Using the Web to teach programming

I’ll describe today a pilot version of CS 3 taught summer 2002:

– implementation
– results
– implications for instruction at Berkeley and elsewhere.

### CS 3

• CS 3 (“Introduction to Symbolic Programming”) is a first programming course using Scheme.
  • It covers Functional (side-effect free) Programming.
  • It includes activities based on case studies (~200 lines of code).
  • It ends with a relatively complex project:
    – use of higher-order functions.
    – recursion.

• It started by an instructor and two or three lab assistants.

• Three lab sections (enrollment = 22, 18, 10) were system and presented in a custom course “portal”.

• Activities were all online, developed in the WISE
  – 14 hours of lab per week.
  – 0 hours discussion section, and
  – 0 hours lecture.

### Contact hours for summer CS 3 (8-week session):

• 2 hours Lab
• 1 hour Discussion
• 2 hours lecture

### Summer 2002 CS 3

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### Traditional CS 3 Contact Hours

• 2 hours Lab
• 1 hour Discussion
• 2 hours Lecture

Elsewhere:

• Implications for instruction at Berkeley and elsewhere.

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WISE (Web-based Inquiry Science Environment)

- WISE (Web-based Inquiry Science Environment)
  - combines a database of pedagogical activities with a front-end that organizes them.
  - Activities include:
    - Web page reading
    - Quizzes
    - Online discussion
    - Comparing online answers
    - Online note-taking
    - Online discussion
    - Web page reading
    - Online note-taking
  - Activities include:
    - Web-based Inquiry Science Environment

CS 3 use of WISE

Course Portal

CS 3 Logistics

- Homework often involved contributing to discussion.
- Some work was visible to the staff; mini-lectures proceeded through a bunch of the other kinds of activities.
- The typical day started with a quiz, and activities were organized in relatively small steps.
- Students did relatively more of their work in the lab rather than at home.
- Pacing was flexible; there were occasional "catch-up" days.

More CS 3 Logistics
Student discussion

Collaborative problem solving

Students must post their own responses before they can view the responses of others.
Scheme tools

Summary of differences

• Higher proportion of supervised online activity.
• Constant monitoring of students; timely tutoring.
• Wider variety of activities, including implicit and explicit collaborations.
• Flexible pacing.

Results

• Better performance on comparable final exams (average = 32.9 out of 60 compared to 25.8).
• Extremely high course evaluation ratings.

Ratings of “respond then review” questions (5 is best, 1 worst)

• (3.7) Supply a solution to an exercise with several higher proportion of supervised online activity.
• (3.5) Supply a suggestion for understanding.
• (3.5) Explain how you got an answer.
• (3.4) Explain how it works.
• (3.4) Report the results of experiments.

Flexibility of pacing.

and explicit collaborations.

Wider variety of activities, including implicit understanding.

Timely tutoring.

Consistent monitoring of students.

Higher proportion of supervised online activity.
Ratings of discussion questions

(5 is best, 1 worst)

• (3.3) Summarize the case study.
• (3.3) Devise a quiz for the case study.
• Programminig difficulty (e.g., reaching a dead end).
• (3.4) Suggest how you might handle a given understanding larger programs.
• (3.6) Explain productive techniques for understanding.
• (3.6) Suggest tips for understanding.
• (3.8) Comment on mistakes you made.

What does the instructor do?

• Train staff.
• Tune the curriculum.
• To identify misconceptions.
• To help identify students who need help, and
• Monitor online work.

Ratings of discussion questions

(5 is best, 1 worst)

• (3.1) Supply the “largest” or “smallest” solution to a problem.
• (2.9) Provide an opinion about choice between alternative designs or code segments.
• (2.8) Reflect on what might make ___ hard to understand.

Ratings of discussion questions

(5 is best, 1 worst)

• (2.8) Provide and compare images of recursion.
• (2.8) Else to learn.
• (2.6) Explain why ___ is hard for you or someone else to learn.
• (2.6) Describe features of a given design.
• (2.6) Describe productive techniques for understanding larger programs.

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• Tune the curriculum.
• To identify misconceptions.
• To help identify students who need help, and
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Research questions

- Does it work in the regular school year? (Summer students may be exceptional somehow.)
- What good are the new activities?
- How much does timeliness matter?
- What role does physical location play?
- Would a "virtual" lab section work?
- Can CS 3S (self-paced version of CS 3) benefit?

Implementation at U.C. Merced

- Plans for Spring 2003
  - Experimental section of CS 3: 6 hours of lab, 1 hour of discussion/lab.
  - Spring 2003: New format for CS 3: 1 hour lecture, 6 hours of lab, 1 hour of discussion/lab.

Plans for Berkeley CS 3

- Fall 2002: Experimental section of CS 3.

More research questions

- How do curricular segments compare?
- How do we capture it?
- What value does a good lecturer provide, and who succeeds that didn’t in the old system?

Additional notes:

- Berkeley staff will watch Merced online activities and College (one instructor, no lab assistants).
- A version of CS 3 will be run through Merced Community College "learning centers" in Modesto, Fresno, and Bakersfield.
- Students will take classes in Merced and at remote lower-division courses to U.C. Merced.
- Campus is expected to open in Fall 2004.
- The CITRIS project is supporting the transfer of our lower-division courses to U.C. Merced.

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Plans for Berkeley CS 3

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Questions

- Can the system accommodate Merced students?
- Does virtual tutoring work?
- How much expertise is needed at the remote site?
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Long-term CITRIS-sponsored work

Research directions

- Customization
- Studies of the process of course instruction
- Analysis of elements of technologically-based instruction
- Methods for benchmarking educational innovation

Tools

- Development
  - Activities in the data base
  - The Course Customizer, which allows a prospective instructor to build a course from a data base of richly annotated course activities.
  - The Curriculum Builder, which manages a data base for lower-division CS courses, plus courses in other areas.
  - Versions of the other lower-division CS courses.

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