Integrating Computing into Middle School Disciplines Through Projects

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Outline

• Introduction and Motivation for Adventures in Alice Programming and other work
• Materials for Integrating Alice into K-12
• Discipline Specific Projects
• Analyzing Worlds
• Conclusion and Future Work
Three problems with teaching computer science in K-12

1. It’s not really in many schools ..... 
   There are lots of efforts to get it there....
   10,000 teachers, exploring CS, etc.

2. Where are the women and minorities?
   Numbers low .... See stats such as ncwit.org

3. The traditional teaching of CS ...
How do we Introduce and Teach Science?

• Physics – experiments

• Chemistry - experiments

• Biology - experiments
If taught, how do we introduce CS?

- Write a calculator
- Write a banking program
- Etc...

NOT VERY EXCITING!

NOT ANYBODY AT SIGCSE of course, but those professors who didn’t come here!
Why Can’t the Introduction of Computer Science be exciting?

• Programming – it’s always been
  – Hands-on
  – Interactive
  – Frustrating!

• What’s missing?
  – Not Getting Exciting Results
    • Easily, right away
  – Too textual-based, including errors
  – Not appealing to today’s kids in which media and technology are a part of their life!
Bring on Alice Virtual Worlds!

• Alice is
  – Hands-on!
  – Interactive!
  – Visual!
  – Less Error prone
  – Exciting Results right away!

• Alice has the potential to excite kids about computer science in the same way that experiments excite kids about chemistry, physics and biology!
Alice Programming Language

• Create interactive stories or games
• Learn programming in an easy way, drag-and-drop your code
• Problem solving with visual feedback
  – Objects are visual!
• Alice is free: www.alice.org
• Developed by Randy Pausch
  – Carnegie Mellon University
Why Alice?

- Lots of other great tools you can hear about at SIGCSE
- Alice is easy to use, drag-and-drop, objects already exist
- Find it attractive to girls
Success - Alice attracts diverse group

• At Duke
  – CompSci 4 Spring 2005
    • 22 preregister, 30 enroll (12 female + 3 African Amer.)
  – CompSci 4 Fall 2005
    • 20 preregister, 31 enroll (17 female – 1 African Amer.)
  – CompSci 4 Fall 2006 – 2 sections
    • 64 students, 33 female, 7 African Amer.
  – CompSci 4 Fall 2007 – 2 sections
    • 84 students - > 50% female
  – CompSci 4 Fall 2008 – 2 sections
    • 100 students - > 50% female
  – Same for Spring 2009, Fall 2009...
  – Advertised in school paper
    • picture of ice skater
    • Web site of animations
Success - Alice Excites 4th-6th Grade Girls

- Duke Femmes Event, April 07
- 60 girls – 4 groups of 15
- Taught them Alice for an hour
- Handout to take home
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Adventures in Alice Programming
Grades 5-12 Outreach

www.cs.duke.edu/csed/alice/aliceInSchools
Adventures in Alice Programming

• Summers 2008-2015

• 3-week Teacher workshops
  • Over 150 teachers, mostly middle school, some high school
  • All disciplines
  • Taught them Alice, Developed Lesson Plans

– 1-week middle school camps

• Main Sites:
  – Durham, NC
  – Charleston/Columbia, SC
  – Oxford, Mississippi
Targeting all subject teachers

• Subject teachers using Alice
  – Language Arts
  – Mathematics
  – Science
  – History
  – Foreign Language
  – Music, Art
  – Media, Technology
  – Business

• Mostly Middle school, some Elementary, and some high school subject teachers (physics, chemistry, english, etc)
Using Alice in Middle/High Schools

• Teachers
  – Examples in lecture
  – Make interactive quizzes
  – Make worlds on concepts for students to view

• Students
  – Projects (in place of a poster, a model)
  – To take or build quizzes
  – To view and answer questions about a world
  – Older students can do more with Alice.
Our Free Materials
Over 40 Tutorials

1. Getting started tutorials
   – 1-4 hours

2. Tutorials on CS topics
   – Methods, conditionals, lists, etc
   – Variables (timers/scores).

3. Animation tutorials
   – Lights, camera, scene change, billboards, invisible objects,
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Most Recent Focus
Tutorials for Projects in different disciplines
Language Arts – Animate a story

By Betty Stone
Animated by Deborah Nelson

KITTY STORY
Project: Book Report

Charlotte's Web
by E.B. White
Science – Population Change
Science – Population Change (end)
Science Example
How a volcano is formed
¡Bienvenido al programa de cocinar!
Cooking Spanish – More detailed

Vamos a hacer pan de plátanos!
Cooking Spanish – setting the table
Most of our focus on math

Math Example – Plotting Numbers

I am going on a bike ride
Math Example

\[ f(x) = 0x + 0 \]

Score: 0
Math Example - Percents

Score: 0.0
INSTRUCTIONS

• Today we are going to learn about probability and sampling by looking at two boxes containing red and blue balls.
  • In a **simple random sample**, each ball has an equal probability of being selected, regardless of box.
  • In a **stratified random sample** of these marbles, each ball has an equal probability of being selected—once a box is selected, we choose balls from that box only.
  • Type S to see a simple random sample or T to see a stratified random sample.
Math Example – Scientific Notation
Math Example – Rounding Numbers

**Rounding World**

Choose the level of difficulty by clicking on the handle:

- **Level 1**: round numbers up to the hundreds
- **Level 2**: round numbers up to the thousands
- **Level 3**: round numbers up to the millions

START
Math Stories to Attract Girls

- Danica McKellar
A variable like $x$ is just a placeholder for a number.

$2x + 3 = 11$
Simple Game – Control, earn points

To win this game, you must steer the boat through each ring and beat the clock. You receive one point for each ring, and there are 10 rings, so if your score is less than 10 at the end, you lose!
Adventure Game – Find objects in order
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Analysis of Teachers Worlds
Summer 2011

• Two-week workshop
  – 26 teachers
  – Developed 32 Alice worlds and lesson plans

• Examined their worlds
  – Which concepts did they use?
  – Planned usage of the world?
Number of teachers using Alice features in the worlds they built
Observations of Worlds

• 69/98 features used in some world
• 20.78 features used per world on average
• Advanced worlds might have 46 different features
• 32 worlds
  – 12 examples for future projects
  – 11 for interactive games
  – 9 for animation elements
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Conclusions and Future Work

• Teachers excited - see different ways to use it
• Projects best for integrating into a course
• Multimedia/Business Technology seems the best place for more extensive teaching of Alice
  – Pairing up with a teacher in another discipline
• Future
  – Workshops through 2015, Alice Symposium 2013
  – Other formats for tutorials?
Adventures in Alice Programming web site

www.cs.duke.edu/csed/alice/aliceInSchools

Questions?