Innovative Instruction in the CS Classroom

Why faculty aren't obsolete ... yet

Kate Lockwood

Cal State, Monterey Bay

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

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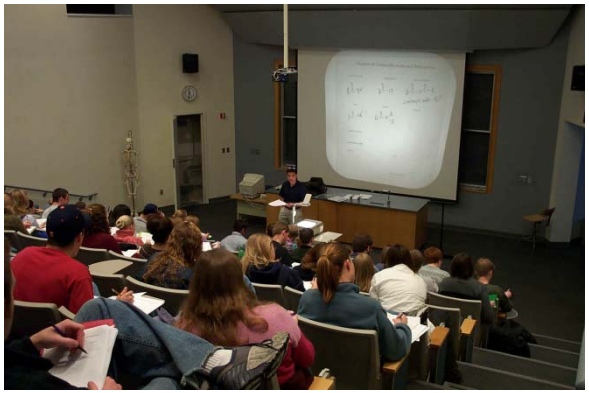

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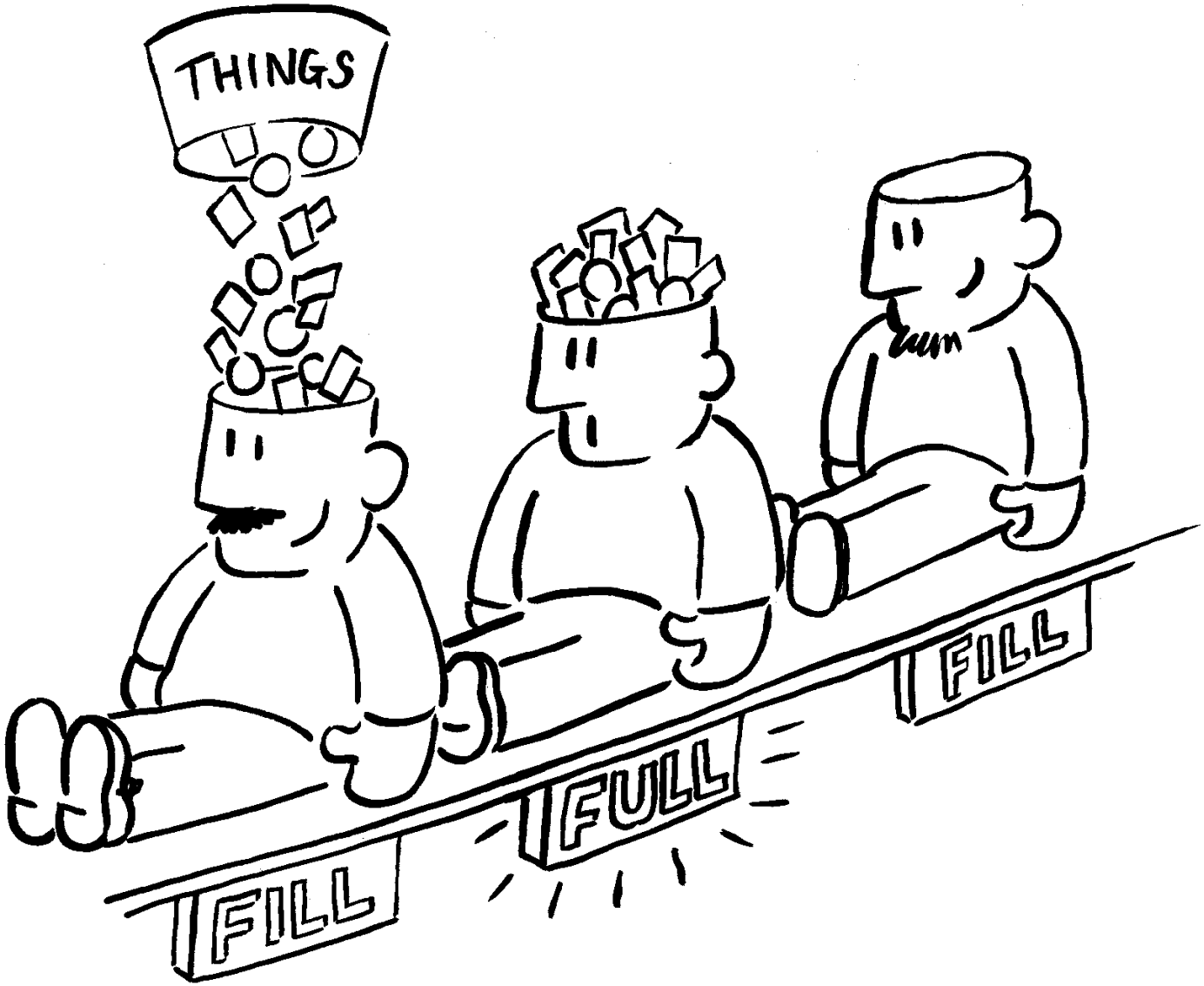
= LEARNING


THINGS
FILL
FULL
FILL

Unengaged students

High absence rates

Copied homework

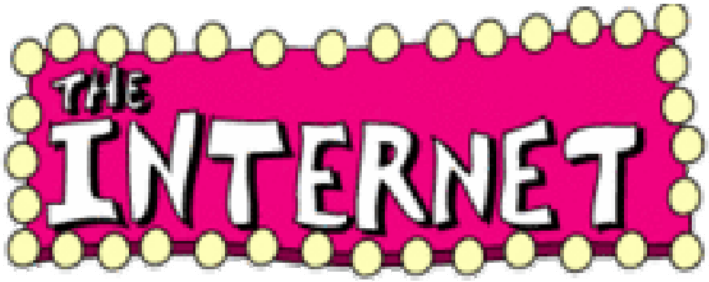
Consistent fail rate ~25%

“I’m just not good at computer science”

“I understand the concepts but can’t figure out the programming problems”

