Dancing Computer: Concepts of Computer Literacy through Dance

MICHIGAN STATE UNIVERSITY

Matthew Rhodes, Noah Keppers, Madeline Levinson

Faculty Mentors: Dr. Charles Owen, Dr. Laura Dillon, Alison Dobbins

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Background

Dancing Computer is an offshoot of Theatre Engine: FlashMob - both Theatre Engine and Dancing Computer strive to bring an element of performance art into the world of computing and STEM (science, technology, engineering, mathematics) in general [3]. As computers permeate nearly every aspect of society, children need to understand how they work and the principles of programming. The Dancing Computer project aims to create a system to teach children basic programming concepts through dance.

By participating in Dancing Computer, children embody a computer, performing dances step by step. This helps build an understanding of not just the effects of the code they write, but of how a computer might execute that program. Forming more complete representations of how computers work rather than simple if-then relationships leads to a more in-depth understanding of programming [2].

The realization of the importance of computer science education for children has led to programming languages and environments such as Scratch and Alice, which simplify the process of learning to program. All of those tools are based on the concept of teaching children how to write code that a computer can understand. Both Alice and Scratch utilize a building block system that allows children to drag and drop commands to form a program that manipulates images on the screen. By using building block metaphors, both Alice and Scratch help children understand how to write simple computer code [1][4]. Dancing Computer proposes a tool that will, instead, first teach children to read. Much as children are taught to read before they are taught to write, the Dancing Computer team believes that understanding computational concepts will later make it easier for students to learn how to write code in the future.

Problem

The objective of the Dancing Computer project is to develop a system for teaching computer programming through dance with a reading first approach using STEAM (science, technology, engineering, art, mathematics) principles. The effects of this system on students' understanding of computer science principles will be analyzed through use of pre- and post-assessment of student ideas surrounding programming, as well as through evaluation of student performance during the Dancing Computer activity.

Ultimately, the goal of the project is to introduce programming to a wider and younger audience while creating interest in the Computer Science field. If children understand the concept of executing a program and can do so in a very real physical sense, they will be better able to understand the capabilities and limitations of computers and how they are integrated into systems. Additionally, teaching children to understand the basics of programming from a young age builds scaffolding for further instruction as they grow.

Works Cited

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[4] M. Resnick, J. Maloney, A. Monroy-Hernández, N. Rusk, E. Eastmond, K. Brennan, A. Millner, E. Rosenbaum, J. Silver, and B. Silverman, "Scratch: programming for all," *Communications of the ACM*, vol. 52, no. 11, pp. 60–67, 2009.

