Effective Teaching and Class Management

CRA-W Early CMW
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What is Professor “of the Practice”?

Position exists in many departments at Duke
   About 20% of Arts and Sciences Faculty
PhD preferred, or appropriate professional experience
Non-tenure track, permanent position, promotable
Renewable contracts (4 – 8 yrs)
Focus on “education in the discipline”
Focus on undergraduates
Main tasks
   Teaching (2 courses per semester)
   Research (related to education) – grants/publish in CSED
   Service, advising
Be Aware: Different Types of Learners

Learning Styles
- Visual Learners – visual displays
- Auditory Learners – verbal lectures, discussions
- Kinesthetic Learners – moving, doing, touching

Some people are a mix

How do you reach all learners?
- Provide pictures, diagrams and text
- Discuss what you are doing
- Provide activities for trying it
Teaching a Course

• **Surviving** as a teacher…
  • Ask others for their course materials
  • Find course materials on line
  • Do the same thing every year

• **Thriving** as a teacher…
  • Create a class you’d like to attend
  • Entertaining, Relevant, Challenging, Clear
  • Experiment – try new ways to present
  • Active teaching, Active Learning
    • Flipped classroom, “Think, Pair, Share”
You could dress up as a data structure

What data structure is this?
YARN, in the shape of a binary tree. Subtrees made with molecule kit. What is it?
2D-range tree

Search in x-y plane
Main tree organized by x-values
Subtree organized by y values
Planning - Syllabus

• Book, papers, online materials
• Outline of topics and assigned readings
• Homework/assignments
• How many tests? Final exam?
• Grade based on?
• Course policies - explicit
  • collaboration? On which assignments?
  • Who can they get help from? Internet? People outside the course?
  • Check assignments with Moss
Read the book

Read before coming to class
Ready to work in class

Reality
Run out of time to read, not prepared

Bring on – Reading quizzes
Online
Turn off when class starts

Question 4 of 8
What is the output of the following:
```python
alist = [6, 3, 4, 9]
del alist[1]
print alist
```

- A. [6]
- B. [3, 4, 9]
- C. [6, 3, 4]
- D. [6, 4, 9]

Reset Selection
Have an engaging book....

Runescape (Brad Miller)
Electronic Textbooks (ebooks) engage students

OpenDSA (Shaffer, Virgina Tech)
Algorithm animations built in
runestoneinteractive.org (Brad Miller,
Several books (Python)
• Python - try and run code built in
• Quizzes

Zyante.com – interactive textbooks
Track student progress

Requirements and design strategies for open source interactive computer science eBooks
ITiCSE 2013 Working Group (Korhonen, Naps, et al)
Preparation for first day and first day...

What type of lecture?
What type of room?
Classroom rule:

NO SITTING IN THE LAST FOUR ROWS!

Come forward

Yes YOU who is sitting in the last four rows.
Get to know your students!

- Get their picture
- Pass around a camera the first day
- Registrar photo lists
Ways to Select students to answer questions

Problem – same students always eager
How do you get other students to participate?
  Randomly call on them
  Work in groups – call on group
  Assigned groups – call on group numbers
Randomly Select a Student
Pick A Student Program

Collect pictures
of students

program that
cycles through
and randomly
picks one

Remove, then
start again

From Owen Astrachan
Lecture Format

Traditional way of teaching
Professor Lectures
Students hear only 13%
Most of what they hear is:

BLAH BLAH BLAH BLAH BLAH BLAH
Interactive or “Flipped” Lecture

Students must prepare (read, video)
Lecture/Introduce for 5-15 minutes
Students solve a problem
   Solve problem from scratch (longer)
   Find what is wrong with a “solution” (shorter)
Discuss solution
   Ask how many did X? (gets students involved)
   Go over your solution (intentionally make mistakes)
   Go over student attempt/solution
   Student present solution (longer)
REPEAT
Pair Programming

Students work on problem with one computer in pairs “Driver” and “navigator”
Alternative