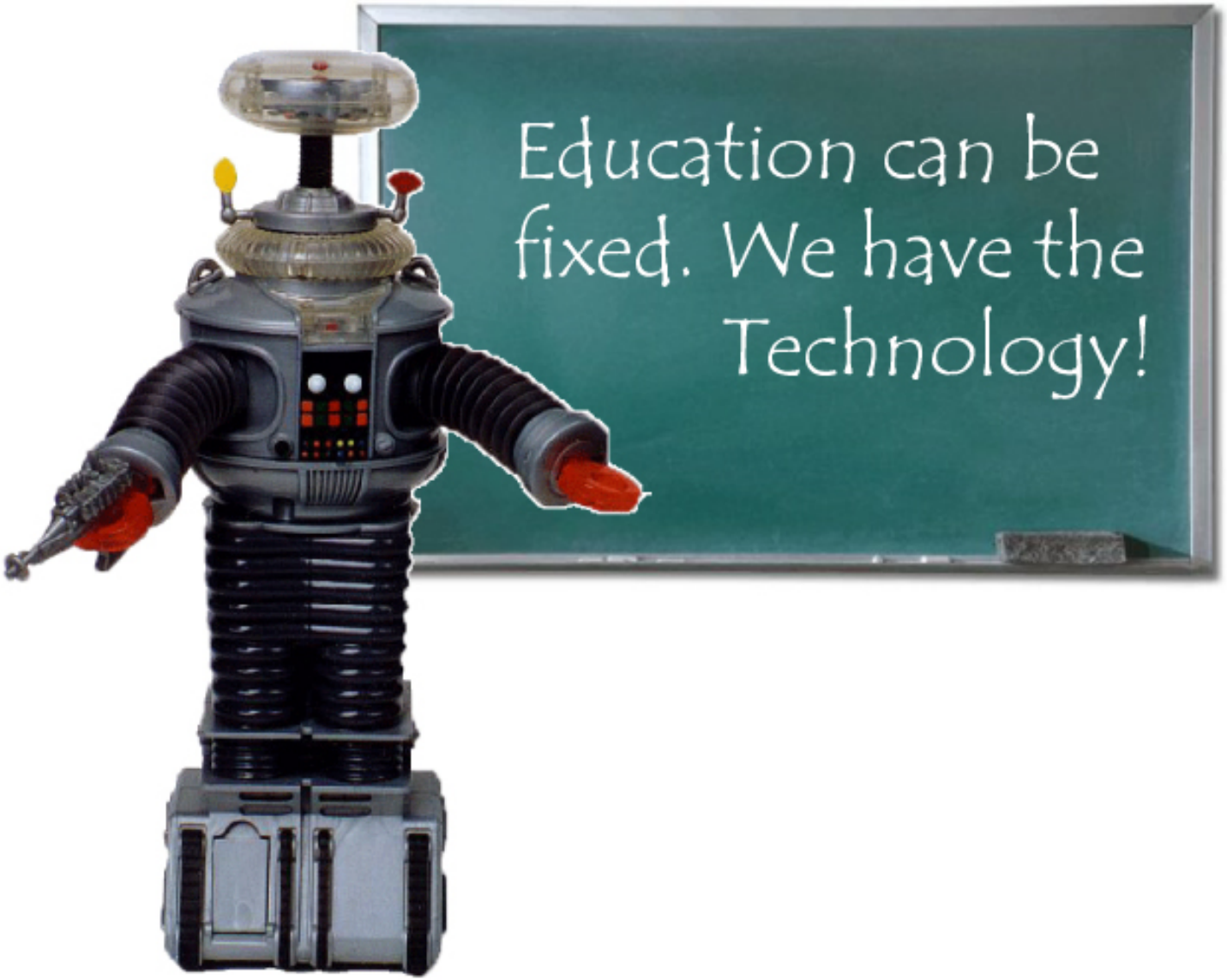
the sage on the stage


YouTube
coursera
edX
UDACITY
KHAN
ACADEMY

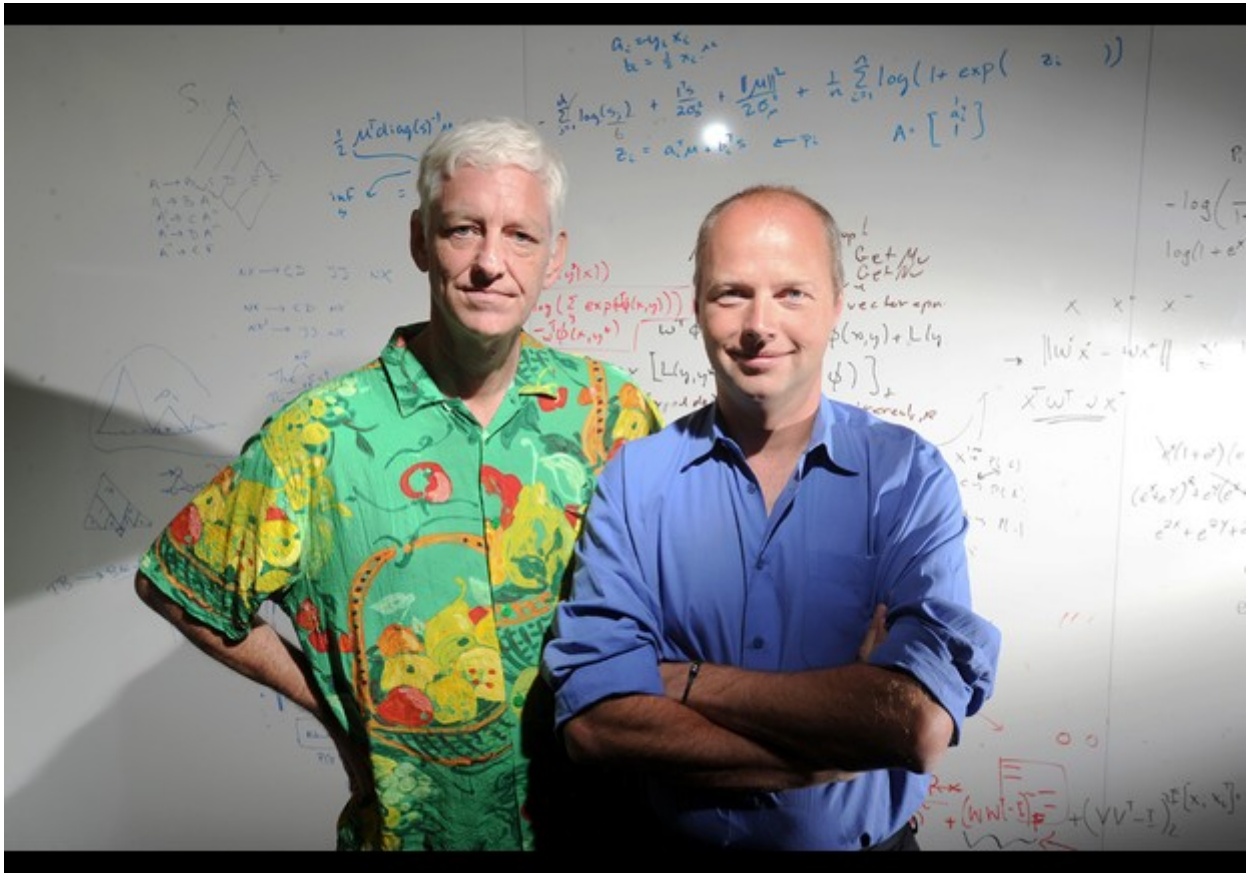


VS.

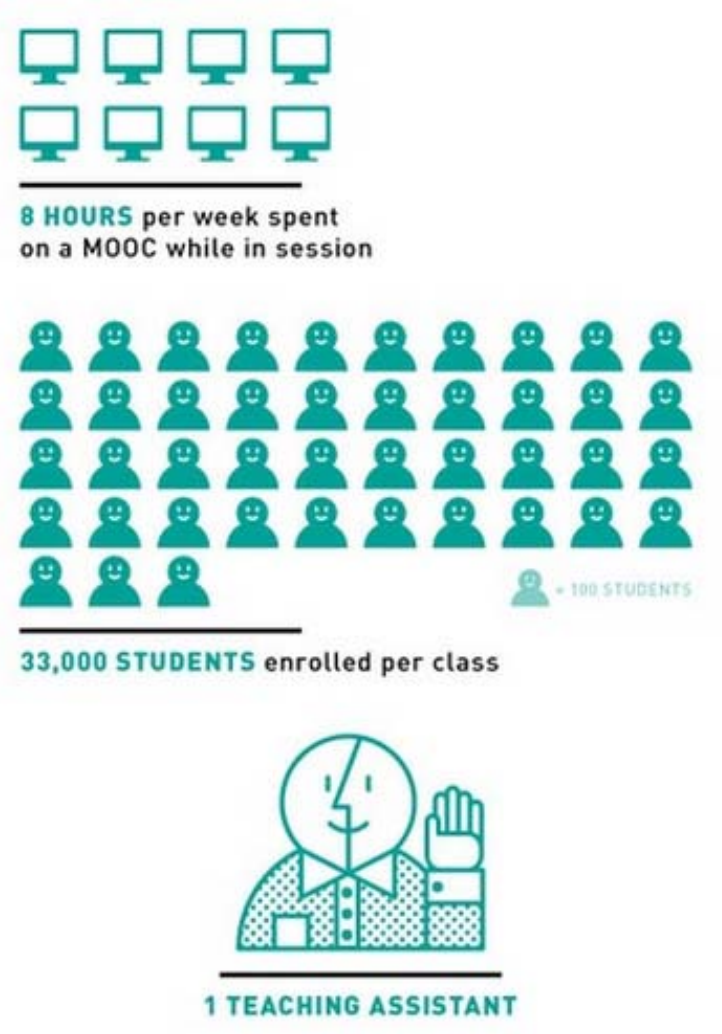
CLASS


Education can be
fixed. We have the
Technology!


RISE OF THE
MOOCS



MOOCS



- "…in 50 years there will be only ten universities left in the world"

ACM TECHNEWS

A Master's-Level Computer Science Degree, Delivered Via MOOCs

