Innovative Instruction in the CS Classroom
Why faculty aren't obsolete ... yet

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Overview

• Background on how I got interested in innovative ways to teach CS
• Introduction to some instructional techniques
  – Inverted classroom
  – Peer instruction
• Discussion: opportunities in CS education
My Background

Bachelor’s in Computer Engineering
University of Michigan: 43,000 students, Est. 1817

Master’s in Information Science
University of Michigan: 43,000 students, Est. 1817

PhD in Computer Science
Northwestern University: 20,000 students, Est. 1851

Assistant Professor – 4 years
Cal State Monterey Bay: 5,000 students, Est. 1994
Unengaged students
High absence rates
Copied homework
Consistent fail rate
~25%

“I’m just not good at computer science”

“I understand the concepts but can’t figure out the programming problems”
the sage on the stage
CLASS vs. THE INTERNET vs.
Education can be fixed. We have the Technology!
MOOCS

- “…in 50 years there will be only ten universities left in the world”
A Master's-Level Computer Science Degree, Delivered Via MOOCs

ZDNet

May 22, 2013

The Georgia Institute of Technology, College of Computing, plans to offer the first online Master of Science degree in computer science that can be earned via a massive open online course (MOOC) format. The degree will be delivered through the Udacity MOOC platform, and AT&T will provide financial support.

Students enrolled in the program will pay a fraction of the cost of traditional on-campus master's programs. Total tuition for the
Figure 3. Student persistence in *Bioelectricity, Fall 2012*

- Registered: 12,725
- Watched at least one video: 7,761
- Took any quiz during the course: 3,658
- Scored >0 on both Week 1 quizzes: 1,267
- Scored >0 on either quiz in Week 4: 561
- Attempted the final exam: 346
- Earned a certificate: 313
- Earned a distinction certificate: 261
Coursera Partnership

• The partnership with Coursera will give professors the option to experiment with and improve upon the “blended learning” model, which combines online video lectures and content with active, in-person classroom interactions.
How do students learn?

Acquisition

Lectures, readings, videos

Assimilation

Solving problems, hands-on projects, creative works
Lecture Course

Class
• Lecture
• Quizzes
• Exams
  Acquisition &
  Demonstration

Home
• Reading
• Problem sets
• Projects
  Mostly Assimilation
Inverted Classroom
The Inverted Classroom
CS20 at Harvard

- **Homework would be daily.** There would be a reading assignment for every class. But when they got to class, they would talk to each other instead of listening to me. In class, I would become a coach helping students practice rather than an oracle spouting truths. We would “flip the classroom,” as they say: students would prepare for class in their rooms, and would spend their classroom time doing what we usually call “homework”—solving problems.

- And they would **solve problems collaboratively**, sitting around tables in small groups. Students would learn to learn from each other, and the professor would stop acting as though his job was to train people to sit alone and think until they came up with answers. A principal objective of the course would be not just to teach the material but to persuade these budding computer scientists that they could learn it.
Inverted Classroom

Class
- Lecture
- Quizzes
- Exams

Home
- Reading
- Problem sets
- Projects

Acquisition & Demonstration

Mostly Assimilation
Pilot Course: CST 231

Homework
- Fewer projects
- Online workbooks

In-Class
- Quizzes
- Group problem solving
- Labs
  - Done with pair programming partners

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For loops
Just about any kind of repetition you could want to model can be done with the while loop that we learned last time. In C++, for loops are also handy for modeling repetition; they are particularly good at writing loops that involve a counter (or doing an action a known number of times). The syntax for a for loop is a little more involved and in the general case, it looks like this:

```c++
for (initial statement; loop condition; update statement)
{
  statement(s);
}
```

The rules for how a for loop:
1. The initial statement
2. The loop condition
3. The statement(s)
4. The update statement will update the loop

TO DO: How many times does the loop below print “Looping”? (copy/paste below)
```c++
int main()
{
  int num = 10, sum = 0;
  for (int i = 1; i <= num; i++)
  {
    cout << "Looping\n";
  }
  return 0;
}
```

Your answer: 10

Submit!
Pilot Course: CST 205

- Use existing resources when possible
- Free online books
- Codacademy
- Media computation
Do they do the work??
How often did you complete the workbooks before coming to class?

- Always: 10 (56%)
- Most of the time: 8 (44%)
- About half of the time: 0 (0%)
- Almost never: 0 (0%)
- Workbooks??: 0 (0%)

How often did you review a workbook after its due date to reinforce a concept or for clarification during lab?

- Almost every lab: 4 (22%)
- Frequently (more than 75% of labs): 5 (28%)
- About half of the time: 8 (44%)
- Rarely (around 25% of labs): 0 (0%)
- Never: 1 (6%)
• I like the hands-on problem solving work in class

• I would prefer a lecture-based course
Peer Instruction
Peer Instruction

1. Pre-class preparatory work
2. Question posed to class (typically multiple choice, often using clickers for student response)
3. Students discuss answers in small groups
4. Question answered again (students may change their answer based on group discussion)
5. Class-wide discussion led by the instructor
Example Question

• Which of the following is best suited for a dictionary instead of a list?
  – A. The order in which people finish a race
  – B. The ingredients for a recipe
  – C. The names of world countries and their capital cities
  – D. 50 random integers
Peer Instruction

Existing Resources

Operating Systems Peer Instruction Materials
Published July 21, 2012 - No Comments

Topics Coverage Summary: This is an introductory course on the principles of operating systems. Topics include processes, scheduling synchronization, memory management, virtual memory, file system I/O, protection, security, networking, and distributed systems. There is a significant sys ...

read more
Other Innovations/Techniques

- Problem-based learning
- Pair programming
- Peer review
Some Commonalities of Successful Innovations

• Frequent, low-stakes, formative assessments
• Some materials provided for home-study
  – Students held responsible for materials
• Hands-on, in class problem solving
• COLLABORATION
Education != Content Delivery
What (I think) I’ve Learned

• Instructors still have a valuable role to play

• Encourage students to learn through *doing*

• If you assign homework, hold students accountable

• Use technology as a means not an end

• Borrow liberally from others
Questions/Discussion