Everyone has their own laptop
But work in pairs
Groups/Pairs

Assigned

CompSci 4 Section 1
Pairs as of October 22, 2009

Front of room

G1  G2  G3  G4
G5  G6  G7  G8  G9
G10 G11 G12 G13 G14 G15
G16 G17 G18 G19 G20
G21 G22 G23 G24 G25

Group 1
Interactive Lecture Notes and Handouts

Create 4 versions of my lecture
  Slides with holes
  Handouts with holes
  My notes – holes filled in
  Library notes (handouts with holes filled in)
    • Don’t give out any more
How to create Lecture notes

Latex – 1 file with tags
  %M – my notes only
  %S – slides and handout
  %SO – slides only
  %LH – library notes, my notes and handout
  Etc..

Powerpoint
  Use notes feature, print slides 4 per page

Tablet PC
  Different views
Does Your School have special rooms to teach in?
Example: Special Layout with Computers

20 computers, 40 students
Extra desks for group work
Advantage: see what students are doing
Teaching Assistants
Undergraduate/Graduate

• Mandatory training session
  • Behavior - Don’t date your students
  • How to help someone
  • What not to do
• Link to Duke site
  www.cs.duke.edu/courses/spring15/compsci101/training/
• Meet weekly with them
  • Make them do X before they help students with X
Large Courses

- Cut back on Email
- Use Bulletin Board – like Piazza
  - Students can post anonymously
  - Lots of people can be answer questions
  - You can endorse answers
- Manage with google forms
  - Form if you are sick and need extension
  - Form if you get test accommodations
  - Form to sign up for alternate exam time
  - Form to request a regrade
- Automate Grading of Assignments
Instant Feedback in Lecture

Clickers
Google forms
Mystery While

* Required

NetID of person 1 *
Example: abc123

NetID of person 2
Example: abc123

NetID of person 3
Example: abc123

NetID of person 4
Example: abc123

Names of people filling out form *
(first and last name for each person, separate each name by a comma)
Google Forms (cont)

What does Mystery2 do (in words)?*

What does Mystery3 do?*
(in words)
<table>
<thead>
<tr>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does Mystery3 do?</td>
<td></td>
</tr>
<tr>
<td>It counts every character in a word except for lowercase &quot;e&quot;s</td>
<td></td>
</tr>
<tr>
<td>It counts the number of characters in the word that aren't lowercase e's.</td>
<td></td>
</tr>
<tr>
<td>It is counting the number of characters in the word that are not e's</td>
<td></td>
</tr>
<tr>
<td>Count the number of characters that are not 'e' in the word</td>
<td></td>
</tr>
<tr>
<td>Mystery 3 returns a given word without the lowercase e's.</td>
<td></td>
</tr>
<tr>
<td>Counts the lowercase es in the word.</td>
<td></td>
</tr>
<tr>
<td>It returns the number of characters in a word that are not e.</td>
<td></td>
</tr>
<tr>
<td>Counts all of the letters in word that aren't 'e'</td>
<td></td>
</tr>
<tr>
<td>Counts the number of characters that are not e in the word.</td>
<td></td>
</tr>
<tr>
<td>Counts all the characters that aren't e</td>
<td></td>
</tr>
<tr>
<td>counts how many letters there are that are not &quot;e&quot;</td>
<td></td>
</tr>
<tr>
<td>Mystery 3 counts the characters in a string that are not 'e', then returns the total count.</td>
<td></td>
</tr>
</tbody>
</table>
Setting up Google Forms

Make it easy for students to get form

Use bit.ly links
Problem Solving with Feedback

APT – Algorithmic Problem Tester

Test one function

Runs on multiple inputs

Autograde
Engaging students in a group activities/large course

Acting out stories, games
  *Everything I needed to know about teaching…* - Pollard, Duvall (SIGCSE 2007)

Acting out algorithms with the whole class
  - Make a binary tree with the whole class
  - Calculate the height of the tree
  *Making Lemonade … large lecture classes* – Wolfman (SIGCSE 2002)

Acting out algorithms with a subset of students
  - Sorting algorithms – selection sort, insertion sort, etc
  - CS Unplugged activities
Large Courses - UTAs