ZDNet

May 22, 2013
Comments

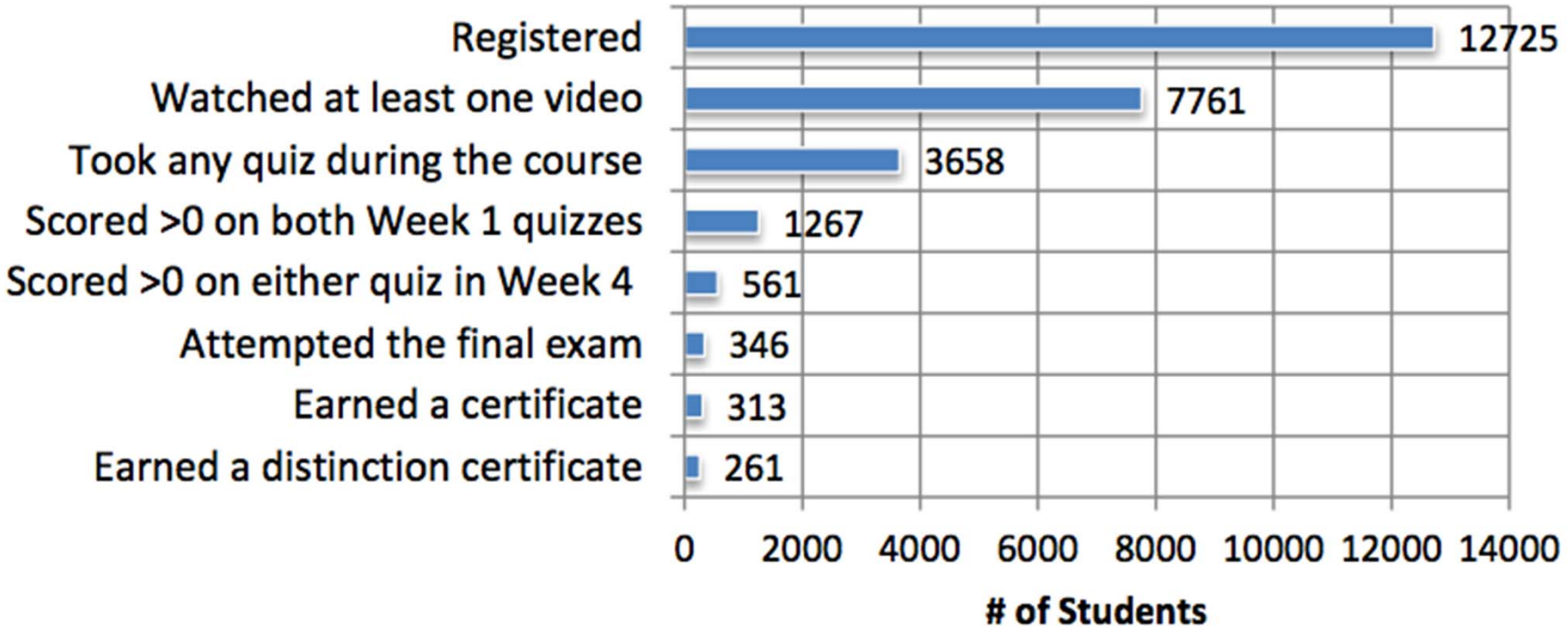
The Georgia Institute of Technology, College of Computing, plans to offer the first online Master of Science degree in computer science that can be earned via a massive open online course (MOOC) format. The degree will be delivered through the Udacity MOOC platform, and AT&T will provide financial support.

