Engaging Middle School Teachers and Students with Alice in a Diverse Set of Subjects *

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ABSTRACT

This paper describes the integration of the Alice 3D virtual worlds environment into a diverse set of subjects in middle school, including the development of tutorials, example worlds and lesson plans. In the summer of 2008 our experiences with middle school teachers included three-weeks of training in Alice and guidance in the development of lesson plans. Our experiences with middle school students involved two one-week summer camps of instruction in Alice. We found both the teachers and the students strongly engaged with Alice. The teachers created lesson plans with Alice worlds to interactively teach a topic and other lesson plans in which students build an Alice world on a particular topic either from scratch or using a template world. The students in the Alice camps had both instruction in Alice and free time to develop Alice worlds of their choice. We found that the students used a large variety of basic Alice concepts and computer science concepts in the worlds they built in their free time.

Categories and Subject Descriptors

K.3.2 [**Computing Milieux**]: Computers and Education-Computer and Information Science Education

General Terms

Human Factors

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Keywords

Alice, virtual worlds, K-12 education, middle school, underrepresented groups, introductory computer science

1. INTRODUCTION

The number of jobs in information technology is on the rise, while the number of students majoring in computing has steadily decreased since the peak of the late 1990s [3, 12, 13]. One of the problems is that students start thinking about their future careers while still in middle school. Middle schoolers have a good idea of careers in education and the medical field as they have personal experience with teachers and doctors, and they learn about careers such as astronauts and forensic scientists through the media. However, the majority of middle schoolers have little idea of careers in computer science other than the media images of the noninteractive geek (most likely male) sitting in his cubicle all day.

In our own experience, we have taught a non-majors Alice programming course at the college-level for four years that attracts around 50 percent females. Although many of the students enjoy the course, the majority of them are not taking another computer science course. Two reasons are 1) they are taking the Alice course to satisfy a quantitative requirement and 2) they come to college with a major already decided (not computer science), possibly with decisions forming from all the way back in middle school.

We are working on changing those perspectives by integrating the 3D-Virtual worlds Alice programming environment [4, 1] into K-12 schools. Six sites around the U.S. (Durham, NC, Virginia Beach, VA, San Jose, CA, Denver, CO, Charleston, SC, and Oxford, MS) are integrating Alice into schools by training teachers, with the majority of the sites focusing on Alice in a high school programming course. Our site in Durham, NC is instead focusing on integrating Alice into middle schools throughout the state of North Carolina, not as a programming course, but rather as a tool for learning and project presentation in a diverse set of subjects.

Our project with Alice in the summer of 2008 included the following. We developed tutorials and example worlds to teach Alice to middle school teachers and students. We worked with middle school teachers in a wide variety of disciplines in developing lesson plans that use Alice. We taught

Alice to middle school students and analyzed their use of Alice constructs.

In Section 2 we discuss previous work in Alice and other tools for K-12. In Section 3 we give an overview of our program for both middle school teachers and students. In Section 4 we describe our work with teachers and in Section 5 the use of Alice with students. We describe the tutorials and examples developed in Section 6. We discuss feedback in Section 7 and conclude in Section 8.

2. PREVIOUS WORK

Several projects focus on computer science at the high school level including the more intense nationwide computing curriculum of the Israeli model high school program for grades 10, 11, and 12, [8] to the explorations in computer science of the CS4HS program from Carnegie Mellon [2] and the Purdue program for linking mathematics and computer science [7].

Several other projects are focusing on computing at the middle school level and earlier. In the mid 1960s, Logo was created by Seymour Papert and Wallace Feurzeig and over the years was integrated into the K-12 environment and still exists today [10]. More recent tools for programming that are being integrated into middle school are Scratch[16] and Alice[1]. Several papers show the use of Scratch in K-12 with [17] presenting a 3-hour workshop module for teaching Scratch to 8th grade girls, and [11] reporting on the Scratch programming experiences of youth ages 8-18 at an after school center. Alice has been used in several ways with middle schools. Kelleher and others [9] recognized the storytelling aspect of Alice, creating a new storytelling version of Alice and compared its use with Alice for middle school girls, showing that the girls who used the storytelling version spent more time programming and expressed a stronger interest in future use of Alice. Other uses include using Alice as one of several tools to engage middle schoolers in computing such as in [6] where Alice was used as one of several activities for immigrant middle school students.

