Dance-A-Bit: Integrating Dance with Teaching Algorithmic Thinking

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Abstract

Science, technology, engineering and mathematics (STEM) has been the foundation for many years for teaching critical thinking and problem-solving skills. The U.S. Department of Education website includes information about the importance of STEM in an increasingly complex world and the importance of all youth to have problem solving skills. Many researchers and practitioners propose moving from using the acronym STEM to science, technology, engineering, arts, and mathematics (STEAM). The difference in STEM and STEAM is the inclusion of arts of any kind, aligning artistic creativity with STEM learning. Zimmerman and Sprung concluded that motivation and self-confidence in computing for females is increased when they can learn CS in the context of a content area, they are already comfortable with [1].

Recognizing this cross-disciplinary connection approach, Mississippi State University researchers in 2014 integrated a physical art component module that enabled girls to design robots using crafting material, with positive results. In 2019, the team piloted a 4-day camp that integrated learning dance moves with algorithmic thinking and computer programming. This paper will discuss the results of that camp that was offered in a very small rural town in a southern state in the United States, and how the arts component influenced the learners' perception of computing.

Introduction

Science, Technology, Engineering, Art and Mathematics (STEAM) has been defined as interdisciplinary education that includes the arts with Science, Technology, Engineering and Mathematics (STEM) in ways to promote creativity and reflection [5]. With younger citizens in the United States using online computers more than ever before, and research indicating that the high school years is likely too late to influence perceptions and self-efficacy in computing as a career path, it is imperative that we engage participants early in life [6]. By engaging participants in computer science at an early age, we can promote the development of self-efficacy in computing before adolescent opinions are formed that may discourage girls from seeking curricular or co-curricular experiences in computing [7]. A study by the National Girls Collaborative Project states that although women earn 57.3% of bachelor degrees in all fields in 2013 and 50.3% of science and engineering bachelor degrees, only about 17.9% of women receive these degrees in computer science [8].

To engage diverse populations in computing, we need to better understand how to support participants in navigating conflicts between identities with computing and their personal interest and values [9]. One way to do this is to incorporate non-computing content to bridge the gap between computer science and other content areas in which learners may already have self-efficacy and self-confidence. In general, dance has seen little attention in STEAM education efforts, however, dance is a promising domain because it has the affordances of improving creativity and problem-solving, engaging the participants in abstract thinking, and giving the participants an embodied mode of expression [10]. Dance also provides an opportunity for

cultural relevancy, in that girls may bring the expression of dance from their family and community traditions into the learning environment. To create an artistic product, whether a drawing or a choreographed dance, creativity and innovation are necessary skills, not unlike skills needed by computer scientists and engineers. To innovate the technical solutions of tomorrow, we need a diverse set of imaginations and creative, entrepreneurial thinking.

Background

Other outreach programs have integrated art with computing. Art2STEM emphasized design and creativity as an introduction to opportunities in STEM. Facilitators sought to leverage the interest and skills in creative arts among learners and show how that can be applied to STEM [14]. In The Arts & Bots robotics program at Carnegie Melon tied creative art to the creation of a robotic model of an historical figure [15]. In 2014, Bulldog Bytes, with collaboration of faculty in the computer science, art, and English departments, begin designed an interdisciplinary project-based computing curriculum that uses Hummingbird Robot Kits to bring merge creative art and expression through writing with engineering design [16]. With the Hummingbird kits used in a gender-specific informal learning activities, learners use art and other supplies to create the 'shell' for a robot that they later program.

The Bulldog Bytes summer camp program at Mississippi State University is an important link in the MS Alliance for Women in Computing that places particular emphasis on increasing the number of women on computing pathways. Established in 2013 with funding from the National Center for Women and Information Technology (NCWIT), the program has reached more than 1000 K-12 students through day and residential camps and weekend workshops with informal computer science and cybersecurity learning to date. Day camps for elementary girls have been offered since 2015. The first author has worked as the Bulldog Bytes lead instructor since summer 2017 and has observed elementary aged learners needing more 'movement time.' To address this observation, and to seek more relevancy of computer science learning to under-represented groups, Mississippi State University sought to use the integration of learning dance to learning computer science concepts [13].

The NCWIT AspireIT program is designed for Aspirations in Computing (AiC) community members to 'reach back' and engage other girls with computing in fun, creative, and hands-on environments through a mini-grant program [2][3]. NCWIT awarded two AspireIT grants to Mississippi affiliate AiC awardees in 2019 for summer outreach programs. This paper will focus on the Dance-A-Bit camp for girls in grades 3-8 grade, that was held at the Mize Attendance Center in Mize MS. Mize Attendance Center is located in rural Mize MS. Fifty percent of students at the school are eligible for free and reduced lunch. Racial demographics of the school district are reported as: Asian: 1, Black: 107, Hispanic: 10, White: 660, Two or More Races: 5 [4].

