A Summer Programming Workshop for Middle School Girls

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ABSTRACT
Westminster College runs a math, science, and computing summer camp for middle school girls called AWE+SUM. Core to the camp is a set of workshops that allow for creative hands-on experiments and exploration. One of the most popular workshops is called “Programming with Alice” where we introduce the girls to programming concepts through Carnegie Mellon University’s Alice software. This paper describes our experiences in running this workshop five times over the past three years.

Categories and Subject Descriptors
K.3.2 [Computing Milieux]: Computers and Education-Computer and Information Science Education[Computer science education]

Keywords
Summer Camp, Gender, Attracting Women to Computer Science

1. INTRODUCTION
The recent drop in enrollment in computer science programs can be partially attributed to female students’ dramatic decline in interest. While the percentage of incoming male college students who indicate they plan to be computer science majors is the same as a decade ago, the percentage of female students is half of what it was in the early 1990’s [11].

Studies have shown that girls begin to lose interest in math, science, and computers in middle school and that this trend continues through post-graduate education. The middle school years are particularly pivotal in many girls’ lives. Girls who have been doing well in math and science classes are confronted with pressures to conform and they lose confidence and interest in these areas. Girls often opt out of advanced high school math and science classes, which limits their options in college [8]. If they later develop an interest in computer science in college, they find themselves playing catch-up on the prerequisite math classes.

The low numbers of female undergraduate computer science majors translates to poor gender diversity in the workforce. As of 2005, only 24.9% of non-administrative IT workers in America were women [4]. Even worse, only 11.5% of game developers were female [5]. If more women were involved in producing video games, perhaps more games that appeal to girls would be developed. In the meantime, the scarcity of video games that engage girls is often cited as one reason why girls lack interest in computers [1]. Exposing middle school girls to the programming concepts in a fun context may be one way to counter this lack of interest.

To increase middle school girls’ interest in math, science, and computing, Westminster College runs a residential camp for girls who may not be performing in school at their true ability level in these classes. This summer camp is designed for girls entering eighth grade that fall. We invite the girls back to campus for a reunion the following January, prior to when they schedule their high school freshman classes.

The “Programming with Alice” workshop is one of the most popular sessions at the AWE+SUM camp. The workshop uses storytelling in 3D virtual worlds to teach computer programming. Alice 2.0 and Storytelling Alice are two versions of an educational software package that allows students to easily create interactive animations, while slyly teaching important programming concepts. While having fun creating narratives involving ice skaters and penguins, the girls are gaining valuable experience with complex programming concepts such as control structures, methods, and object-oriented design. At the end of the workshops, the students share their results with one another.

Figure 1: The girls who attended the June 2006 camp are photographed here with their camp counselors.
Westminster has offered the AWE+SUM camp five times (June 2005, June 2006, July 2006, June 2007, and July 2007). This paper describes the “Programming with Alice” workshop, its strengths, and areas for improvement.

2. BACKGROUND
Carnegie Mellon’s Alice is a freely available programming environment that was originally developed to allow non-programmers to create interactive 3D graphics [2, 10]. Since then, Alice has become a useful environment for teaching programming. Its drag and drop interface precludes syntax errors, which may be the single greatest source of confusion and aggravation for beginner programmers. Alice comes with several tutorials that demonstrate its potential for creating interactive 3D virtual worlds. These tutorials have a user-friendly stencil interface that catches mistakes and reduces frustration [7]. Alice includes a database of 3D characters and worlds. All characters come with a suite of basic methods and functions, facilitating the creation of a new user’s first program. Because all characters in Alice are objects with methods, students who learn to program using Alice have an intuitive understanding of object-oriented design. Studies have shown that using Alice in a college level CS 1 course improves college students’ performance in the class and increases the percentage of students continuing in the major [3, 9].

Several other colleges and universities have also used Alice in summer camps for middle school students, including Carnegie Mellon (Summer Academy for Minority Students), the Colorado School of Mines (Tech Camp 101), and Georgia Tech (Technology, Engineering, and Computing Camp).