3. OVERVIEW AND DEMOGRAPHICS

In summer 2008 we held a three-week Alice workshop for thirty-three middle school and high school teachers of which two-thirds of the teachers taught fourth to eighth grade. The majority of teachers had never been exposed to programming before and were not interested in teaching a programming course, but rather integrating Alice into their disciplines which included math, science, language arts, social studies and art. The first two weeks in June 2008 were TECS-style[18], concentrating on instruction in Alice, practice with Alice and integrating Alice into their discipline. The third week was split over two weeks in July 2008 in which half the teachers came each week and wrote and presented Alice lesson plans. Also in both of the third weeks, we held one-week Alice camps for about 16-19 middle school students at the same site as the teachers. This gave the teachers some opportunity to observe and work with the students.

To advertise for the teacher workshop we gave several talks in 2007 and 2008 in the Durham area at technology fairs, teacher workshops and local conferences. In addition, we contacted schools in a few other counties, sent an announcement on a NC teacher email list and created an online application that was found by many teachers interested in Alice. Over 120 teachers applied for the workshop, which shows the rising interest in Alice. The makeup of the participating teachers and their schools was the following. All but two of the teachers were from North Carolina. The North Carolina teachers were from twelve different counties, from twenty-three different schools. All but one of the schools were public. The two teachers from outside North Carolina were high school teachers.

We advertised for students mostly through the teachers, word of mouth and an online application. Over 65 students applied. The makeup of the mostly middle school students was the following. Most of the students were from the Durham region as it was a day camp, but a few traveled from further away coming with teachers. The camps were roughly gender-balanced and had between 45 percent and 30 percent underrepresented minorities. The students were from sixteen different schools and one student was homeschooled. The first week there were sixteen students with the breakdown of seven females, nine males, and five underrepresented minorities. Three of the students were from private schools. The second week there were nineteen students with the breakdown eleven female, eight male, and eight underrepresented minorities. Five of the students were from private schools.

4. MIDDLE SCHOOL LESSON PLANS

The majority of middle school and high school teachers had never been exposed to programming before but were attracted to Alice by the storytelling nature and storytelling constructs of Alice such as scene changes, camera views, and dialogues between objects. They built a variety of lesson plans and examples including Alice worlds to show their students (some with interactive questions), template worlds for their students to add to, and lessons in which the students build an Alice world from scratch. We describe how they use Alice in several disciplines.

4.1 Math

Alice was used in math to solve problems or to answer questions about concepts. A sixth grade example shown in Figure 1 involves a labeled coordinate plane with 3-D objects appearing on some of the intersection points. The world first reviews terms such as *quadrant*, *x-axis*, and *y-axis* with animations, and then students have to interactively name the coordinate positions of the objects that can move around in the plane. Similar problems are in [5]. A seventh grade example lesson on surface area includes an Alice world in which students identify the type of objects such as circle, triangle, triangular prism, and cone and whether the objects are 2-D or 3-D. Example eighth grade lesson plans include understanding the rate of change and slope by building an Alice world to move objects at different distances and rates; exploring realistically rolling a ball by examining its circumference, number of rotations and distance rolled (see Chapter 6 of [4] for further details); and exploring dilations of two and three dimensional figures.

4.2 Science

Alice was used in science as an inquiry-based design tool to support student learning. Fifth and sixth grade examples have students build an Alice world of an ecosystem or a food web with items such as producers, consumers and

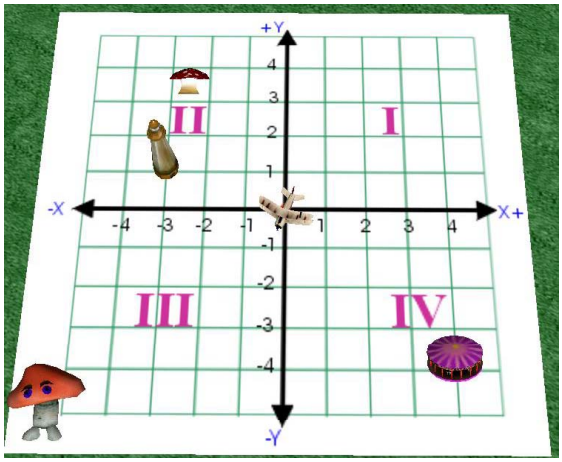

Figure 1: Coordinate Plane

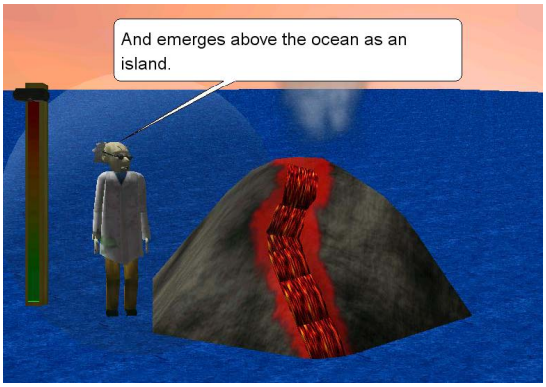

Figure 2: Formation of Volcano

decomposers, and have to investigate the impact of humans and/or pesticides in their system. Other sixth grade lesson plans include reading science fiction and having students use Alice to design scenes from the story; and exploring myths about space and building Alice worlds to illustrate the myths. There were lesson plans from both sixth and seventh grade to build an Alice world to review the steps of the scientific method. Another seventh grade lesson plan included completing an Alice world on tornadoes to show the destruction created after a tornado moves through a town. Eighth grade lesson plans included building Alice worlds on wetland habitats, and building an Alice world of a model of an atom using colored spheres. One example world built by a teacher and shown in Figure 2 shows how volcanoes are formed. A scientist goes underwater and underground and explains what happens as an animation of the volcano formation is shown.