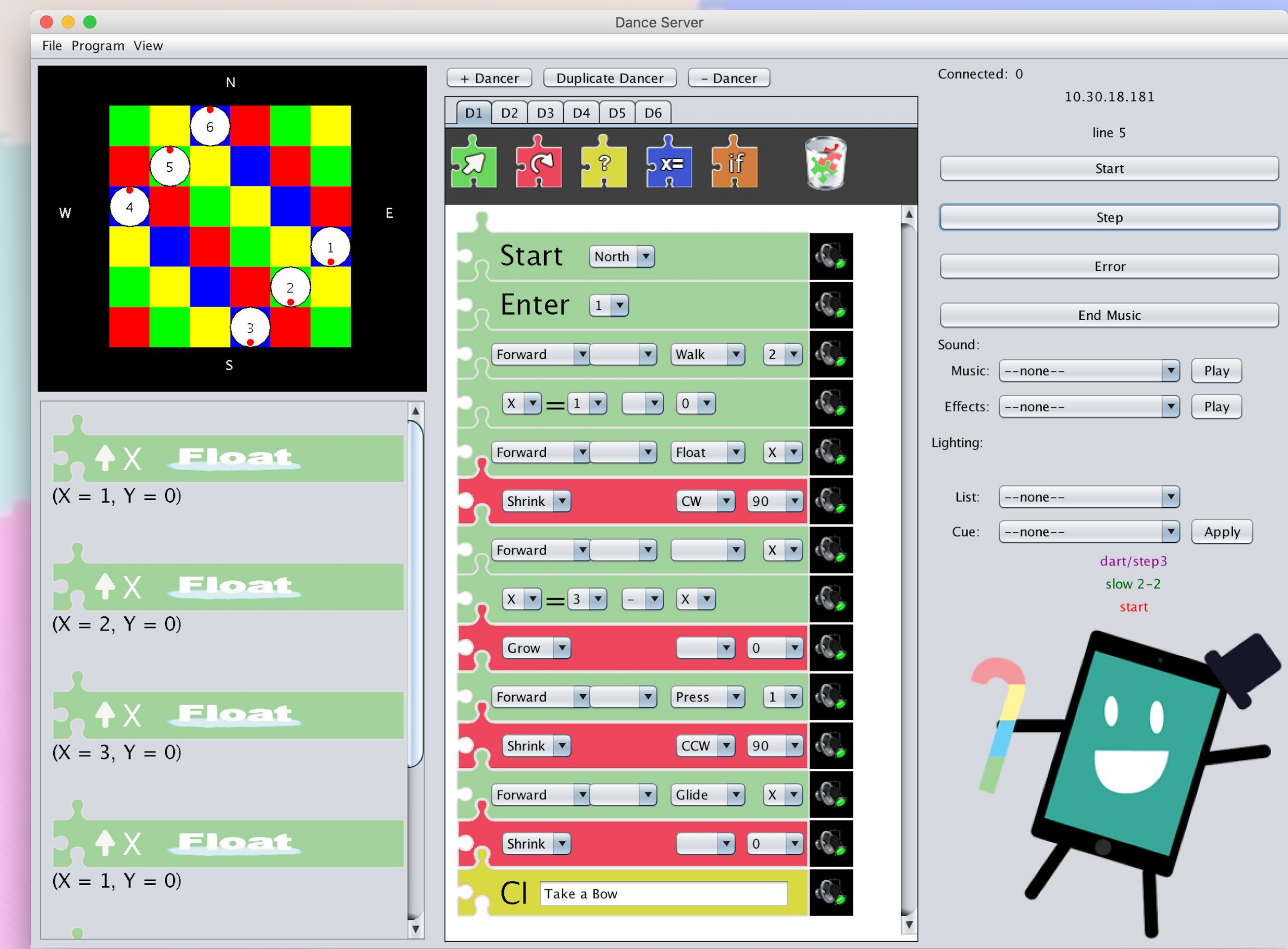

Figure 1

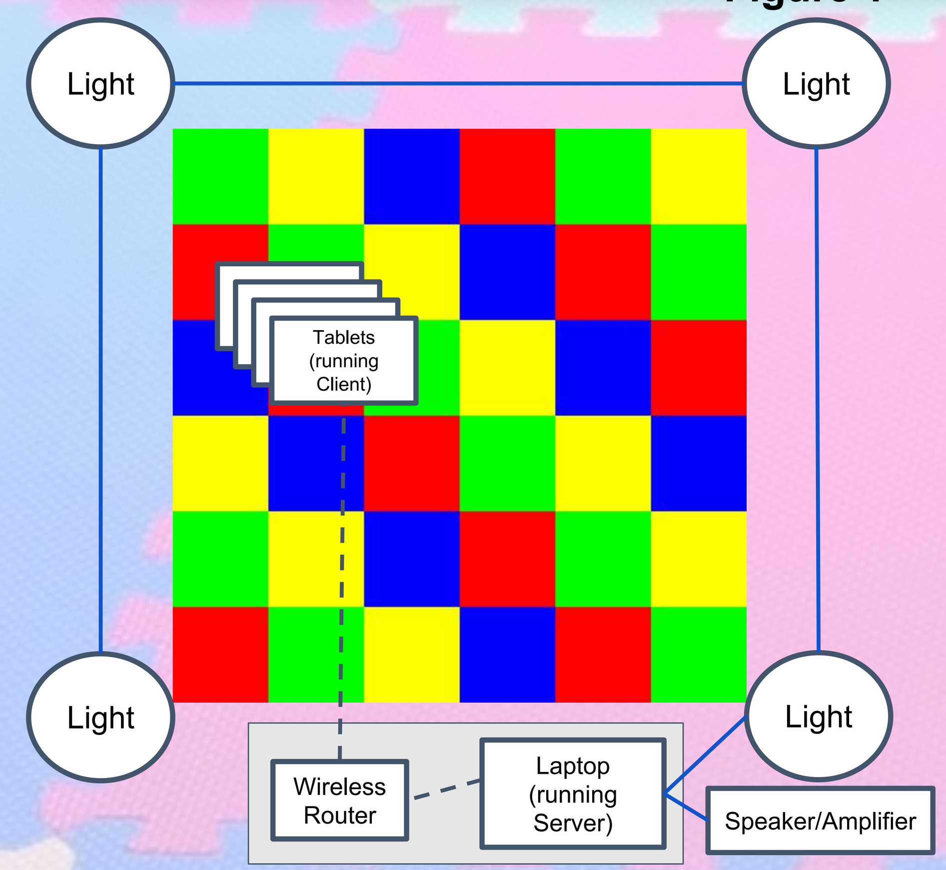

Figure 2

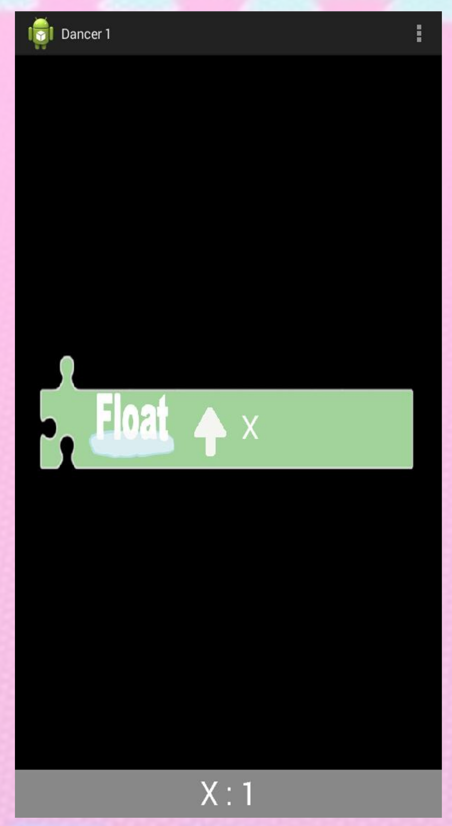

Figure 3

Design

Dancing Computer consists of two programs - a server (Figure 1), run from a single laptop computer, and a client (Figure 3), run from several Android tablets. Both the server and client were written from scratch for this project using the Java programming language. By communicating via a local WiFi network, a "program" made up of dance steps is sent to the clients by the server, causing dance steps to be displayed on the tablets. Each student follows the dance steps on a single tablet, executing the "program," or dance, on a gridded floor made up of interlocking foam tiles (Figure 2) - just like a computer might execute lines of code.

As the students dance, the server also controls lighting and sound cues which create a more immersive experience. No external sound or light boards are required - all music and lighting are handled internally by the server. Lighting output occurs through the DMX protocol: the server sends cues to four light bars through a DMX USB Pro interface. Sound output occurs through an amplifier connected to the server with a 3.5mm cable. Together, transitions in sound and lighting engage students while communicating changes in dance steps.

The Dancing Computer activity is divided into four stages: pre-assessment, instruction, dancing, and post-assessment. During pre-assessment, students' prior knowledge of programming is evaluated through a focus group discussion. At this time, students may also be asked to direct a dancer to perform a sample dance that has been demonstrated beforehand. Next, comes the instruction phase, where the basics of the dancing computer system (namely the meanings of the symbols and instructions shown on the tablets) are taught through a PowerPoint presentation. After instruction concludes, students are ready to dance. Students take turns stepping through dances - usually in groups of four, but sometimes in larger groups of six or eight as students progress. As students become more comfortable dancing, other more challenging computing concepts such as variables may be introduced. After all students have had the chance to do as many dances as time allows, the growth in students' programming abilities is assessed - usually through another focus group but when applicable a written survey where students write their own dances is used.

Results

