Exploring Novice Programmer Example Use

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Programmers spend ~19% of their time programming on the web.

Stack Overflow

21 Answers

Use a sequential for loop:

```
var myStringArray = ["Hello","World"];
var arrayLength = myStringArray.length;
for (var i = 0; i < arrayLength; i++) {
    alert(myStringArray[i]);
    //Do something
}
```

Java Doc Tutorials

```
printPersonsWithPredicate(
    roster,
    p -> p.getGender() == Person.Sex.MALE
    && p.getAge() >= 18
    && p.getAge() <= 25
);
```
Existing Example Support

Novice Programmers Struggle Using Examples

Non-expert programmers have trouble reusing code found online without support

- Messing up working code
- Code not accomplishing goal

Example Use Studies Focus on Adult Programmers

Increasing number of programming applications and resources for children

Research Questions

1. What **hurdles** do novice programmers encounter using examples?
2. What **strategies** do novice programmers use while attempting to use examples?
➢ Exploratory study
➢ Labelled transcript data to understand behavior
➢ Hurdles & Strategies
User Study
What does novice example use look like?

“\textit{I don’t like to copy because I like to learn how to do it myself.}”

Novice Example Use

Task: Make the pig wave both of his hands up and then both down to signal the helicopter.

Use this example to help you solve the task:

Do together:
- Pig: 
  - say: "I'm here! I'm here!!"
  - getRightShoulder: turn BACKWARD, 0.25 rotations
  - getRightShoulder: turn FORWARD, 0.25 rotations
  - getLeftShoulder: turn BACKWARD, 0.25 rotations
  - getLeftShoulder: turn FORWARD, 0.25 rotations

- Dolphin: 
  - move: up, 2.5 meters
  - turn BACKWARD, 0.125 rotations
  - move FORWARD, 2.5 meters
  - turn FORWARD, 0.125 rotations

Play Example
Do together task

Task

Example
Do together task
What are novices thinking while completing tasks with examples?
Study Format

Training Task

Coding

4 min.

Coding

4 min.

Interview

×6
Study Format

Training Task + ×6 Coding

Coding Interview

Coding Interview
Study Format

- 6 concepts: simple parallel execution, for loop, API method, function, while loop condition, for each iterator
- Based on formative and pilot studies
Study Format

Training Task

[Diagram showing a training task with images of people and a microphone]

×6

Coding

Interview

4 min.

Coding

Interview

4 min.
Study Participants

9 pairs of participants

Participant screening criteria:

- aged 10-15
- <= 3 hours of programming experience
Research Questions

1. What **hurdles** do novice programmers encounter using examples?
2. What **strategies** do novice programmers use while attempting to use examples?
Qualitative Analysis: Transcription Labeling

- Inter-rater agreement: 20% of transcripts, **83% agreement**
- Two groups:
  - Focus Area: which part of the task/environment
  - Process: what they’re doing
Focus area labels

Programming Environment:
“Pig actions Place da da da da da . Turn. Appear disappear, resize. Hmm”
Focus area labels

Task Code:  
“There's get right shoulder. hmmm. Get right shoulder hmm”
Process labels

- Description
- Idea
- Evaluation
- Unknown/Other
Process labels

- **Description**
- Description-realization
- Description-don’t understand

“Play the example again cause. It goes up and then it stops and turns a bit”
“Play the example again cause. It goes up and then it stops and turns a bit”
Process labels

- Idea
- Idea-realization
- Idea-don’t know how

“Maybe I could try using two of them [do togethers] instead.”
“Maybe I could try using two of them [do togethers] instead.”
Process labels

- Evaluation-working
- Evaluation-possibly working
- Evaluation-not working

“I'm just gonna see if this works. YESS! We did it!!! awesome!!!”
“OHHHHH! So I don't know where we'd get this whole repeat 4 times thing, but I think I kind of understand it.”
“OHHHHH! So I don't know where we'd get this whole repeat 4 times thing, but I think I kind of understand it.”

“Ohh, so jump. Jumping jack. Then you do repeat two times”

“Wait a minute. wait can I see that again? STOP! OHH cause it's like. here, give me the mouse.”
Realization Point: the “first” realization

Definition: the point in time when one participant first talks about the concept in the example needed to complete the task
Results

1. What **hurdles** do novice programmers encounter using examples?
2. What **strategies** do novice programmers use while attempting to use examples?
How can we identify strategies and hurdles?
Task Times Before and After Realization Point
Task Behavior Groups
Hurdles & Strategies

Hurdles:
- Example Comprehension
- Programming Environment
- Code Comprehension
- Context Distraction
- Code Misconception

Strategies:
- Idea Generation
- Code-Example Comparison
- Example Emphasis
Hurdles
Example Comprehension Hurdle

“Play example. I don't get how that's supposed to help us. Yeah, I have no idea.”
Example Comprehension Hurdle

“Play example. I don't get how that's supposed to help us. Yeah, I have no idea.”
# Example Comprehension Hurdle

<table>
<thead>
<tr>
<th>Label</th>
<th>No realization</th>
<th>Slow start, incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Execution Example Code</td>
<td>0.8 × average (BR)</td>
<td>1.6 × average (BR)</td>
</tr>
<tr>
<td>Example Code</td>
<td>0 × average (BR)</td>
<td>1.6 × average (BR)</td>
</tr>
</tbody>
</table>

![Graph showing data points categorized by execution speed and correctness.](image-url)
“Then you do repeat two times. How? But it says that you can repeat. Where is the times thing? I don’t see that. “
“Then you do repeat two times. How? But it says that you can repeat. **Where is the times thing? I don’t see that.** “
# Programming Environment Hurdle