• Had 35 UTAs for CS 1!
• Get Head UTAs
  • One to run the lab training
  • One to organizing evening consulting hours
• Have separate Piazza site for Profs/TA/UTAs
• Fill out time card AND google form to account for what hours spent on
• Costly!
Assessing Course/Teaching

- Course Evaluation – end of semester
  - These matter to your Dept/University
  - What do the majority say, ignore outliers
- Get feedback earlier – do your own
  - Have anonymous form for feedback and encourage
- Get Someone to sit in and provide feedback
- Determine what you need to improve on
Improving Teaching

• Is there a teaching and learning center?
• Video tape yourself and watch it
• Class boring? Voice monotone?
  • Practice tongue-twisters
  • Take theatre or public speaking course
  • Toastmasters
• Talk too fast? Note to remind to slow down
• Don’t move? Start moving around
  • Get a wireless/laser presenter
Improving Teaching
Attend SIGCSE

• Conference focuses on CS Education
  • Papers, Panels, Workshops, Bofs
  • Been attending over 20 years, always get new ideas to try in my courses
  • Friendliest and Cheapest Conference
• If you can’t attend, check out SIGCSE papers in ACM Digital Library
Online Teaching

• MOOC or Regular Course/Other Sites
• Videos – you make or work with professionals, short or full course length
• Prepare material way in advance
• May have to prepare many additional materials
  • Quizzes may randomly select questions
Using Animations/Software Tools in Class
Algorithm Animation Software/ Aps/Videos

AlgoViz.org – collection of algorithm visualizations
Samba, Jsamba - Stasko (Georgia Tech)
AnimalScript – Roessling (Darmstadt Univ of Tech, SIGCSE 2001)
TRAKLA2 – Software Visualization Group – TKK Finland

Lots of animations and systems on the web!
Lots of videos of algorithm animations on the web!
Learner Engagement Taxonomy with visualization software

Different forms of Learner engagement
- No Viewing
- Viewing
- Responding
- Changing
- Constructing
- Presenting

ITiCSE Working Group Report 2002 (Naps et al.)
Example – Arrays
Shuffle, then Selection Sort

Sort by height
Use of Algorithm Animation in CS 1/2

Instructor
Make/Use animations for lecture
Stop/Pause – ask what will happen next
must be interactive

Student
Create animations
Replay animations from lecture with same or new inputs
Use engaging and visual tools
Example: Python Tutor
www.pythontutor.com
Use of JFLAP by Instructor

Is this correct for $a^n b^n c^n$?

How do we fix it?
Active Learning

• CS Unplugged – csunplugged.org
Middle School students sorting themselves with Bubblesort
Example of Problem Solving:  
Be A Robot

Group of 4 – brain, eyes, 2 hands
Only brain knows what you are building
Only eyes can see
Must work together precisely like a robot
Teaching with Props
Interaction in Class – Props
Passing “Parameters” in Class

Pass by reference – throw frisbee

Pass by value – throw copy of frisbee

Pass by const reference – throw “protected” frisbee
Interaction in Class – Props
Linked List and Memory Heaps

ITiCSE 98 – Astrachan – “Concrete Teaching: Hooks and Props as Instructional Technology”
Ways to use playing cards: www.cs.duke.edu/csed/wikipedia

Insertion Sort
Card Class – shuffling, dealing hands
Poker hands – Full house, Flush, etc.
Example of Computer Science concept

Children’s book

The Cat in the Hat Comes Back
By Dr. Seuss

Also a story about recursion
Edible CS

• Make treats for students
• Use food to solve a problem
• Then eat the treats!
CS 1
Sorting
Cookies
Automata Theory
Interaction in Class – Props

Edible Turing Machine

TM for \( f(x) = 2x \) where \( x \) is unary

TM is not correct, can you fix it?
Then eat it!

States are blueberry muffins
Students building DFA with cookies and icing
Discrete math
A graph and its Dual Graph
CS 2 – Data Structures
Red-Black Tree (cookies)
Alice Programming Language