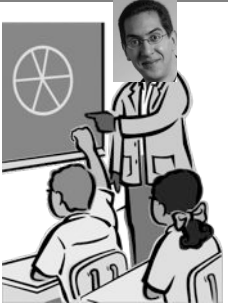## Teaching Tips, Best Practices, and Other Initiatives to Improve CS Education

Dan Garcia, Ph.D.
Lecturer SOE, EECS Dept, UC Berkeley
(on Sabbatical in Melbourne until 2008)
`www.cs.berkeley.edu/~ddgarcia/`

Overview

- Quickie background
- SIGCSE plug
  - This talk from 3 in 2007
  - ACE2008 in Wollongong
- Improving CS education
  - Teaching Tips
  - Best Practices from survey of US schools
  - ACM Education Board

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Teaching Tips Archive

`www.cs.berkeley.edu/~ddgarcia/teaching/tips/`

- Goal: Gather great CS teaching tips on a wiki
  - 4 seasoned educators seeded with 10 tips each
- Categories : Lecturing, Office (hrs), Staff, Exams, Labs, Section, Projects, Grading, Meta
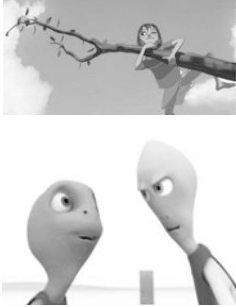
Dan Garcia — UC Berkeley
Owen Astrachan — Duke Univ
Nick Parlante — Stanford Univ
Stuart Reges — U Washington

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Share Your CS Passion (Lecture)

`www.siggraph.org/publications/video-review/`
`ucbugg.berkeley.edu/`

- For each of these, feel free to shout "Amen, Brother!", and why it did / didn't work for you

- I show SIGGRAPH animations before every lecture
  - I talk about opportunities for students to join my graphics group (UCBUGG)
  - The videos are available for $40/video to ACM members

SIGGRAPH2007

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Team-teach (Meta)

`gsi.berkeley.edu/resources/discussion/fiveways.html`

"Classroom Observation: The Observer as Collaborator"
–LuAnn Wilkerson

- Rather than having a single lecturer / TA cover every lecture / section, if two can attend each other's sections, pair up & alternate weeks.
  - ON week they do everything (TAs would cover both secs)
  - OFF week they sit in the ON's first section, as an observer, taking notes of how well the ON TA did, and debrief after
- TAs Buddy TA in weeks 2 through n-1 (not first and last)
- Learn tips from each other!
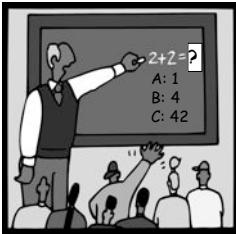- Can avoid stuff you hate doing (that co-inst may enjoy)

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Clickers & Peer Instruction (Lecture)

`mazur-www.harvard.edu/research/detailspage.php?ed=1&rowid=8`
`www.interwritelearning.com/products/prs/`
`www.einstruction.com`

- We instituted them in our lower-div classes
  - Cost: ~$40/clicker
    - Two pricing models, subscription or purchase
  - Midway through lecture, ask "concept test"
    - Students vote w/clicker
    - 2 min peer instruction time with neighbor
      - Must reach consensus
    - "Team" votes again
    - We discuss answers
  - Real-time feedback!
  - Can ask real-time Q!

2+2=?
A: 1
B: 4
C: 42

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Empower TAs (Staff)

www.chezpanisse.com

- Ask TAs teach a lecture
- Have TAs and readers help write, beta-test, grade exams
- Let TAs participate in syllabus discussions
- Open your life to your staff
  - Share cell numbers (great for emergencies)
  - Grade exam at your home
  - Take your admins out to a fancy lunch every term

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Enlightened Grading (Grading)

- Absolute grading, bump up at the end but never down
- Allow later exams to replace earlier exam grade(s)
- Give EPA! sprinkle points
  - Effort
    - How much student tried
    - Office hours? Does all hw?
  - Participation
    - Does the person ask Qs in lecture or discussion?
  - Altruism
    - Helping others in lab / newsgroup / office hours
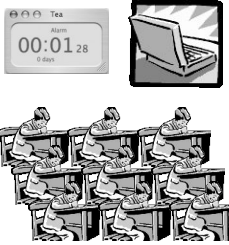- EPA grades are hidden, and can boost up ~ 1/2 +- grade