Students enrolled in the program will pay a fraction of the cost of traditional on-campus master's programs. Total tuition for the

MORE NEWS & OPINIONS

Improving Communication

Figure 3. Student persistence in *Bioelectricity, Fall 2012*



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.*

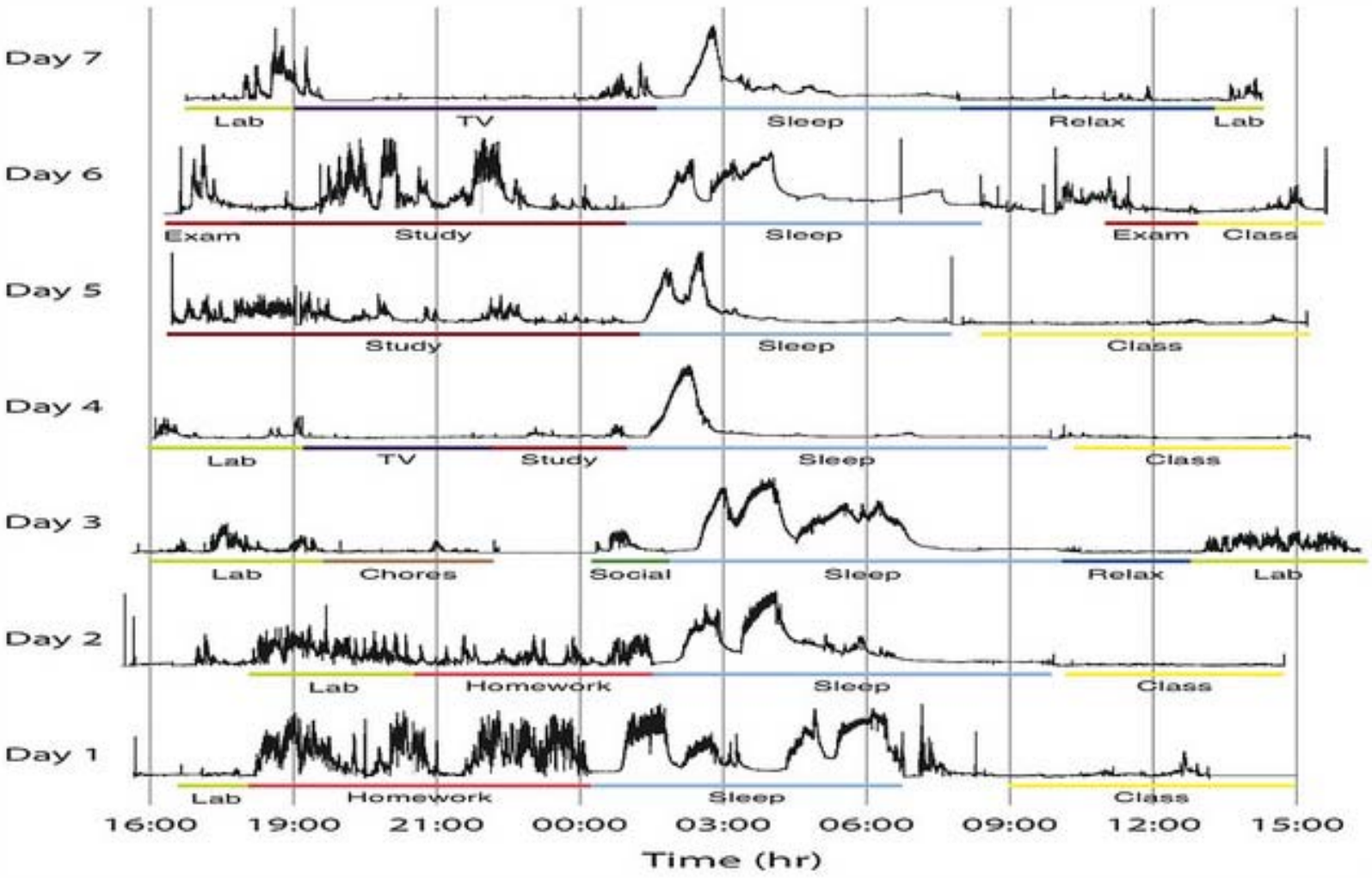
How do students learn?

Acquisition

Lectures, readings, videos

Assimilation

Solving problems, hands-on projects, creative works


Day 7
Lab
TV
Sleep
Relax
Lab
Day 6
Exam
Study
Sleep
Exam
Class
Day 5
Study
Sleep
Class
Day 4
Lab
TV
Study
Sleep
Class
Day 3
Lab
Chores
Social
Sleep
Relax
Lab
Day 2
Lab
Homework
Sleep
Class
Day 1
Lab
Homework
Sleep
Class
16:00
19:00
21:00
00:00
03:00
06:00
09:00
12:00
15:00
Time (hr)