Our camp at Westminster is unique in that it is a residential math and science camp that specifically targets girls identified by their teachers as not performing up to their potential. While we hope that our camp can make a difference for this pool of students, these campers do sometimes have behavioral problems that require extra attention from camp counselors. We have learned to select counselors able to keep the girls in check.

Our campers do not express an interest in computer science before arriving at the camp, but they are all exposed to programming through the Alice workshop. In our anonymous post-camp surveys, a high percentage of the girls consistently indicate that the Alice workshop was their favorite session.

3. AWE+SUM'S ALICE WORKSHOP

3.1 Overview
Westminster College has offered the AWE+SUM camp five times. In its inaugural offering, 39 girls attended the two and a half day residential camp, from June 26-28, 2005. Due to the first camp’s popularity and success, we lengthened the camp to three days and offered it twice in 2006 and 2007. Approximately 40 girls attended each of the camps, for a total of 80 per year. Based on our experiences, I modified the Alice workshop after each camp.

To recruit girls from all socioeconomic levels, we sought to make the camp as inexpensive as possible. Our goals were to charge only a nominal fee for each girl to reserve her place at the camp, and to waive that fee for anyone who showed financial need. Thus, securing external funding has always been the greatest challenge to running AWE+SUM.

We first began planning a girls’ summer camp in September 2003, but did not secure sufficient funding to offer a camp in 2004. The 2005 summer camp was partially funded by a Mathematical Association of America (MAA) Tensor Foundation Grant, the American Association of University Women (AAUW), and private donations. Westminster College contributed resources and personnel, and faculty volunteered their time when not enough funds were raised. The girls were charged only US$25 for the two and a half day camp. We were also able to fund transportation costs for two Navajo girls to attend the camp from 300 miles away. We stretched our finances to host a reunion in January 2006, when all the girls were invited to return and interacted with professional women mentors and high school guidance counselors.

In 2006 and 2007, we ran two AWE+SUM camps that were each three days long. Once again, the MAA Tensor Foundation, the AAUW, and Westminster College contributed money and support. Additional funding for one camp was provided by the local NASA Space Consortium and private donors. Our state financed the second of our two AWE+SUM camps. Thanks to the generosity of our sponsors, the girls were once again only charged US$25 for the camps, and we paid all transportation expenses for girls from the Navajo reservation. In January 2007, girls from both 2006 camps were invited back for a joint reunion, where we encouraged them to take math, science, and programming classes in high school. We are currently planning a January 2008 reunion for the 2007 campers.

The 2003, 2004, and 2005 camp efforts were primarily organized and run by Westminster College faculty, volunteers, and students. After securing camp funding for the 2006 and 2007 camps, faculty have been transferring control of camp logistics to campus staff. Some of our funding is used towards the salaries of this staff.

3.2 A One-Day Alice workshop (June 2005)
Six different science, math, and programming workshops, all taught by female Westminster professors, were offered during the June 2005 AWE+SUM camp. Due to time constraints, not all the girls attended all the workshops: 20 girls participated in the two hour “Programming with Alice” workshop.

I began the workshop by introducing computer programming and Alice v2.0. I randomly assigned the girls to pairs and walked all the girls through the first half of a standard Alice tutorial. This tutorial, which is part of the Alice system, introduces novices to the Alice environment and explains how to call existing methods (with parameters) in a 3D virtual world. Afterwards, each pair worked through the rest of the tutorial before making their own modifications to the sample program. Most of the girls enjoyed writing their own code, and within five minutes, many were asking how to create their own methods.

I then started the girls on the second tutorial, which explained how to create new methods. While writing their own methods, the girls also learned how each 3D character was actually composed of several parts (chest, arms, legs, etc.), and how to manipulate each part to create the desired motions. Many of the girls were surprised by the many steps it took to make a character move. This experience taught the girls why writing several smaller methods is preferable.
to writing one large main method.

The pairs spent the remaining hour building their own virtual worlds, populating them with characters, and writing their own stories (programs). As they experimented, some of the girls began asking about more advanced programming constructs, such as how to repeat a sequence of actions multiple times (loops). Many of the girls wanted to continue programming even after their time was up. At the end of the workshop, the girls watched enthusiastically as I played their programs for the group. All the campers, even those who did not attend the workshop, were given Alice v2.0 on CD to take home.