A+

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Bring Laptops to Exams (Exams)

hogbaysoftware.com/product/clockwork

- Visible timer
  - Interrupt vs polling!
- Show exam bug corrections on screen
  - …and can fix right there
- Auto-announce time left
  - `echo 'say "You may begin."' | /usr/bin/osascript`
  - `sleep 1800 # 1/2 hour`
  - `echo 'say "Sorry for the interruption... You have two hours left!"' | /usr/bin/osascript`
  - … etc …
  - `plaympeg ./epilogue.mp3`

Tea
Alarm
00:01 28
0 days

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Conclusion, pt I

- I presented 6 "hidden" tips from our collection
  - Lecturing
  - Office (hrs)
  - Staff
  - Exams
  - Labs
  - Section
  - Projects
  - Grading
  - Meta
- As the Borg say:
  - Contribute your uniqueness to the collective (our Wiki)

Teaching tips
1. …

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A Survey of Intro CS Curricula

- Goal: Understand what top US PhD-granting schools did in their intro CS curricula
- Survey sent out, collected, results presented
  - Today I'll talk about the best practices we noticed

Survey!

Jeff Forbes
Duke Univ

Dan Garcia
UC Berkeley

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Schools (2006 "US News & WR")

1.	CMU	15.	U Michigan-Ann Arbor
	MIT	18.	Columbia
	Stanford		Purdue - West Lafayette
	UC Berkeley		U Penn
5.	Cornell		Yale
	UI Urbana-Champaign	22.	Brown
7.	U Washington		Rice
8.	Princeton		UNC - Chapel Hill
9.	UT Austin	25.	Duke
	U Wisconsin-Madison		U Mass - Amherst
11.	Cal Tech		USC
	Georgia Tech	28.	Johns Hopkins
13.	UC San Diego	29.	NYU
	U Maryland - College Park		Rutgers - New Brunswick
15.	Harvard		UC Irvine
	UCLA		Virginia

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What works really well and what is broken?

- **Brown**
  - High TA-student ratio
  - Intro Experience Disparity
- **Cal**
  - Closed required labs
  - Undergrad teaching staff
  - More pair programming
- **CalTech**
  - CS11 is several minicourses.
  - Each student only takes 1 of these a term (of their choice)
  - A course can be repeated three times for credit
- **CMU**
  - All courses taught in small sections – no large lectures!
- **Cornell**
  - DrJava demos during lecture
  - Closed required labs
  - 1/2 Matlab, 1/2 Java
- **Georgia Tech**
  - (Compared to peers) very low attrition
    - 90% success in Media CS2
  - No closed labs
- **Harvard**
  - Teacher training
- **Princeton**
  - Appl to commerce, science, engineering w/real datasets
  - Too much to cover!
  - Huge increase in enrollments

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What works really well and what is broken?

- **Purdue**
  - Lecture, lab
  - Hard to have creative projects but consistent grading
- **Rice**
  - Some want to move intro Scheme course to Java
    - Easier later transition
    - But, wide background variety!
- **Rutgers**
  - Online exams
  - Java as intro language!
- **Stanford**
  - Undergrad section leaders
  - Staffing in computer cluster while students work on assignments, which are good
  - We (all of us) still tuning CS1 Java
- **UC Irvine**
  - Informatics curriculum
- **UCLA**
  - Getting students to program to specs
  - Intro experience disparity
- **UCSD**
  - Accelerated intro course track
  - Closed labs
  - Teaching memory allocation to beginners
- **UIUC**
  - All courses!
  - Undergrad-led reviews
  - Assembler EOS competition
  - Programming studio structure
  - Low-level understanding
  - New student communities

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What works really well and what is broken?

- **U Penn**
  - Compelling programming assignments
- **USC**
  - Intro experience disparity
- **UT Austin**
  - Students move well through CS2
  - Java doesn't allow them to learn memory management!
  - One course is "geeked out" which could turn off non-programmers
- **UW**
  - Procedures-first intro to OOP
- **U Wisconsin**
  - Information overload
  - Reduce sources of info
  - Active and collaborative learning!

- "Information overload has been mentioned repeatedly to me by students as a principle problem in many of their courses.
- It is not uncommon for courses today to have a textbook or two, course notes, as well as lecture slides which overwhelm students with presentations of the same or similar material.
- Add to that course email, web pages/links, blogs, etc. and students get trapped spending too much time reading and reviewing and insufficient time actively applying their newly gained knowledge.
- What has worked well for us is to reduce the sources of information and to direct students' efforts to more active and collaborative learning both in and out of class."