Lecture Course

- Lecture
- Quizzes
- Exams

Acquisition & Demonstration

Class

- Reading
- Problem sets
- Projects

Mostly Assimilation

Home

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

- Lecture
- Quizzes
- Exams

Acquisition & Demonstration

Class

- Reading
- Problem sets
- Projects

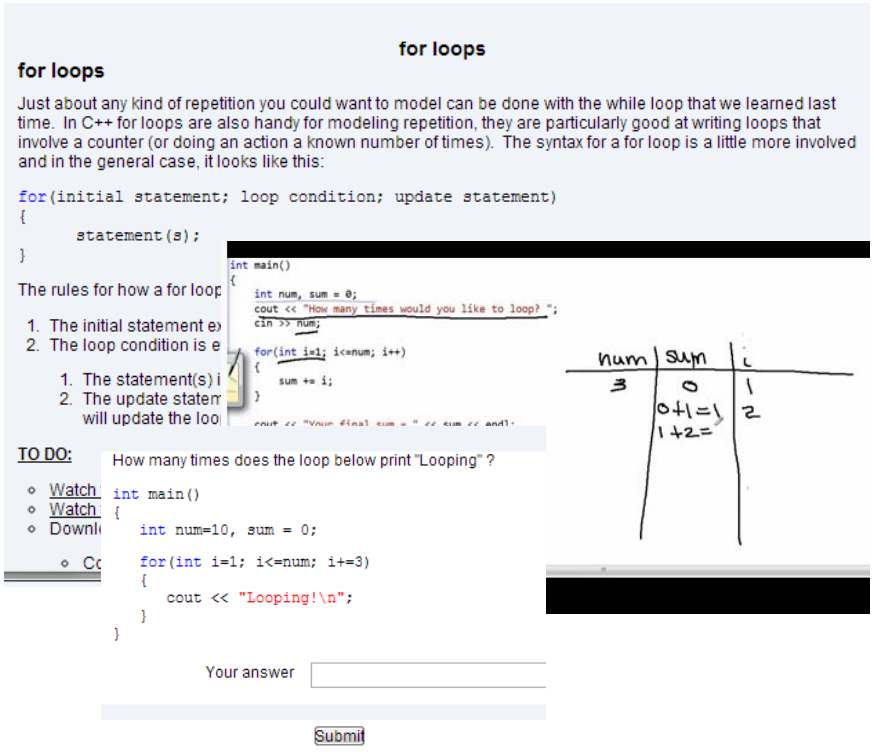
Mostly Assimilation

Home

Pilot Course: CST 231

Homework

- Fewer projects
- Online workbooks

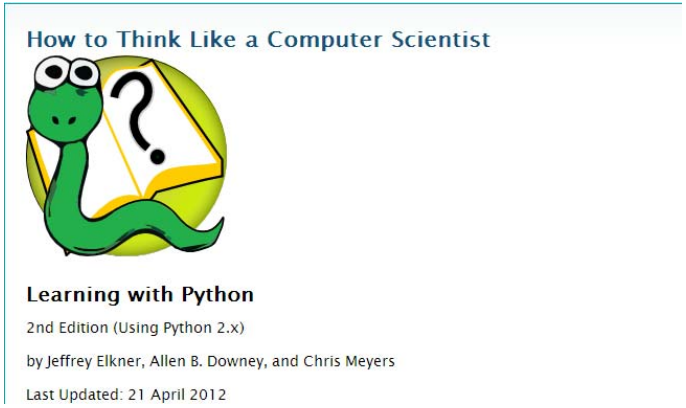


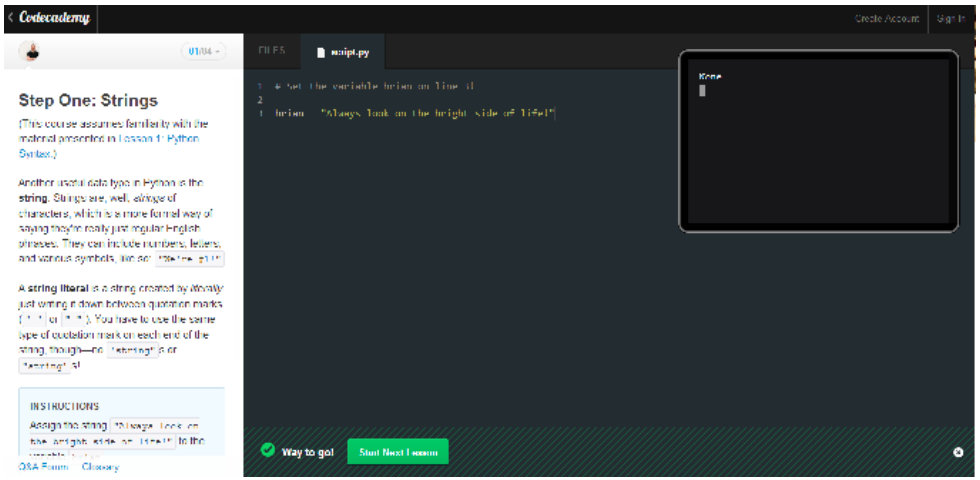
In-Class

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

Pilot Course: CST 205

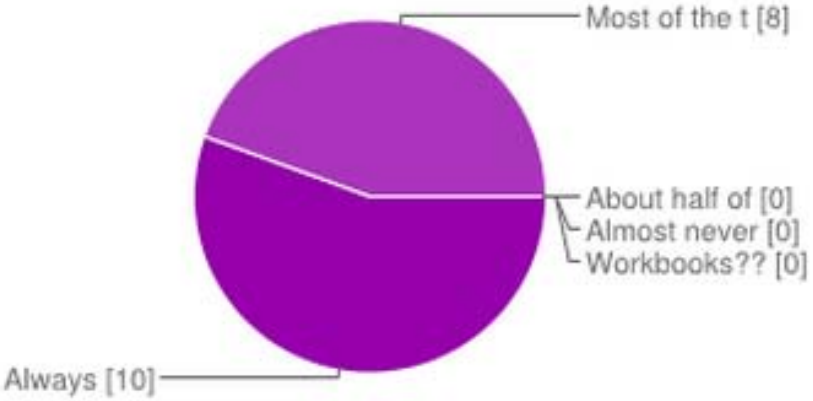
- Use existing resources when possible
- Free online books
- Codacademy
- Media computation





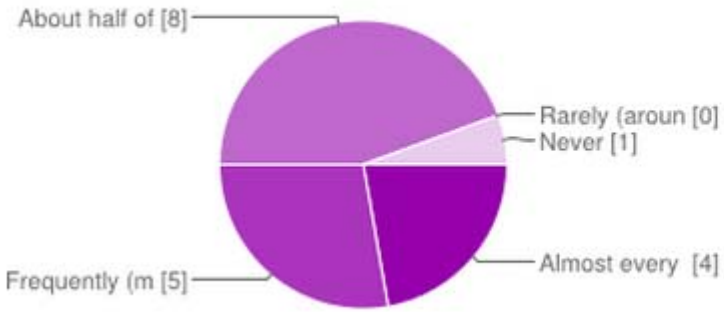
Do they do the work??