By the end of the workshop, the girls all had written their own programs and gained an understanding of sequential programming and object-oriented design. However, there were a few weaknesses in the workshop’s format. Some of the pairs worked poorly together, because the girls were not already friends and differed too widely in their interest in Alice. Secondly, two hours was not a sufficient amount of time to cover many programming topics. Finally, we did not give the girls enough time to fill out their post-camp evaluations on the final day of the camp, and only about half the girls returned the evaluations. Those girls who did return the evaluation rated the Alice workshop a 3.89 (on a 1 (boring) to 5 (great) scale, where 3 represented okay).

3.3 Extending to a Two-Day Workshop (June 2006)

Based on the 2005 workshop’s popularity, we decided to have all the girls attend the Alice workshop in 2006. The workshop itself was also extended over two days. The girls all participated in two ninety-minute programming sessions over two days, followed by a presentation of their work on the third day. To keep the group sizes manageable, the girls were divided into two groups, and each programming session was run twice.

This year, girls were allowed to select their own pairs, and camp counselors helped pair girls who were more hesitant about working together. The first day was similar to the 2005 workshop. The girls worked through the two tutorials individually before experimenting in pairs with building their own virtual worlds and programming.

On the second day, I reviewed the topics covered on the first day and clarified confusing areas, including how to easily position new characters in a virtual world, pass parameters to methods, and modify the timing of actions. I also demonstrated how to program in parallel (Alice has a simple “do together” feature) and how to write a simple loop. The girls then had time to work in pairs and complete their own programs. Approximately a quarter of the pairs finished early, and started a second program. The majority of girls finished at least one program by the end of this session, and some of the more enthusiastic groups asked for permission to skip their swimming pool time for the opportunity to expand on their programs. One group added to their program during their evening free time back in the dorms.

The third day, we asked the girls for volunteers to share their programs, and I presented those programs for the entire camp. Most of the pairs decided to participate, and everyone enjoyed seeing each other’s programs. Figure 2 shows a screen shot from one pair’s program.

Once again, we gave all the girls their own Alice CDs to take home. The original CDs only had the PC version of Alice, and I promised on the first day to make CDs of the Mac version. Several of the girls asked for these Mac CDs repeatedly before I distributed them on the third day, revealing their enthusiasm for Alice and programming.

There remained a few weaknesses in this extended Alice workshop. The girls continued to struggle positioning characters and other objects in their virtual worlds, sometimes spending more time populating worlds than writing their programs. Several groups also wrote long main methods, instead of writing and calling other methods.

Overall, the Alice workshop was a great hit with this camp. On a scale of 1 (boring) to 5 (great), the girls rated the Alice workshop a 4.64. This score was the highest average in the post-camp assessment, higher than those of the other math and science workshops and even of the non-academic activities. A comparison of the girls’ pre-camp and post-camp perceptions of math and science (Table 1) indicates that the camp may have succeeded in increasing interest in both college and math and science, although the differences were not statistically significant.


3.4 Storytelling Alice (July 2006 and the 2007 camps)

Between the June and July 2006 camps, I attended a presentation by Caitlin Kelleher of Carnegie Mellon on “Storytelling Alice,” a new version of Alice especially geared towards middle school girls. By emphasizing the storytelling aspect of Alice programming, Storytelling Alice attracts and holds the girls’ interest better than the standard Alice system. The characters and virtual worlds in Storytelling Alice lend themselves better to middle school girls’ stories, and many of the methods common to all 3D objects have been modified and renamed for the middle school vocabulary. For example, “orient to” has been replaced by “look at.” Other useful methods like “walk” and “touch” have also been added. Finally, new tutorials teaching object placement and camera control have been added to Storytelling Alice. Kelleher’s studies showed that girls spend less time on scene layout and more time programming with Storytelling Alice than the standard Alice [6]. She generously allowed us to use a beta version of Storytelling Alice in the July 2006 AWE+SUM camp. Storytelling Alice was released to the public in 2007.

On the first day, I again introduced the girls to the main topics of each tutorial before having them complete the tutorials individually. In past camps, girls struggled with positioning and moving objects in a virtual world. Since these topics were now addressed by the new Storytelling Alice tutorials, I had the girls complete all three tutorials before starting their own worlds with their partners.

