

My Life with Case Studies

Mike Clancy
 Senior Lecturer, CS Division
 U.C. Berkeley
 clancy@cs.berkeley.edu

AP CS professional night 1

A little bit about me

- Undergrad math major at U.I.U.C., grad in computer science at Stanford
- Lower-division coordinator at Berkeley since 1977
- Member, AP CS Test Development Committee, 1986-1992; chair, 1987-1992

AP CS professional night 2

My formative years in math

Theorem
 Lemma ... QED
 Lemma ... QED
 Proof ... QED
 Corollary
 Proof ... QED

AP CS professional night 3

My formative years in CS

```
solve:
  procedure (L);
  ...
  /* beautiful code */
end solve;
```

AP CS professional night 4

The problem solving tree

problem statement

choice points

solutions or dead ends

AP CS professional night 5

A teaching philosophy

- Focus more on the *process* of problem solving than on the *end product*.

AP CS professional night 6

My life with case studies

1972 2007

AP CS professional night 7

Teaching in graduate school

- Mini-case studies as solution handouts in introductory programming course
- Case studies as solution writeups for "Problem Seminar" (Knuth, 1976; Stanford report CS-TR-77-606)

AP CS professional night 8

My life with case studies, 2

1972 2007

AP CS professional night 9

Early Berkeley years

- (1979-80) Case studies in data structures courses, again as solutions to assignments
- (1982) Start of long collaboration with Marcia Linn
- (1983) Case studies worthy of study on their own

AP CS professional night 10

Research on case studies

- (1985-88) Used in Berkeley introductory programming courses and in SF Bay Area AP CS courses

AP CS professional night 11

Reactions

- Teachers: "These are nice, but they're taking up time I need to cover pointers."
- Students, requested to read 30 pages of text overnight: "I can't do that!"

AP CS professional night 12

What we learned

- We need to keep the reader actively involved.
 - Diagrams, stop-and-... questions
- A good problem for a case study is one originally assigned as homework.
 - Length, familiarity with solution space
- Students can write them too!

Research study

- Four case studies, ten AP CS courses
- Three conditions:
 - student solution + expert code
 - student solution + case study
 - case study alone, without student solution
- Test questions:
 - Modification
 - Application
 - Analysis
 - Debugging

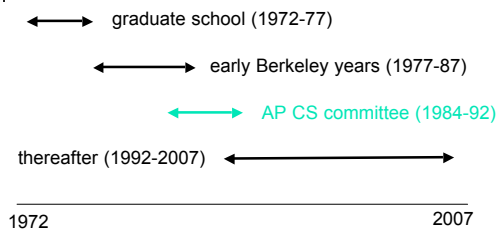
Results

- Students who worked with the case study did significantly better than those who only received expert code.
- Students who solved the problem on their own prior to receiving the case study didn't necessarily do better.
- Reference: "The Case for Case Studies of Programming Problems", March 1992 CACM.

Benefits of case studies

- They make programming knowledge explicit.
- They provide good models.
- They encourage reflection.
- They provide a context for assessment.
- They make large programs accessible.

My life with case studies, 3



Early interaction with AP CS

- I reviewed the 1984 AP CS exam. Ugh.
- "Large Programs in AP CS", *The Computing Teacher*, June 1985.
- I joined the AP CS committee in 1986.

AP CS concerns

- Authenticity
 - portfolios? (Studio Art)
 - online exam? (Carnegie-Mellon)
- Multiple-choice question design

AP CS professional night 19

Typical multiple-choice draft

Questions 15 through 37 are based on the following background ...

AP CS professional night 20

First steps

- “Directory Manager” case study was commissioned 1987, completed 1988.
- Tim Corica’s “Long Integer” case study was commissioned 1988.
- “Bowling Scores” case study was made available in 1989.

AP CS professional night 21

1989 survey

- College CS 1 compared well with high school AP CS A.
- College CS 2 involved larger programming assignments than high school AP CS AB.

AP CS professional night 22

ETS pilot study (1991-92)

- 24 high schools were involved, balanced in a variety of ways.
- Students took a special AP CS exam along with the actual exam.

AP CS professional night 23

Questions

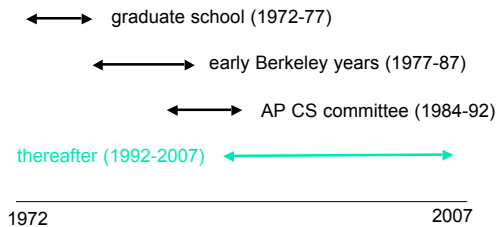
- Can the Committee invent good case study questions? **YES**
- Are the case study questions measuring something different than the test is already doing? **YES**
- Are the results measuring students or teachers? **students**
- What impact does the case study have on learning the current AP CS curriculum? **+**

AP CS professional night 24

Another item of interest

- Females did much better on the case study questions relative to males than they did on previous AP CS exams.

My life with case studies, 4



Life after AP CS

- Marcia Linn and I wrote two collections of case studies (*Designing Pascal Solutions*, Freeman, 1992 and 1996).
- Students write case studies—design writeups—in our data structures course.
- Research on case studies continued with our switch to Lisp in our introductory programming course in 1990; case studies written then are still in use.
- I'm still working on new case studies.

Research questions

- What aspects of case studies lead to improved learning?
- How close is working with a case study to writing a program from scratch?
- What aspects of case studies account for gender differences?
- How should a case study best be presented?
 - format?
 - use of multimedia?

Subsequent AP cases

- “Directory Manager”, 1995-96
- “Large Integer”, 1997-2000
 - spanned switch to C++ in 1999
- “Marine Biology”, 2001-07
 - spanned switch to Java in 2004
- “GridWorld”, 2008-

The future of AP case studies

- Hard to write: are they worth the effort?
- Case studies can help *teachers* (e.g. in language switch).
- Case studies can aid curriculum change.
 - ADTs (“Large Integer”)
 - OOP (“Marine Biology”)
 - Curriculum driven by applications, e.g. societal?



I love writing case studies!

- Standard procedure:
I write a draft, a colleague finds lots of unjustified steps.
- Why did I solve the problem that way?
How did I get from there to here?



Resources

- <http://www.cs.berkeley.edu/~clancy/web/case.studies.html>
(ready within a week)