How often did you complete the workbooks before coming to class?



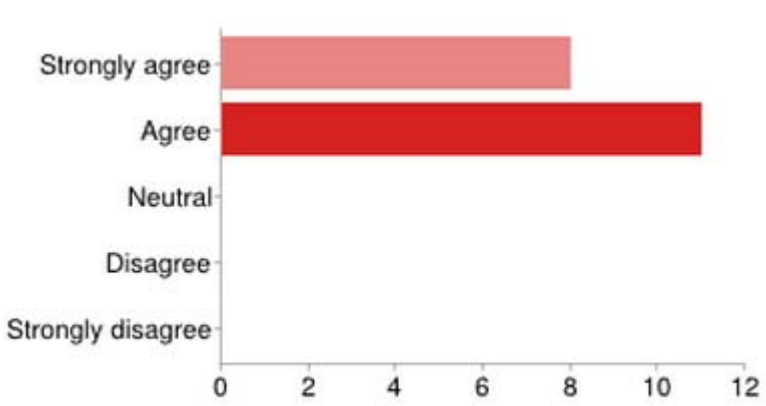
Always	**10**	56%
Most of the time	**8**	44%
About half of the time	**0**	0%
Almost never	**0**	0%
Workbooks??	**0**	0%

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

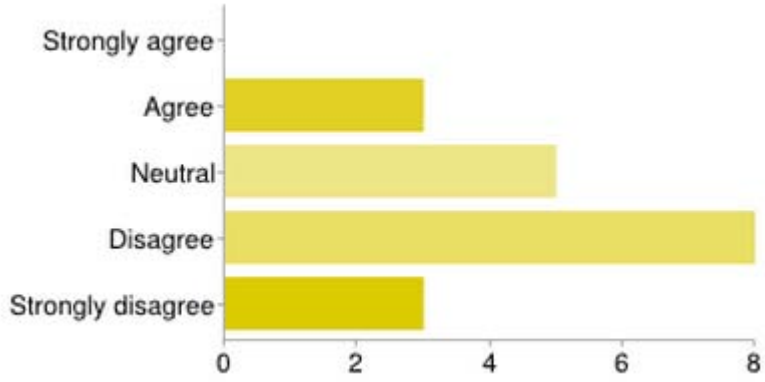


Almost every lab	**4**	22%
Frequently (more than 75% of labs)	**5**	28%
About half of the time	**8**	44%
Rarely (around 25% of labs)	**0**	0%
Never	**1**	6%

