

## CS Education (High-school): Clash Between Cultures

Students	Teachers and instruction
One layer approach (manipulating HCI)	Three-layers approach (HCI, program code, machine)
Members of the informals' and the technology users' cultures	Representatives of the <b>academic</b> culture
Perceive themselves as old-timers in computers world	Perceive students as newcomers to CS world
short term goals of production and manipulation of innovative technology products	Emphasize the stable (long-term) notion of algorithmic problems and design.

## Students' alternative standards for correctness

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## Influence of User's Culture on Standards for Correctness

- Edwards – students maintain inadequate work habits for too long:
  - Rely exclusively on trial and error
  - Carelessly conclude on correctness
    - after executing once or twice
    - After a successful compilation
- Iftikhar – students demonstrate inadequate methods, YET believe their methods are systematic and compatible with industry

## Culture clash in higher education?

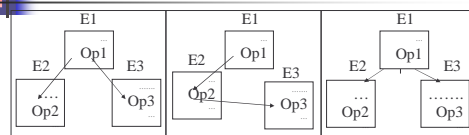
- Booth – mutual disappointment between CS instructors and students
- Gries – educators make decisions that are not purely pedagogical but are an outcome of pressure from students and industry

## What is a "Working Program"?

- Student: *It [program] works. It prints some **garbage** at the top of the screen but that **isn't important**.*
- Teacher: *[goes to student's computer] Show me.*
- Student: *[executes the program and enters input; points to the screen] Here, it works.*
- Teacher: *Is it the output you were expecting?*
- Student: **I don't know.**

Jonl and Soloway (1985)

## The Notion of Relative Correctness



- SG1 – Op2 and Op3 perform after Op1
- SG2 – there will be no other unnecessary constraints

▪ Half thinks correct b/c SG2 is not important, it works!

## Research Method

- 16 college students, 24 high school (10<sup>th</sup> and 12<sup>th</sup>), good school
- End of the year, anonymous

questionnaire

**Part A: students' practices**

Five statements about practices, norms, perceptions

**Part B: students' standards for correctness**

Description of three programs and unexpected output

## More on Relative Correctness

- Students failed to develop a correct algorithm for An ATM.
- They believed their programs were relatively correct because ...
- The programs worked for **many** input examples
- There is always a possibility that for some input examples your program doesn't work

## Results: students' practices

Statement	High school N= 25	College N = 15	Total N= 40
A.1 many executions	50%	50%	50%
A.2 reasonable output	33%	69%	48%
A.3 Solely compiling	42%	31%	37%
A.4 systematic verification	71%	75%	72%
A.5 Errors are possible	54%	81%	65%

## Part A: Students' practices

A1	I executed a program I had written many times and got valid output, therefore I know that my program is correct
A2	I wrote a program that computes a complicated calculation. When I test the program, I sometimes do not calculate (manually) the expected output, but rather satisfied if the output displayed looks reasonable
A3	There are cases that I am sure that a program I wrote is correct and then I am satisfied with compiling it (with no executions)
A4	When I test a program I systematically verify that I checked all the possible input examples
A5	There is always the possibility that there is an input example for which the program does not work that I did not find

## Part B: standards of correctness

- Given a program goal and a description of unexpected output in the execution of the program, mark if you agree, disagree, or otherwise with each of the following statements (room was left for comments):
- The program is correct
- The program is incorrect
- The program is relatively correct

## Results: the Systematic students

Statement	Percentage of students who agreed		
	High School N=18	College N= 11	Total N=29
A.1 many executions	44%	36%	41%
A.2 reasonable output	22%	36%	28%
A.3 Solely compiling	33%	27%	31%
A.5 Errors are possible	44%	45%	45%

### Part B: Standards-assignment 1

Value of X	The output
X<20	low
20 <=X<60	medium
X>=60	high

```

if X < 20 then println("low")
if X < 60 then println("medium")
else println("high");

```

Value of X	The output
70	high
40	medium
10	low medium

### Part B: a description of the assignments

	Program goal	Demonstration of extra output
If-then	Display the matching message (given code, 2 if-then sentences)	I/O example
abstract	"complicated calculations...hundreds of output"	"in the end one output item that doesn't suit PR"
Family	Information about your family	"asked for... cousins...in the end...one of your uncles"

### Part B: Standards-assignment 3

n You developed a program that produces information about your family at your request. When you gave your family data and asked for the names of all your cousins, the program displayed the names of all your cousins but in addition, in the end you got the name of one of your uncles .

### Part B: Standards-assignment 2

n You developed a very complicated program that should display hundreds of outputs. The program displayed all the output you expected to get but also in the end displayed one output item that does not suit the program requirements.

### Results: Part B

Rank	Responses			High school, N=24			College, N=16		
	C	I	R	#1 If-then	#2 numbers	#3 family	#1 If-then	#2 numbers	#3 family
1	X	√	X	38%	58%	83%	31%	19%	44%
2	X	√	√	50%	13%	0%	25%	13%	6%
3	√	X	√	0%	13%	8%	25%	25%	13%
3a	√	X	X	0%	0%	4%	0%	13%	13%
4	Indecisiveness			12%	16%	5%	19%	30%	24%

### Part B: classification of responses

Rank	Responses		
	correct	Incorrect	Relative
1	X	√	X
2	X	√	√
3	√	X	√
3a	√	X	X
4	Indecisiveness		

## What We Saw in Students' Comments

- n "The program (assignment 1) fulfills its requirements even though it prints unnecessary output".
  - n "The program (assignment 2) is not perfect but it works and that's what counts".
  - n "The program (assignment 3) is correct but it is not finished".

## Results: Summary of part B

- n High school students performed better than college students
- n Subjective factors on decisions – better Responses to assignment #3 (families) than assignment #2 (numbers)
- n Strong correlations. "Relative correctness" is common among students. Overlapping the concept of correctness.

## Conclusions: students' work habits, standards

Testing = **Systematic examination** of input examples  
**Systematic** = all input examples I could think of  
**Examination** = (sometimes) estimation of output reasonability

Correct program = working program = exhibit reasonable I/O for many legal inputs

Reasonable output = mostly correct but OR output that looks like what one would program to display

\*expectations vary according to subjective factors // or tolerance toward the unexpected varies according to subjective factors

User culture?

## What We Didn't See in Students' Comments (but Wished to)

- n There is a logical mistake in the structure of program 1...
- n The relationship between entities that constitute program 1

## Future work

- n So, first...
  - n Small N
  - n one type of output "symptom", extra output
  - n Local Israel culture or universal phenomenon?
- n Eventually, practical guidelines for instruction
  - n Test-data?
  - n responsibility
  - n Long term/short term perspectives

## Correctness and user's culture

- n Short-term goals of manipulation
  - n local goals on a particular I/O rather than global Responsibility
  - n one layer approach
- n Success = "it works" = I managed to get the specific (or much) output (garbage /reasonable output)
- n (mostly) correct