We would also like to mention a few science lesson plans for high school that were developed. These include demonstrating alternative energy resources with an example Alice world using windmills; interacting with an Alice world of the solar system with facts that appear upon clicking each planet; and in physics to explore gravity and to learn the independence of component velocities.

Figure 3: Magic Tree House Quiz

4.3 Language Arts/Literature

Alice fits naturally into language arts with its storytelling capabilities. Fourth grade to ninth grade lesson plans all include students creating an Alice world based on a story or poem they have either read or written. In one additional lesson plan the students must create a movie trailer.

We include three types of example worlds for language arts on the examples page of our website [15]. One type is writing a story. We include an Alice animated version of a childrens book called "Kitty Story" about a child that has to wear leg splints, and another Alice animated story called PJs Dream. Both of these stories include scene changes, camera motion, and billboards as backgrounds. A second type is animating a poem. We include an Alice world and voice narration of the poem "The Fog" by Carl Sandburg. The third type is an animated quiz asking multiple choice questions. We include a world of quiz questions based on the Magic Tree House story Dinosaurs Before Dark [14]. The story is about a brother and sister named Jack and Annie who travel back in time, and the world includes a boy and girl representing these characters from the book. The "player" can click on either the brother or sister at the start and that character will take you through the quiz. In Figure 3 we have chosen Annie. Annie is showing us one of the questions in the quiz.

4.4 Social Studies/History

With Alice's rich library of objects, Alice worlds can be written for projects on civilizations. A sixth grade lesson plan includes an Alice presentation on continents that includes map images, powerpoint slides of facts, 3D text and animal objects. Students view the world and then answer questions about continents on a handout. Seventh grade lesson plans include students creating an animated overview of ancient Egypt and an animated overview of feudal Japan.

4.5 Art

The lesson plans on art for middle school students focus on bridging art and computers. Students build Alice worlds to enhance their study of stop motion animated film and also enhance their connections to careers in art and computers. One example world we include on our website is a group of ballerinas performing a dance.

4.6 Technology/Programming

The remaining lesson plans created were for technology or programming courses. Many of them focus on basic Alice concepts and are beginner tutorials. One example world teaches students camera views by creating scenarios and

moving the camera with dialogue to describe the types of camera views.

5. USE BY MIDDLE SCHOOL STUDENTS

In the summer of 2008 we held two one-week summer Alice camps for middle school students with sixteen to nineteen students in each camp. The camps consisted mostly of 3-4 hours of Alice instruction and about 2-3 hours of free time with Alice each day. Animation fairs of students presenting their Alice worlds were held on the third and fifth days. The Alice instruction/tutorial consisted mostly of students building an Alice world on a particular topic with the presenter.

5.1 Usage of Alice

We collected all the student Alice worlds and examined their contents after the camps. First we looked to see what types of objects they used in their worlds. The top five types of objects that girls used the most in their worlds were people, animals, environments, nature, and 3D text. The top five types of objects that boys used the most in their worlds were vehicles, people, buildings, scifi and special effects.

Second we examined their worlds to see which programming constructs students used in their own worlds. They were allowed to build worlds in their free time on any topic. The table below shows the basic Alice constructs and shows the percent of students that used them in their own worlds they built at least once (second column), and the percent that used the construct three or more times (third column). The data shows that they mostly used basic constructs that allow them to easily build a story such as built-in methods, "do together" to run methods at the same time, camera control, color property to change the color of an object, isShowing to make an object invisible and vehicle property to attach one object to another. Note that "Do In Order" is the default and is not necessary to use, so that may explain why only 60% of the students used it. Not many students used comments (8.5%), even though they were taught about comments on the first day.