<table>
<thead>
<tr>
<th>Label</th>
<th>Long Conclusion, incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Environment: description- don’t understand</td>
<td>3.6 ✗ average (AR)</td>
</tr>
<tr>
<td>Programming Environment: idea- don’t know how</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing performance categories](image_url)
Code Comprehension Hurdle

“Why is he not on the ground?”
Code Comprehension Hurdle

“Why is he not on the ground?”
## Code Comprehension Hurdle

<table>
<thead>
<tr>
<th>Label</th>
<th>Long Conclusion, incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task execution: description- don’t understand</td>
<td>3.7 ✗ average (AR)</td>
</tr>
</tbody>
</table>

![Graph showing different task execution strategies](chart.png)
Strategies
Idea Generation Strategy

“Do we have to put that up there or what? Do we move them in there or something? For it to work? Do we move this?”
“Do we have to put that up there or what? Do we move them in there or something? For it to work? Do we move this?”
# Idea Generation Strategy

<table>
<thead>
<tr>
<th>Label</th>
<th>Long Conclusion, correct</th>
<th>Quick, correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Code: idea</td>
<td>1.25 × average (AR)</td>
<td>.4 × average (AR)</td>
</tr>
<tr>
<td>Task Code Execution</td>
<td>1.1 × average (AR)</td>
<td>.8 × average (AR)</td>
</tr>
<tr>
<td>Task Code: Description- don’t understand</td>
<td>.5 × of average (AR)</td>
<td>.5 × of average (AR)</td>
</tr>
</tbody>
</table>

![Graph showing different categories of task duration](image)
“Not is true. But here it’s just is true ... That looks like the example [...] but it’s got this not thing.”
“Not is true. But here it’s just is true ... That looks like the example [...] but it’s got this not thing.”
## Code-Example Comparison Strategy

<table>
<thead>
<tr>
<th>Label</th>
<th>Long Conclusion, correct</th>
<th>Quick, correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example Code</td>
<td>1.4 ✗ average (AR)</td>
<td>.75 ✗ average (AR)</td>
</tr>
</tbody>
</table>
What can we do with these hurdles and strategies?

Educational Systems • Visual Programing Systems • General Example Use
For Educational Systems

Certain behavior can indicate good times for novices to return to examples.
For Educational Systems

Certain behavior can indicate good times for novices to return to examples.

Examples of such behaviors include:

- many interface interactions that do not lead to solution (BR)
- many incorrect attempts or repeated attempts with minor modifications (AR)
For visual programming environments

It is important to enable novices to easily access code elements in examples.
For visual programming environments

It is important to enable novices to easily access code elements in examples.

- visual cues
- functionality to improve and expedite access
General Example Use

How can we help novices better understand and utilize the relationships between examples and program code?
Thank You

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Context Distraction Hurdle

“Wait, can you, wait click ‘as seen by’ just out of curiosity”
“Wait, can you, wait click ‘as seen by’ just out of curiosity”
## Context Distraction Hurdle

<table>
<thead>
<tr>
<th>Label</th>
<th>Slow start, correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Environment: idea</td>
<td>3.75 ✗ average (BR)</td>
</tr>
<tr>
<td>Instructions: description don’t understand</td>
<td>4.3 ✗ average (BR)</td>
</tr>
</tbody>
</table>
Summary

- Novice programmers may need time to get familiar with task, example, environment before example is useful to them.
- Example is often used as a starting point:
  - Use idea generation to try out new plans.
  - Returning to the example can help.
  - Programming environment and lack of further assistance can slow down or impede process.
“Okay, make the pig wave both hands up and both hands down to signal the helicopter.”
Focus area labels

Task or Example Execution

“Play it.”
### Focus area labels

<table>
<thead>
<tr>
<th>Label</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown/Other</td>
<td>“That was hard!!!”</td>
</tr>
<tr>
<td>Off-topic</td>
<td>“Eat fish while the eat fish eat a fish.”</td>
</tr>
</tbody>
</table>
Qualitative Analysis: Transcription Labeling

7.6 hours of audio
Focus area labels

Example Code: “It says do together, so we should try to find a way to do that.”
<table>
<thead>
<tr>
<th>Process labels</th>
<th>“What a beautiful pig.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown/other</td>
<td></td>
</tr>
</tbody>
</table>
“Maybe you put the right shoulder, maybe you switch those around. [...] Cause then it would go in sync.”
“Maybe you put the right shoulder, maybe you switch those around. [...] Cause then it would go in sync.”
## Code Misconception Hurdle

<table>
<thead>
<tr>
<th>Label</th>
<th>Long Conclusion, incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Code: idea</td>
<td>3 ✗ average (A)</td>
</tr>
<tr>
<td>Task Code Execution</td>
<td>2.5 ✗ average (A)</td>
</tr>
</tbody>
</table>

![Graph showing code misconceptions](image)
Example Emphasis Strategy

“We just saw the outline.”
Example Emphasis Strategy

“We just saw the outline.”
# Example Emphasis Strategy

<table>
<thead>
<tr>
<th>Label</th>
<th>Slow Start, correct</th>
<th>Slow Start, correct</th>
<th>Quick, correct</th>
<th>Long Conclusion, correct</th>
<th>Long Conclusion, incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example Code</td>
<td>1.7 × avg. (B)</td>
<td>1.7 × avg. (B)</td>
<td>0.3 × avg. (B)</td>
<td>1.3 × avg. (B)</td>
<td>1 × avg. (B)</td>
</tr>
</tbody>
</table>

![Graph showing various stages and results](image-url)
Example use as part of non-expert programming behavior

- Code Reuse\textsuperscript{1}
- Debugging\textsuperscript{2}
- Programming behaviors\textsuperscript{3}
- [Programming with examples]\textsuperscript{4}