- I like the hands-on problem solving work in class

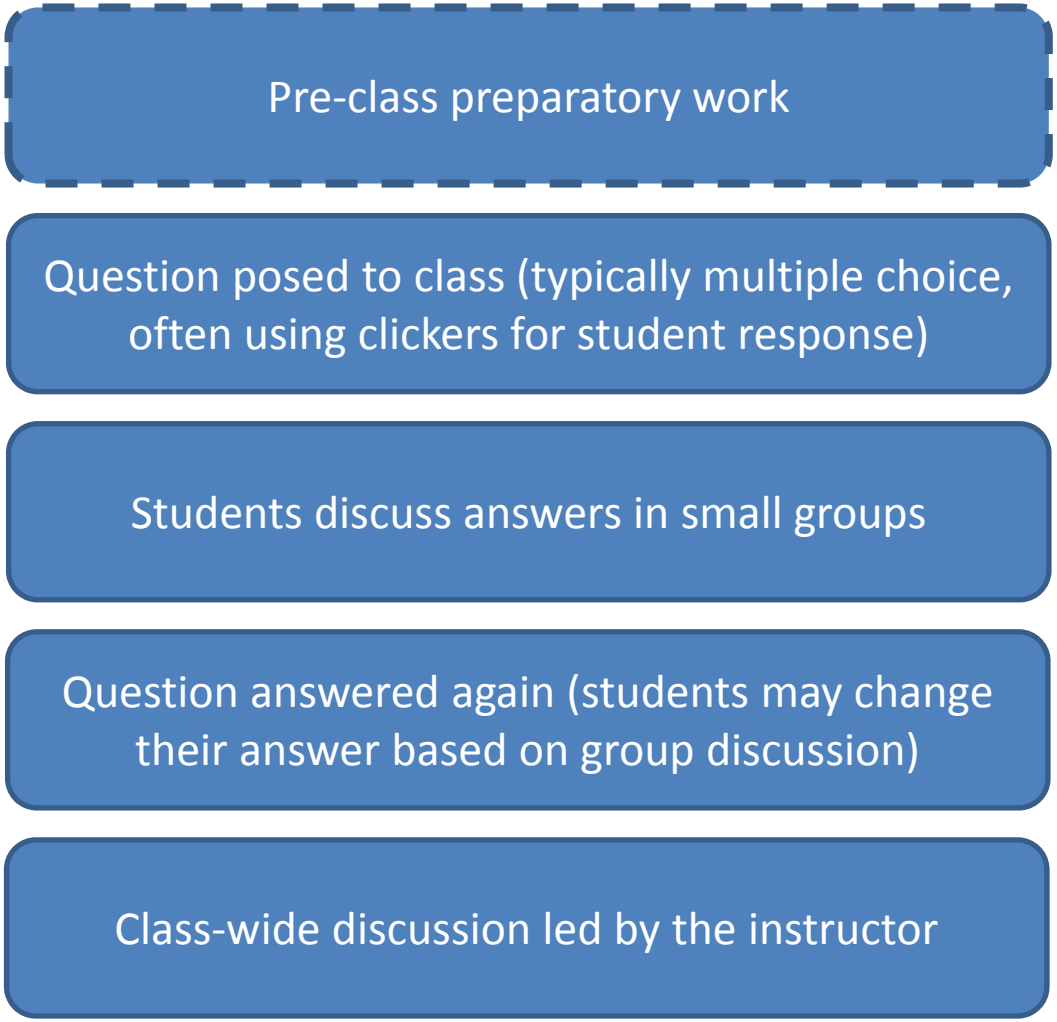


- I would prefer a lecture-based course



Peer Instruction

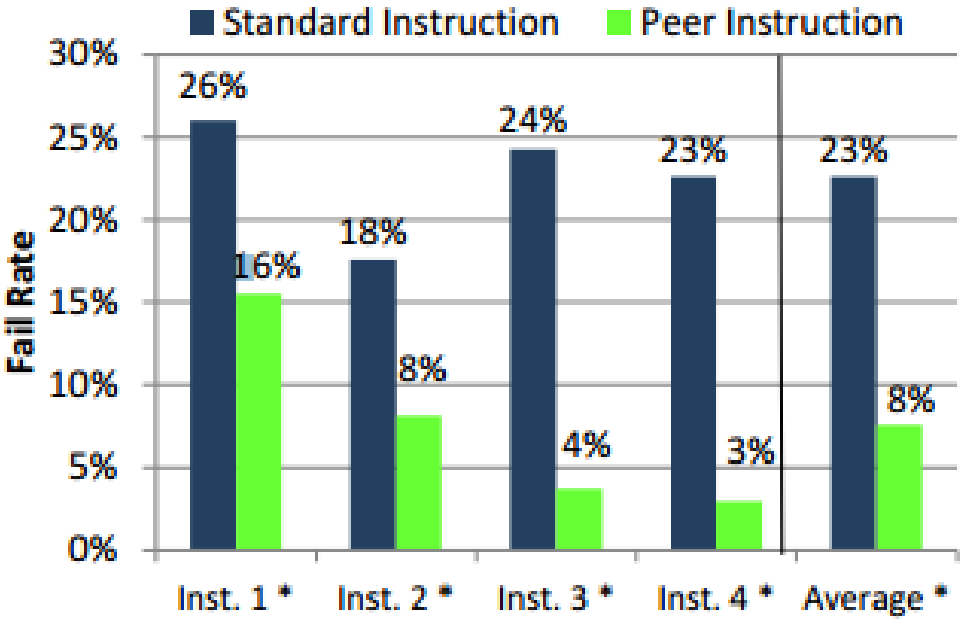
Peer Instruction



Example Question

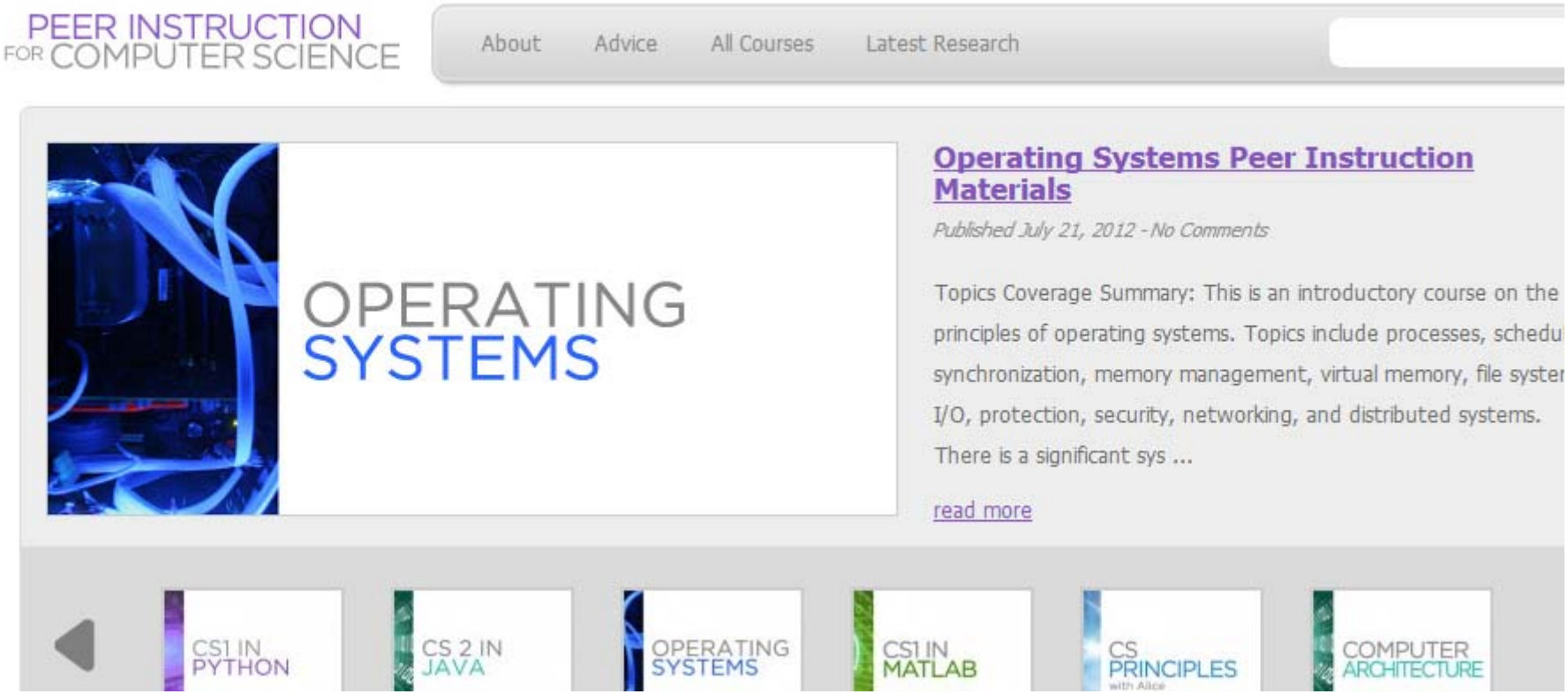
- Which of the following is best suited for a dictionary instead of a list?
  - A. The order in which people finish a race
  - B. The ingredients for a recipe
  - C. The names of world countries and their capital cities
  - D. 50 random integers

Peer Instruction



- Porter, L., Bailey-Lee, C., and Simon, B. (2013). *Halving Fail Rates Using Peer Instruction: A Study of Four Computer Science Courses.* SIGCSE 2013.

