

TJHSST Computer Systems Lab Senior Research Project Computer Science for the Young Mind

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Abstract

Technology plays an integral role in today's society, yet there seems to be a limited effort to teach computer science at the elementary school level, which this project addresses. The purpose of this project is to implement computer programming to educate elementary school students in math and science. Students at Cardinal Forest Elementary School were thusly taught Scratch programming to serve as a basis for education in the field of computer science.

Keywords: Computer programming, elementary, math, science

1 Introduction

Our education system is constantly adapting to the evolution of technology. Progress is therefore important as to learning technology, especially concerning children.

Although there has been some progress in the past, there's still a lack of significant progress on a large enough scale to be considered noteworthy. The first attempt to educate elementary school students was with Logo, a programming language that used a turtle sprite to draw figures with a pen.

Soon, other programming languages followed, each one improving on the last. Still, computer programming education is a major issue in the world when it comes to students at the elementary school level.

Just how young is too young to start programming? The purpose of this project is to answer this question by advancing an already successful computer science program at Cardinal Forest Elementary School via Scratch, a programming language developed by MIT. (Gates, 2008) Along with fellow students Jessica Gorman and Crystal Noel, I helped teach the students. Though not all the students at Cardinal Forest Elementary participated, enough of them did so to sustain the program.

2 Background

2.1 Computers, Children, and Education

Traditional computer science programs utilize complicated programming languages, such as Java, Python, or C++, all of which are geared toward high school and college students. The first attempt to teach computer programming to younger children was with Logo, which involved telling a turtle how to move around to make various pictures. Since then, other preliminary programming languages, including Squeak, Alice, and Scratch, have been implemented with varied levels of success.

The necessary technology to teach Elementary students computer programming does exist, but unfortunately, most computers are used to reinforce allegedly outdated teaching methods, most commonly as a medium for transferring information. This method has been proven to be very ineffective, possibly due to a level of educational ineptitude on part of the students being left with little to do. As several studies have shown, students learn better when they immerse themselves in lessons instead of simply listening to lectures (Gates, 2008).

The goal of this project was to continue the development of an ongoing computer science curriculum at Cardinal Forest Elementary School. First started in 2007 by Gregory Gates, the curriculum, inspired by "computer clubhouses" at the Massachusetts Institute of Technology (MIT), consisted of weekly sessions that run from 30 to 45 minutes at a time. Not all students participated, but those that did were integral parts of the project.

2.2 Scratch

Scratch was developed and released in 2007 by MIT; it gets its name from its dynamic editing style, allowing users to edit programs as they're still running, similarly to how DJs mix music during performances. Instead of typing commands on various lines of code, the programming language editor uses simple, colored boxes and images to provide coding, as if assembling structures with building blocks (Fildes, 2007).

Reminiscent of art programs such as Kid Pix, the colorful and intuitive interface makes it easy for users to tell that Scratch was specifically geared toward a younger audience, and users need only to drag boxes to designated programming fields and connect them together as they see fit. Users are even given the ability to create and edit custom sprites. Furthermore, its influence isn't limited to children; at Harvard University Extension School, it has been tried out in some introductory computer science classes as a means for students to start making solid programs early (Johnson, 2007).

As of November 2008, the latest release is version 1.3.1, compatible with Windows and Mac operating systems. An unofficial version of Scratch 1.2 is available for Linux.



Figure 1: This image was used as a sample student badge that students needed to display to Mr. Allard in order to participate.

3 Procedures and Methods

3.1 Timeline

In September, I heard of the possibility of implementing a computer science program for elementary school kids and took up the opportunity after careful consideration. I contacted the principals of elementary and middle schools nearby Thomas Jefferson High School inquiring about such a possibility. After weeks of hearing nothing from said principals, I received a call from Mr. Frederic Allard, the same teacher contacted by Gregory Gates last year.

We went to work shortly after I confirmed my willingness to participate. Also working on the project were Crystal Noel and Jessica Gorman, who had previously been chosen as successors to Gates' program, but were nonetheless more than happy to include me. Soon afterwards, we met together in the library to discuss who would cover which aspect of the program; Crystal would investigate Scratch as an online community, Jessica would determine whether or not grade level is a factor in learning capabilities, and I would see how effective unconventional teaching methods are.

The program had to be expanded on; my teammates and I had to work out how we would divide students who had previously taken the Cardinal Forest Elementary School Scratch course from those who had not. The three of us made different contributions to help teach the children and studied various aspects of teaching in the process; by October 9th, 2008, the class had started.

After spending the first quarter using Scratch as a teaching tool for both mathematics and computer science, Mr. Allard introduced various projects for the students to apply their knowledge to. One of which was a "Kitty Rectangle" challenge for the children to work on until December. The goal of this project was to incorporate mathematics into technology; more specifically, it taught the students the concepts of area, perimeter, and angles of a rectangle. Later, the students worked on a Winter Wonderland project, whereupon they had to make a snowman move around an ice skating rink indefinitely by using loops in the programming language.

By April, we started video conferencing via webcams so I could directly talk to the students. Though the sessions themselves were marred by various technical difficulties, including slow connections and faulty equipment, . Soon afterward, plans for a final project were under way, involving suggestions from various students.

3.2 Class Structure

As with last year's program, the class wasn't so much a class as it was a computer club. Every Thursday, the students met with Mr. Allard for lessons designed in part by Jessica, Crystal, and me. Students signed in (for attendance purposes) and quietly sat down at their computers, and then teaching began. We did, however, tweak the program a bit to further accommodate for the various age groups and levels of experience represented in the class, which was divided into five sessions. Each one housed a different grade level and assembled at a different time of day. For example, the kindergartners and fifth graders met in session D, between 1:15 PM and 1:55 PM. Also, starting October 16th, 2008, students were given special badges to distinguish themselves from other students.