BASIC TOPICS	% USED	% USED 3+ TIMES
Use built-in methods	100.00	100.00
Do Together	97.14	88.57
Do In Order	60.00	25.74
comments	8.50	0.00
wait	31.43	8.57
sound voice clip	11.43	5.71
sound song clip	25.72	0.00
image found billboard	17.14	0.00
created billboard	14.28	0.00
vehicle property	88.57	45.71
isShowing property	51.43	37.14
opacity property	25.71	22.85
color property	65.71	17.14
texture property	11.43	2.86
camera controls	80.00	51.43
scene change	51.43	25.71

The next table shows how many students used computer science concepts. 40% of the students wrote their own method and 34% used parameters. Built-in functions were used by two-thirds of the students, but only 14% wrote their own function. 42% used an if statement and 57% used a loop. Lists seemed to be an easy concept for them to grasp as they wanted to have several things move together. 45% used a list with 40% using the "for all together" loop with a list and 23% using "for all in order."

CS TOPICS	% USED	% USED 3+ TIMES
create world method	42.85	14.28
create class method	40.00	17.14
parameters	34.28	17.14
built-in functions	62.85	31.43
wrote a function	14.28	2.86
if statement	42.86	11.43
math	40.00	11.43
simple event	57.14	34.28
four arrow keys event	60.00	25.71
loop	57.14	22.86
BDE	25.71	2.86
score	8.57	0.00
timer	14.28	0.00
random number	2.85	0.00
user input	8.57	5.71
create local variable	11.42	0.00
create class variable	8.57	5.71
create world variable	11.42	2.85
list	45.71	8.50
for all together	40.00	14.28
for all in order	22.85	2.85

6. MIDDLE SCHOOL TUTORIALS

We developed a large number of tutorials and example worlds for middle school students that are available for free on our web site [15]. We used similar instructional material with the teachers first in June, but simplified many of the materials with each new presentation in the student camps based on our experiences. We further revised some of the tutorials after the last camp and developed additional tutorials based on student interest.

We have developed three starting tutorials. The first tutorial is for someone to check out Alice quickly to see if they want to learn more. It is a short tutorial that shows how to add an object, use a few built-in methods and play an animation. The second tutorial involving a fish and fairy is about one hour and aimed at 8 year olds and up. This tutorial shows how to add objects, some simple scene setup, writing and using a new method (with a simple body), camera control, vehicle property and simple events. We tested out the tutorial in a one hour presentation with thirteen kids ages 8-11 attending a separate computer camp. All the kids were engaged with Alice during the presentation, building the world along with us.

The third starting tutorial we developed involving people talking on a cell phone and riding a horse is a four part tutorial for ages 10 and up, with each part about 30-45 minutes. It includes the same topics as the tutorial above but in more detail, and many additional topics. For example the scene setup in this tutorial gives more challenging positioning of objects. Students use quad view to get the positioning correct or to find objects. Other topics included in this tutorial are people builder, more complex methods, 3D text, sound, more events, billboards, isShowing, and "as seen by".

We have developed over twenty tutorials on topics, many of which we used with students in the camp and some that were developed after the camp based on topics students liked. Some topics are on Alice constructs such as writing your own methods, writing your own functions, lights, textures, randomness, begin-during-end event loop (BDE), lists, and events. Others combine concepts such as writing a timer or score (uses variables and loops) or how to build a model atom (adding sphere objects, coloring them, and changing their vehicle property to get them to move together).

7. ALICE CAMP FEEDBACK

As both weeks went on the students were very engaged with Alice and were always asking for more free time to work on their own worlds. After five to six hours of Alice each day, we still had difficulty getting them to stop, turn off their Alice worlds and logout at the end of the day.

We received several notes from parents after the camp was over stating that their child enjoyed the Alice camp such as: "[My daughter] thoroughly enjoyed her week with you. It was a great experience!" and "[My daughter] very much enjoyed the Alice camp." and "[My son] had a wonderful time." We also received a note during the camp from a parent that teaches kids Python and whose son attended the Alice camp. "I'm convinced. Kids like Alice and Alice is a good way to teach kids programming. [My son] is doing my python course and he's not all that interested in python and never touches python between the classes. However in the evenings when he comes home from the Alice course, he works on his Alice worlds."

8. SUMMARY/FUTURE PLANS

Alice is a tool to engage middle school students to write interactive stories in a number of disciplines such as science, math, language arts, history and art. We have found that Alice can be used starting as early as 3rd grade, but in more depth starting in 5th grade. Learning basic concepts, students will know enough to write simple stories or project reports. Some of the starting concepts to focus on are using built-in methods, writing their own methods, scene changes, and camera control. Lists were fairly easy concept for middle school students to grasp and can also be taught early. As students move through middle school they can continue to learn and apply more complicated Alice constructs. Teachers can also encourage Alice's use by creating Alice worlds to introduce or discuss topics, or template worlds students can build on.

The participating teachers in our workshop will be using their Alice lesson plans academic year 2008-09 and will continue to contribute to the lesson plan website. They will attend a followup workshop in summer 2009.

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