Novice Programmers in the First Three Semesters: Gaining a Better Understanding of the Problem

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ALTA Forum, Brisbane
12-13 April, 2012

Project Team

- QUT
  - Malcolm Corney
  - Colin Fidge
  - James Hogan
  - Mike Roggenkamp
  - Donna Teague (PhD Student)
- University of Technology Sydney
  - Raymond Lister
- University of Western Australia
  - Luigi Barone
  - Rachel Cardell-Oliver

Project Team

- All participants are/were teaching 1st, 2nd and 3rd semester programming units
  - Teaching assignments changed
  - Not all of project team now involved
  - Not all replacements keen to participate

What Do We Know?

- Teaching programming is not easy
  - Languages
  - Tools
  - Objects early / Objects late
  - Teachers, engagement, peer learning
- Students learn at different rates

Motivation

- Plethora of literature discussing ways of improving L&T for novice programmers
- Little real data on novice programmers' capabilities
- Most studies concentrate on first programming subject

Project Aims

- Goal
  - Longitudinal study (three semesters) of students' performance on test and exam questions
- Expected Outcomes
  - An archive of "in class test" and exam questions
  - An anonymised repository of students' tests, final exam scripts etc.
  - Performance data from students from multiple universities

Project Methodology

- Action research approach
  - Two iterations
    - Iteration 1 - Semester 2, 2011
      - Informed by pilot study
      - QUT - CS0, CS1
      - UTS - CS1
    - Iteration 2 - Semester 1, 2012
      - QUT - CS0, CS1, CS2
      - UTS - CS1
      - UWA - CS1

Instruments

- In-Class Tests
  - Not for marks
  - Presented as informal quizzes in lecture sessions
  - Learning opportunity - answers are modelled
  - Gives regular snapshots of understanding of concepts
- Exam Questions
  - Questions similar to in-class tests
  - In longitudinal chain of units

Pilot Study

- CS0
  - Swapping
  - Assignment Statements
  - Reversing
- CS1
  - Explain in Plain English questions
- CS2
  - Soloway's Rainfall Question

Iteration 1 - Semester 2, 2011

- Neo-Piagetian Concepts
  - Conservation
  - Reversibility
  - Transitive Inference

Conservation

- Find the longest string value in an array/list
- Two implementations – choose which option for each line

```
best = [a) 0
        b) names[0]]

for index in range(len(names)):
    if (len(names[index]) > [a) len(best):
                             b) len(names[best]):]
        best = [a) names(index)
                b) index]

print [a) names(best)
       b) best]
```

Reversibility

- Given code to shift elements of an array one position to the right, write code to shift them back

```
temp = values[len(values) - 1]
   for index in range(len(values) - 1, 0, -1):
      values[index] = values[index - 1]
values[0] = temp
```

Transitive Inference

- Code given that prints smaller of two stored values

```
if adam < bob:
   print adam
else:
   print bob
```

Transitive Inference

- Code given with three variables

```
if adam < bob:
   # code to swap adam and bob:
   temp = adam
   adam = bob
   bob = temp
if bob < charlie:
   # assume code to swap bob and charlie is here
if adam < bob:
   # assume code to swap adam and bob is here
```

- Ask for purpose of code in plain English
  - Puts values in descending order

Iteration 2 - Semester 1, 2012

- Leading Questions
- In class tests running each two weeks in first unit
- Will be followed with the NP concept questions in exam
- Progressive questions will be asked in second unit exam
- Progressive questions will be asked in in-class tests in third unit

Outcomes to Date

- Pilot Study
  - 1 x ACE 2011 Paper
  - 2 x ACE 2012 Papers - Best Paper Award
  - After grant was received, this project became part of a successful ALTC grant application - BABELnot
  - ACE 2011 work replicated by Murphy et al, SIGCSE 2012
- Iteration 1
  - Paper submitted for ITiCSE 2012
  - Paper to be submitted to ICER 2012
- Anonymised repository nearing prototype stage
- Informed Improvements for Teaching

Future Work

- Analysis of Iteration 2
- Iteration 3
- More Collaborators
- Acknowledgements
- Questions