the pairs were given the opportunity to either create their own program or complete one of four difficulty varying programs suggested by the instructors. The four programs gave objectives to complete and utilized several of the nine programming blocks taught throughout the lessons. An example of one program was the creation of a zoo. Students had to add five different stickers of animals that had to say their sound (i.e. "Buzz" for a bee), as well as populate the accompanying text when clicked on. The program also had to change the color background of the canvas based on if the animal lived on land, water, or the air. Some students were able to complete several of the programs and/or go beyond the given objectives before the allotted time for programming was over. At the completion of the day, students were given passwords to access their programs after they left CodeIT Day. Kano World is free and accessible on any browser and computing device.

Day of Agenda

CodeIT Day starts with check in and breakfast and ends with a final showcase that parents are also invited to attend. Once the students get an overview of what to expect for the day, they are then sent to their classrooms. The participant pairs are assigned and then the students split into two classrooms with one lead teacher and multiple aids in the room. The agenda consists of building the Kano (30 minutes), a two-part lesson plan to learn some basics of programming the Kano (an hour and a half before lunch and an hour after lunch) and time to work on their self selected projects for the showcase (about an hour). The two teachers are given the same set of slides and teaching directions to go through the curriculum provided. At the end of the day, the students present their projects at the showcase to each other and family members. They are also given certificates for participating and information on how to access their projects later. Lastly,

optional student focus groups are held to get more information about their experience.

Data Collection

In order to continue to improve CodeIT Day for the future, it was important for the team to formally collect data from the students. Parents and students had to consent and assent, respectively, and participants could still participate in CodeIT Day even if they did not participate in data collection. The data collection happened at the start and end of the day. When students arrived and checked in, their parents completed a demographic survey and the students completed a pre-survey. The pre-survey for students consisted of questions from a STEM attitudes survey targeted towards each grade level. The 5th graders were given the Upper Elementary School Student Attitudes toward STEM (S-STEM) Survey³, while the 6th graders were given The Middle/High School Student Attitudes toward STEM (S-STEM) survey⁴. The survey has a section on Math, Science, Engineering/Technology and 21st Century skills that have statements on a Likert scale ranging from "Strongly Disagree" to "Strongly Agree," to obtain students' opinions of, and performance in, these categories. There is also a section titled "Your Future" to evaluate the students' interest in certain subject areas related to STEM. The only difference between the surveys was that the Middle/High School survey also asked 2 additional questions about advanced classes and college plans. When filling out the pre-survey, we noticed students were getting restless because the survey contained approximately 50 questions, with most statements repeated for each different category. Students would talk to each other, shift in their chairs and ask unrelated questions. Although the surveys were geared towards this age group we realized that in the context of the day the full survey was too long. Due to this and the focus of CodeIT Day being geared towards technology, we asked students to complete the Engineering/Technology section and the questions related to Engineering/Technology in the "Your Future" section. We hoped this would cut down the survey time and allow them to focus on their feelings towards technology and engineering as that is what CodeIT Day hopes to improve.

The goal of the pre and post surveys were to see if/how students' attitudes towards STEM, on a high level, changed after participating in CodeIT Day. However, it was extremely important for us to not only look at impact, but also engagement. Researchers observed students throughout CodeIT Day and the day ended with a focus group with students who decided to participate. This data helped to inform the team on engagement levels the students had and how to improve the structure of the overall program.

The survey results suggest that participants attitudes toward STEM did not change much at all; however, most students already started with a positive attitude towards STEM. On the pre-test, 91.67% of fifth graders and 75% of sixth graders said they were interested in Computer Science. On the post-test, 100% of those students who answered said they were interested in the subject. The following statements had improved responses for both grades from pre-test to post-test: "If I learn engineering, then I can improve things that people use every day," "I am interested in what makes machines work," and "I am curious about how electronics work." One statement, "I am good at building and fixing things," had a decline in positive responses in the post-test, which could be due to frustration experienced while physically putting the Kano Kit together.