The Dancer Computer project's target audience is students ages 8-10 in groups of about 20 students. However, the project has been presented to students of various ages in various group sizes and settings. Since spring 2016, Dancing Computer has been presented at 6 different locations to various school groups and summer camps, reaching about 250 students. Though not all data has been fully analyzed there are some trends in the data emerging already.

During the pre-assessment, when asked what a computer does, children responded with a variety of answers indicating general knowledge of how computers are used in their everyday life, but little understanding of programming. When asked what a computer program is, some students had some insight based on programming games that they had played, or because of a parent who had programming experience. Still, most students did not have a concrete answer that linked programming to a computer's actions, or indicated an understanding of programs as sets of instructions.

During the dancing process, students were shadowed by instructors from the Dancing Computer team one time, then asked to rely only on the instructions from their tablets to do the same dance again. The error rates almost always decreased during the second iteration of the dance. 32% of errors were related to orientation in the preliminary analysis, meaning the dancer turned at some point without direction from the tablet. Orientation errors indicate either a failure to understand how computers execute instructions ("A computer won't do anything it isn't told to do.") or environmental distractions (friends, outside sounds, etc). 52% of errors were related to movement in the preliminary analysis, meaning the dancer did not move the correct number of squares, or moved in the wrong direction. 16% of errors were related to rotation in the preliminary analysis, meaning the dancer rotated the wrong amount, or rotated in the wrong direction. Both movement and rotation errors usually indicated confusion about the tablet's instructions - students often were confused about how many degrees to rotate or which direction to move. As analysis of error data from Dancing Computer is not yet complete, further conclusions will be drawn in the future.

Post assessment revealed mixed results. When asked what computers did again, some students made the connection that computers rely on instructions from people, but other groups were less responsive. Additionally, some students were able to write their own dances, remembering and reproducing the Dancing Computer instructions fairly accurately. Other students, however, wrote instructions unrelated to those shown in the Dancing Computer activity (e.g. "kick line," "free style"). Again, the implications of these results are still being examined.