I was the main program writer of the group. Every week or so, I would create and submit a movie made with Scratch for Mr. Allard to review, edit, and post on Blackboard, all of which were used as teaching aids. Since there was no direct way of knowing whether or not the children were learning anything, I just monitored the progress made by the students in each session. Depending on how good or how bad progress was, I made adjustments to my style of programming.

Eventually, I had to see the students face to face via video conferencing to assist them more directly. This initially brought on numerous complications, such as proper preparation of equipment and lack of a feasible means of transportation, but were later addressed. By the end of March, we started conducting video conferencing sessions which, despite some initial technical difficulties, allowed me to more readily gain a sense of how well the students were learning.

3.3 Topics

As with last year's program, the number of topics we covered was dictated by how quickly the students could move from one topic to another. , so we often used Scratch to directly teach the students about angles, integers, axes, etc. Overall, we primarily focused on linking science and mathematics to each other; in order to navigate around the program's output window, students needed to understand the coordinate system and basic geometry. We further emphasized the need for mathematical knowledge in the projects we designed, as well as varying features about Scratch. Ranging from a challenge about

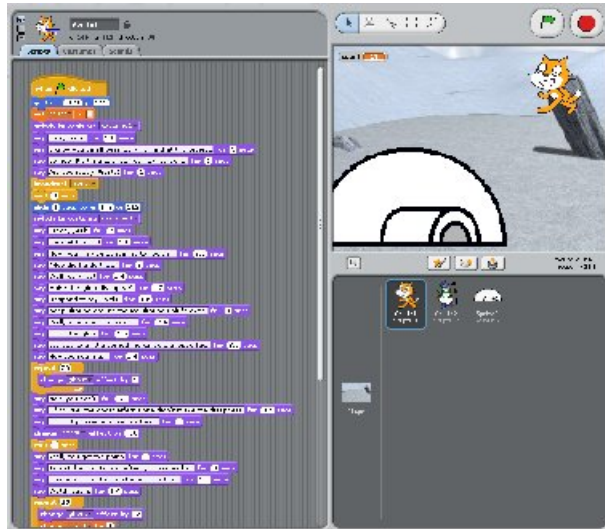


Figure 2: This program was used as a project demonstration for the students in January.

the dimensions and properties of a rectangle to a movie of a snowman circling an ice skating rink, each one incorporated a different aspect of each subject. While we couldn't teach everything there was to know about Scratch, we did what we could and hoped the students would figure out certain aspects on their own.

The potential of Scratch as a teaching aid is not limited to mathematics and technology. The coding is designed in such a way as to be almost like pieces of a colorful puzzle, so in a sense, not only is a user programming, but also painting a picture. The projects we designed allowed the students to apply what they learned from Jessica, Crystal, me, and Mr. Allard in class and at home. In addition, the presentations scheduled into the curriculum allow students to practice and develop their language arts skills, some more so than others.

3.4 Resources

The Cardinal Computer Lab features roughly 30 student computers and one teacher workstation with a computer connected to a SMART Board for presentations to the class. Mr. Allard also used his laptop on multiple occasions, including the video conferencing sessions. A larger room could be more ap-

propriate to engage more students in any given session, but the room provided adequate space and materials to teach as many students as possible at any given session. Eventually, as mentioned earlier, we used webcams to begin video conferencing over long distances.

To acquire the necessary software for the class, we visited several websites that hosted different programs to download, including the Scratch database and programmer, our primary software tool. Initially, we used Skype to perform video conferences, but later used a TANBERG device with a SMART board simulator to do so.

4 Results and Conclusion

4.1 Expectations and Aspirations

As of December 2008, I was hopeful that all would go according to plan. The students, I felt, have learned Scratch efficiently and had a wonderful time doing so. With the success of a WHUT broadcast documenting the Scratch program at Cardinal Forest, I think I really made a difference. Maybe this program could be integrated into Cardinal Forests main curriculum someday. And with no signs of stopping in sight, the course should benefit from the aid of a suitable successor, but who?

4.2 Results

As of March 2009, the program is quite a success. The students appear to be well on their way to learning what they need to learn, and weve made adjustments to the curriculum as necessary. I still see room for improvement, however; the lessons were, on occasion, poorly coordinated due to lack of communication between Jessica, Crystal, and me. As such, there have been widening differences in how we each approached the curriculum, ranging from teaching methods to lessons. Fortunately, theyve all led to similar levels of technological aptitude.

In some ways, the class mimics that of Thomas Jefferson High Schools own computer science classes. The students are allowed more or less complete in-class freedom to work on projects on the computers under teacher supervision (in this case, Mr. Allard). The teachers use various resources, such as projectors and the internet, to reinforce the points of lessons and

demonstrate how certain things work in relation to them.

4.3 Discussion

Computer programming can be—and has been—taught to students at the elementary school level, albeit through radically different means than one would normally expect. The earlier they start programming and showing interest in computers, the better. In the end, the students have made great progress in familiarizing themselves with programming through Scratch, and from what I’ve seen, someday, the computer may very well become the new medium for teaching nearly all subjects, including English and Social Studies. So, how young is too young to start teaching kids how to program (Gates, 2008)? Who knows? Maybe there’s no such thing as “too young” to do so.

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