The AspireIT Dance-A-Bit camp used dance moves to teach algorithmic design to learners. Participants applied the knowledge and experience gained from designing a dance to designing computer programs for mini Sphero robots. Through algorithmic thinking applied to learning and designing dance, participants are able to connect different movements to specific algorithmic functions such as loops and if/then statements. Coming up with a dance routine helped them learn computer programming basics while also tapping into their creativity. One example is the use of the loop, for the two steps they needed, instead of repeating the move three times they

changed it to only repeat twice on the handout paper as depicted in figure 1 in order to match the song lyric and rhythm of the music.

The Project

Although the camp was focused on dance and programming, cyber security was a key theme in the curriculum. Cyber security concepts that were discussed included online safety, email phishing, and encryption. Throughout the week participants learned cybersecurity principles that can be applied to any discipline. Five girls participated in the Dance-A-Bit activities. The camp met a total of 30 hours. Two of the girls were African-American and 3 were Caucasian. The grade levels ranged from 3rd to 5th grade.

Figure 1. Dance Move activity

Figure 2. Dance Move activity with participants

In order to teach participants algorithmic thinking and programming, we used a CS Unplugged [11] activity that incorporated algorithmic movements, as demonstrated in Figures 1 and 2. We covered a variety of programming concepts such as loops and if-then statements. We split the girls up into two groups to start, Group A had 3 members and Group B had 2. They were tasked with creating a dance and choosing a song of their choice. Group A decided to do Old Town Road by Lil Nas X featuring Billy Ray Cyrus. Participants in that group decided on the different steps and instructions needed for their dance based on the different functions and movement in the printouts. Each student in the group added their own "line" to the overall dance.

Participants were observed trying to figure out how to incorporate movements in an "if-then do" scenario as seen in Figure 1. They finally decided that if Student A takes three steps back and turns onto the stage steps, then Student B and C jumps down off the stage and spin and end with a hand movement. Group B did something similar, coming up with their own dance movements based on the CS unplugged activity. During this process both groups had to "debug" their dance plan a few times to make sure their dance fit the song as demonstrated in Figure 2.

Once both groups had mastered their own dances they then had to "switch" and learn the opposite groups dance. This idea was translated to software development in that sometimes computer programmers may have to work with code that was written by someone else. Each dancer played the role of 'code comment' and were asked to explain their dance movements to the other team in a clear and concise manner. The instructor observed participants from Group A having trouble with the step by step instructions for group B's dance. They thought it was complicated and that they could do the same exact dance but with fewer and easier steps. So with

Group A and Group B working together to simplify the steps to Group B's dance they were able to do the same dance originally created by Group B but in a more efficient way.

Once both groups learned each other dances, participants applied that same algorithmic thinking concept to drag-and-drop programming using the Sphero robots and the Sphero Edu app which was downloaded to tablets. The Sphero Edu platform uses app-enabled robots to foster creativity through discovery and play, all while laying the foundation for computer science. Participants had to pick a song and come up with a dance for that song using drag-and-drop programming to enable the Sphero to "dance" [12]. Once the song was picked participants then had to come up with a set of instructions in order for the robots to be synchronized with the lyrics of the song. They tested a few scenarios outside. Once they figured out the steps they then had to see how to run the program on each individual Sphero so the robots would not run into each other. Working together as a team, they solved the problem.

Figure 3 shows the participants finished code. At the end of the camp, participants showcased their dancing robots to their families.

Figure 3. Block programs created.

Students did not use the same song that they used for the CS unplugged algorithmic thinking activity. The code in figure 3 goes with the Cupid Shuffle by the artist Cupid. When asked how they enjoyed using dance to learn algorithmic thinking and programming one student said she enjoyed it because she loves to dance and be creative.

Summary

Usually when teaching algorithmic thinking, we talk about recipes and have them write their favorite recipe down and the steps to make it. An often-used example is defining the steps to make a peanut butter and jelly sandwich. By letting participants incorporate dance when teaching algorithmic thinking, participants were able to connect a familiar activity with the algorithmic process in a hands-on way that was fun. One student commented to the instructor that she loves to dance and to create and to see how dancing and programming could work together was great. This experience supported prior research by the authors that a hands-on, project-based learning approach in a computing camp strengthens teamwork and problem solving skills [13].

Future plans including offering this approach in other computing camps for elementary girls. Having a larger sample size will enable more data collection and assessment of the effectiveness of the approach. We would like to track participants to see if the experience resulted in them joining a STEM club in school or pursuing additional computing education in school. In 2020, we expect to offer one advanced computer science camps for elementary to middle school girls, and 4 day camps for elementary girls, in which we will implement and study this approach. Further, we want to develop a curriculum that can be easily used by others in similar informal or in formal learning environments to teach algorithmic thinking skills.

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