Because many of the girls in the June 2006 camp had completed their programs early, I demonstrated advanced topics in more detail on the second day of the July camp. I asked all the girls to open a simple virtual world that I had prepared before the workshop. Then I demonstrated several topics at the front of the classroom and asked the girls to follow along on their computers. These topics included writing their own methods, the difference between the main method and objects’ member methods, manipulating part of a character’s body, programming in parallel and loops. In the 2007 camps, I also introduced conditionals through if-else statements, before ending this portion of the lesson by creating title screens.

The girls then completed their own programs in pairs. Many of the pairs asked and learned about other advanced features such as camera control as they experimented. Once again, some girls elected to skip their pool time to remain and expand on their programs, and most pairs volunteered to share their programs on the third day.

A few remaining weaknesses from the Alice workshop still need to be addressed. Some girls continued to write one large main method or to use only existing methods, instead of writing their own. Very few girls used more advanced programming constructs such as loops and conditionals, although controlling the camera to enact scene changes was popular. Finally, some girls had trouble keeping up with the advanced topics that I demonstrated at the front of the classroom. I tried to follow each demonstration by asking everyone to repeat the idea on another character, but these girls were not able to replicate it and remained confused even with further assistance. Unfortunately, this problem may be difficult to solve without boring the other girls, because the girls attending the camp varied widely in academic achievement level. For this reason, I added an easier topic (title screens) to the end of this portion of the workshop, so all the girls could feel positive about learning something new.

Once again, the girls rated the Alice workshop (4.28 in July 2006, and 4.40 in June and July 2007) higher than the other academic workshops. The pre-camp and post-camp questionnaires showed the July 2006 AWE+SUM camp had a positive effect on the girls’ perception of math and science (Table 2), although the effect was not statistically significant. Unfortunately, in transferring the logistical details of the camp from faculty to camp staff, the pre-camp questionnaires were not distributed for the 2007 camps.

4. FUTURE WORK

We currently are planning two more camps for the summer of 2008. In addition, now that our 2005 campers are in high school, we are constructing a survey for our past attendees. Our intention is to follow the girls through high school and college, to determine if the AWE+SUM camps have any long-term effects on their high school and college careers.

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<thead>
<tr>
<th>Statement</th>
<th>Pre-camp Average</th>
<th>Post-camp Average</th>
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<tbody>
<tr>
<td>I am likely to go to college someday.</td>
<td>4.81</td>
<td>4.88</td>
</tr>
<tr>
<td>Math and science can be fun.</td>
<td>4.07</td>
<td>4.30</td>
</tr>
<tr>
<td>I am interested in a career involving math or science.</td>
<td>3.51</td>
<td>3.95</td>
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In addition, I am pursuing opportunities to train Girl Scout troop leaders and high school teachers in Alice. While AWE+SUM’s Alice workshop provides an excellent introduction to programming, ultimately it is only a three-hour experience for eighty girls a year. The local girl scout troops and the high schools can provide a more substantial experience for many more girls in the area.

5. RESOURCES

For those interested in learning more about Alice, both versions are available as a free download at http://www.alice.org, courtesy of Carnegie Mellon University. The “Community” section of this website, especially the Community Forums, is helpful to both novices learning Alice and educators interested in teaching with Alice. Several textbooks are currently available, including Learning to Program with Alice by Wanda Dann, Stephen Cooper and Randy Pausch. This textbook also has an informative website with instructor’s materials and a list of schools using Alice: http://www.aliceprogramming.net. For in-person instruction, the annual SIGCSE conference often hosts Alice sessions, and the National Science Foundation has sponsored Alice workshops in the summer.

6. CONCLUSIONS

Alice has proven to be an excellent tool for teaching computer programming to middle school girls. The girls found the interactive graphics and the storytelling elements fun and engaging. Storytelling makes loops and conditionals relevant, and the characters in Alice make object-oriented design and methods intuitive. The girls even learned about parallel programming and some basics of 3D graphics, including manipulating 3D objects and camera control. Most importantly, the girls left the camp with a positive image of programming and computers.

7. REFERENCES