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What are the innovative techniques being deployed?

www.eecs.mit.edu/images/EECS_VI_Fall06_FINAL.pdf
www-tech.mit.edu/V126/N63/63course6.html

MIT

- **Overhauling EECS curriculum**
  - Had been unchanged for nearly 30 years
- **6.001 (Scheme) out, Python in!**
- **6.01 and 6.02 to be new mandatory intro courses**
  - Offer intro to dept
  - Cut broadly across EECS
  - Strong hands-on component
  - Build robots, apply concepts like radio, Fourier transform, networks, large systems
- **Then choose 3 or 4 subjects from foundation courses**
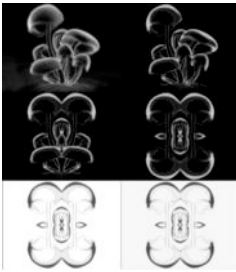 - E.g., Circuits, Signals, Systems

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What are the innovative techniques being deployed?

www.cm.gatech.edu

Georgia Tech

- **Computational Media degree!**
- **Different entry points to major**
  - CS1 for different majors
    - Robotics
    - Media Computation
  - Flexibility
    - CS Majors can take any CS1
- **Contextualization**
  - CS1s are typically dry!
  - Students today use flikr, youtube, etc -- leverage that!
  - Allow the data to be THEIRS
    - movies, sounds, pix

Wil Justis, Milton HS

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What are the innovative techniques being deployed?

inst.eecs.berkeley.edu/~selfpace
www.ucwise.org

UC Berkeley

- **UC-WISE**
  - Web-based learning system
  - Interactive, collaborative & assessment
  - Decrease passive learning in lecture (Old: 3 Lec, 2 Lab)
  - Increase active learning in lab (New: 1 Lec, 6 Lab)
- **Top-down instruction**
  - Scheme, Java, C, Assembler
- **Self-paced courses**
  - 1-unit course for programmers in Matlab, Pascal, C, Scheme, Unix, C++, Java, Python
  - Intro to programming in Scheme
  - Awesome undergrad tutors!

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Conclusion, pt II

- There is so much more analysis I didn't present!
  - It's all online; I encourage you to see our results
- There is some great innovation in the US!
  - MIT, GaTech, UC Berkeley, Caltech, UIUC, …
- It would be great to learn about the innovation going on here to take back with me!

Survey!

ACM Education Activities

acm.org/education

- The ACM Education Board has three active task forces
  - Pipeline Crisis, Image
    - This was "enrollment"
  - Technology and Tools
  - Curriculum
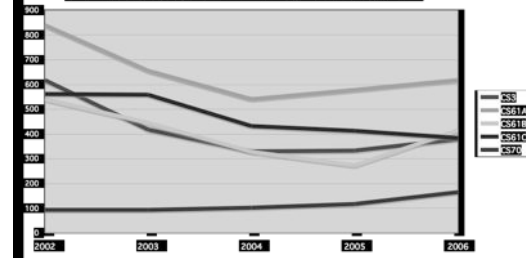- As a member of the Board, I want to learn what your problems are and how ACM could help!

One Take on Enrollment

- Our numbers roughly half that of the 2000 peak

UC Berkeley Computer Science Annual Enrollment, 2002-present

CS3
CS61A
CS61B
CS61C
CS70

2002   2003   2004   2005   2006

Response : Image Site

computingcareers.acm.org

- Numbers across US half that of 2000
  - Some coming back
- Need for computing professionals growing
- Computing image poor
  - Nerds, no life, just coding
- **Computing Degrees & Careers** site launched
  - Supplemental brochure sent to all US high schools

Technology and Tools Site

Final Location: techtools.acm.org
Currently: www.cs.berkeley.edu/~ddgarcia/techtools

- Problem
  - Computing educators (newbies and vets) don't know of all available classroom technology and tools (too hard to keep up)
- Solution (still in beta)
  - Build site for them
    - Just links w/comments
    - What is missing?
  - Support Web 2.0
    - Ratings, tags, how it worked for you, etc.

Conclusion, pt III

- Take-away messages
  - Teaching tips
    - What are yours?
    - Contribute to our wiki
  - Best practices
    - What are yours?
    - Read survey for more
  - ACM initiatives
    - How could ACM help?
    - Talk to me about issues!
- Let's collaborate!

Teaching
Tips

Survey!