There were a total of 9 students who were able to participate in the focus group. The students were divided into two different rooms to keep the group numbers small. The interviewers in each room asked the same questions to the students. Some of the questions asked were: "What did you enjoy the most/least about the CodeIT Day program?", "After attending CodeIT day, do you think you would like to work in computer science in the future?", "Did the workshop change your idea of who could be a computer scientist?" etc. Overall, students were very positive about CodeIT Day. When asked if they would tell friends to participate in CodeIT Day, every student said yes. Some of the favorite parts of CodeIT Day that were mentioned were making the computer (this was mentioned by majority of participants) and writing their own code. Two participants also mentioned that they liked working with a partner and that it helped them. Some things students pointed out not liking were due to technical difficulties, such as WiFi connectivity and pages not loading. There were also issues with the speed of teaching and frustrations with debugging.

Lessons Learned

While debriefing from CodeIT Day, the research team was able to identify what went well and what could be improved on. One observation we made was the difference in teaching styles and how the students felt about each style. Although our two instructors had the same slide deck with step by step instructions, their personal teaching styles were different which caused the classroom environments and progress to be different. Classroom A moved at a pace that seemed to work well for the students and check in with students happened frequently to make sure they were understanding what was going on and successfully completing the tasks. Also in Classroom A the lead teacher was not the only one leading the class; aids would also pitch in with instructions and guidance. Classroom B was presented information at a much faster pace. Students in the focus groups noted the instructor talked fast, so students in that room were getting lost more frequently and relied heavily on the classroom aids to help them one on one. Classroom B had one extra pair of students so all aids couldn't help everyone at the same time. We also noticed that Classroom B was louder than Classroom A as so many different side conversations were going on. Both classrooms were able to complete the given tasks, only one group struggled to finish their final project in time for the showcase. Another issue to improve on is recruitment. We want CodeIT Day to be a chance for those who may not have previously been exposed to computer science to have a chance to not only give it a try, but to also see a diverse set of people who are computer scientists in hopes of changing any preconceptions. This target group was difficult to get this year. We had quite a few students who had programmed before, using Lego Mindstorm kits or even Java text programming. With a mixed group like this, we were worried about those without experience being intimidated and those with experience getting bored. We think it may be better to ask for details about students experience with programming on the application. That would help us to at least improve how we pair students and give priority to applicants who do not have experience at all. This is also part of the reason why the Kano Kits were used; we needed a newer technology that students would be less likely to have had experience with. Even with the varying programming experience, the Kano Kits seemed to work well for all the students. Finally, we saw that the showcase was very beneficial for the students. They got excited about being able to create a project of their choice and that seemed to motivate them to accomplish something by the end of the day. They were also excited to get to show their parents what they worked on. This is a good

motivating factor for students and it seemed to give our students a sense of accomplishment.

Conclusion and Next Steps

CodeIT Day has shown to be a positive experience for engaging students with computer science (and some engineering). The new technology chosen, the Kano Kit, seemed to be a good choice for these students. The day also taught us valuable lessons that will help us to continue to improve CodeIT Day for further gains in the pipeline. Although most students enjoyed themselves, the two classrooms had very different experiences so we would like to control for that better in the future. Varying experience with programming made it even more necessary to have aids in the room to be able to give more personalized help. Also, to better understand the knowledge impact being made by CodeIT Day, in the future, we will assess the program differently, focusing on direct feelings and learning gains not just general STEM attitudes.

CodeIT Day is now a part of a larger program called CASE (Computing and Society Engagement) which seeks to promote technology-based innovation and entrepreneurship amongst underrepresented communities. As a part of CASE, CodeIT Day will be expanding and will be hosted in other cities in the state. CodeIT Day has always been in the same city of the research lab so this expansion is a completely new endeavor. The team has created a manual that details how to run CodeIT Day from early planning and recruitment to the day of and final debrief. The team is also working to plan for the logistical change, taking into consideration the value of community partnerships to help with recruitment and understanding the needs of students in that area as well as getting volunteers. The idea is that the general framework for CodeIT Day will be maintained and executed with partners in the new cities, while the actual event will use volunteers from the original research lab. While the event is being held in other cities, there are no plans to greatly expand the number of student participants for the event due to logistics based on equipment, space and volunteer capacity. CodeIT Day has been making a positive impact so far and we hope to continue those efforts. Although a one day program may not change a student's dream of what they want to be, we hope that CodeIT Day helps students consider technology and/or engineering as a possibility.

References

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