Existing Resources



Other Innovations/Techniques

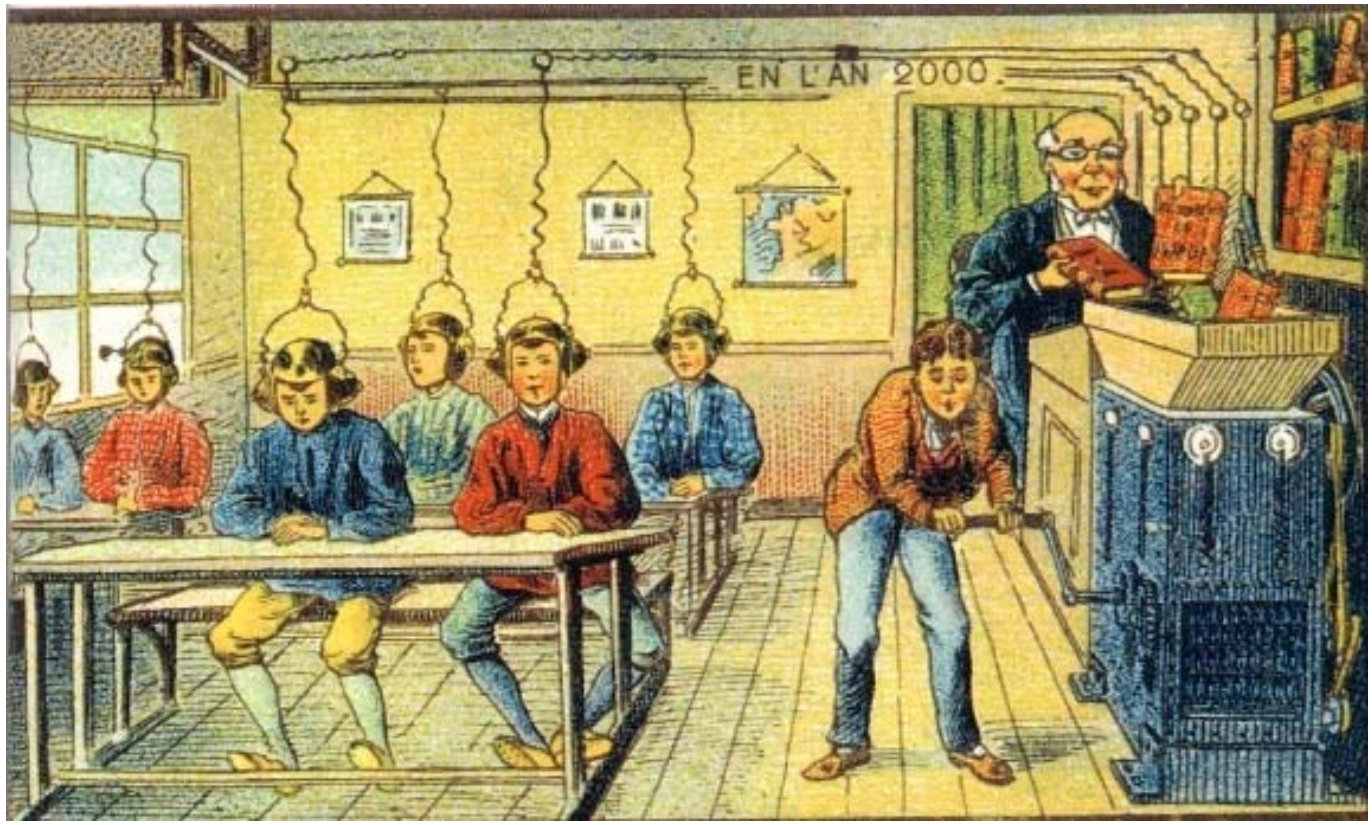
- Problem-based learning
- Pair programming
- Peer review


Perl
PHP
Markup
Scala
Functional
C++
SQL
.NET
XML
Pascal
VisualBasic
Erlang
Ruby
DataStructured
Declarative
Python
Cobol
Prototype-based
Assembly
Yorick
Object-Oriented
Fortran
MATLAB
BASIC
Logic-based
LabVIEW
Logo
Haskell
Visual
Distributed
Interpreted
Procedural
Prolog
Java
Scheme
Clojure
Squeak
Scripting
Multiparadigm
Ada
C-sharp
Smalltalk

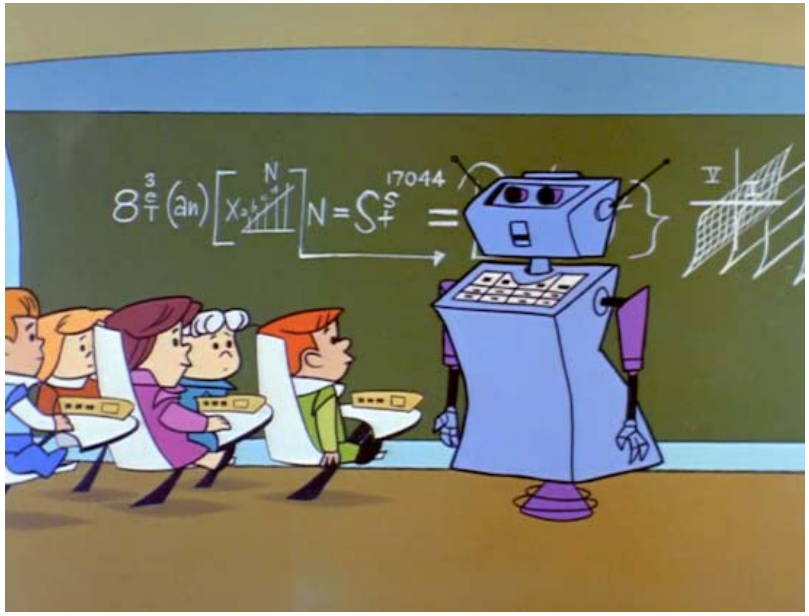
Some Commonalities of Successful Innovations

- 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