Looking Glass: Supporting Learning using Peer Programs

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Engaging Middle School Students with Computer Programming

- Many girls turn away from math and science disciplines, including computer science, during middle school.
- Once they decide to leave, it is difficult to get them back.
Motivating Context

“OK, so I can make the bunny move around. **But why would I want to?**”

-12 yr old girl
Storytelling Alice (demo?)

Approach: Present programming as a *means* to the *end* of storytelling.
Enabling Storytelling

1. Add high-level animations that enable social interaction
2. Create a story-based tutorial.
3. Provide a gallery of characters and animations that inspire stories.
Storytelling Alice users spend 42% more time programming

Time on Alice Activities

- Scene Layout
- Editing Program
- Running Program

Average Time (%)

- p < 0.001

Legend:
- Generic Alice
- Storytelling Alice
Storytelling Alice motivates reluctant programmers

Scene Layout vs. Program Editing

Time (%) on Scene Layout

Time (%) Editing Program

Generic Alice
Storytelling Alice motivates reluctant programmers

Scene Layout vs. Program Editing

Time (%) on Scene Layout vs. Time (%) Editing Program

- Generic Alice
Storytelling Alice motivates reluctant programmers

Scene Layout vs. Program Editing

Time (%) on Scene Layout vs. Time (%) Editing Program

- Generic Alice
- Storytelling Alice
Time on task is a strong predictor of learning

Scene Layout vs. Program Editing

Time (%) on Scene Layout

Time (%) Editing Program

- Generic Alice
- Storytelling Alice
Time on task is a strong predictor of learning

Quiz Performance

p < .05

Score

Interior Decorators  Programmers
Increased engagement isn’t enough either.
Problem Scenario #1

1. Ashley downloads Storytelling Alice.
2. She builds a small story and gets excited.
3. She begins planning a larger scale project.
4. Early on, she gets stuck.
Problem Scenario #2

1. Ashley downloads Storytelling Alice.
2. She builds a small story and gets excited.
3. She builds a few more stories using the same constructs.
4. She gets bored.
Looking for help.

- **Parents/Friends**
  - Few have experience with computer programming.

- **Teachers**
  - CS is rarely taught at the middle school level.

- **Internet**
  - Some tutorials, but finding one related to a specific question is difficult.
Looking Glass

• Keep the storytelling and social interaction motivation.

• Enable kids to teach themselves by finding and adapting animations in programs written by peers.
A Looking Glass Scenario

I want them to throw paper airplanes.

Adapt toy throwing to create throwing paper airplanes.

Find code where owner throws toy for dog.
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Pre-req: Record high level UI actions

1. Click and drag “Petal Beamweb walk to”
2. Drop it at the top of scene 1 method.
3. Choose “trevor” and “the entire trevor” from the menus.
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Every program knows the UI steps necessary to create itself.
Provide UI tools to help users find code they want to use in other’s programs
Use history for selected code to generate tutorial
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How do novice programmers approach finding code in unfamiliar programs?
Novice?
Participants

• 14 adults from the Washington University community
  – Mostly staff (summer break?)
• 12 had no prior programming experience of any kind
• 1 had limited experience with Fortran 20+ years earlier
• 1 had some experience with Matlab 6+ years earlier.
Expected Use

I want that part... where he bends to pick up the banana.
Tasks Mirror Expected Use

• Bounding Tasks
  – Denote begin, end of highlighted functionality

• Modification Tasks
  – Modify highlighted functionality

• 5 tasks for each of the 4 programs.

For this task you will have to modify the Fish World.
## Programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish World</td>
<td>No text, all actions, clear object names</td>
</tr>
<tr>
<td>Woods World</td>
<td>Three concurrent ‘parts’ (methods) timed to appear sequential</td>
</tr>
<tr>
<td>Magic Trees</td>
<td>Long program, three concurrent blocks in one method, hidden method functionality</td>
</tr>
<tr>
<td>Race World</td>
<td>Interactive program, lists, events, randomness</td>
</tr>
</tbody>
</table>
This is hard for novices.

• 41% correct answers
  – 33% correct bounding
  – 72% correct modification

• Bounding task time range: 01:02 – 26:20
• Modification task time range: 01:07 – 27:29
Task Process Model

- Video
- Code
- Output Program
- Solution

Process Model
What Users Focus On: Landmarks

- A specific feature in output or code
What Users Try to Find: Mappings

- A direct connection between a line of code and output function
Task Process Model

Video → Landmarks → Code → Output → Solution

Landmarks & Mappings

Success

Failure
Internal Landmark Model

Excluded Landmark Set

Included Mappings

Output Landmark Set

Excluded Landmark Set

Excluded Mappings

Code Landmark Set
Barriers

• Difficulty matching output with relevant code
• Not knowing where to look to find target code
• Incorrect interpretation of constructs and how they impact instruction sequences.
• Inclusion or exclusion of code based on names.
Hastings: a code search tool for new programmers

(Demo)
Making Connections Between Code and Output
Making Connections Between Code and Output
Helping users know where to look
Helping users know where to look

BigPurpleFish was doing...

in BigPurpleFish.Primp():

- BigPurpleFish's Head.roll(RIGHT, 0.02)
- BigPurpleFish's Finarmleft.roll(LEFT, 0.05)
- BigPurpleFish's Finarmleft.turn(BACKWARD)
- BigPurpleFish's Finarmleft.turn(LEFT, 0.25)
- BigPurpleFish's Finhandleleft.turn(LEFT, 0.5)
Helping users know where to look
Focusing attention can help users build an understanding of constructs.
Focusing attention can help users build an understanding of constructs.
Next Steps

• Informal user tests suggest that Hastings helps new programmers find code for specific functionality.

• We are currently finalizing materials for a formal study.
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Stealing and Adapting Code

1. User identifies code to steal in a source program.
2. User matches 3D models from the source program with corresponding 3D models in the target program.
3. User completes a tutorial to build the stolen functionality.
4. User can use Hastings to identify pieces of the new functionality to change.
Stealing code from other programs

(Demo)
Bernard Harris Science Camp

• 48 middle school campers
  – 24 girls, 24 boys
  – Entering 6-8th grades

• Introduced only to
  – Adding characters
  – Sequential statements
  – Learn everything else through “stealing”
Observations

• Learning Constructs: “Well, I just saw it [a loop] so many times in programs we were stealing from that I decided to make my own.”

• Social Sharing:
  – “Hey, how did you do that?”
  – Horse runs over person animation stolen and restolen.
Problems

• Abstraction now comes in early.
• Work flow is currently a little unnatural.
  – Looking Glass TV?
• Motivation comes back in choice of examples we present to each user.
The End-User Programming Gap

- Workers benefitting from programming
- Lack formal training
- Heavy use of examples


Personal Anecdote (web)

- Finding functionality in unfamiliar code
- Adapting functionality from unfamiliar code

Call your relative working on a Ph.D. in Computer Science

Adapt Relevant Parts
Questions?

Download Storytelling Alice from www.alice.org