AN UPDATE ON THE HIGH SCHOOL COMPUTING LANDSCAPE
Talk Overview

- **Channel Jan Cuny**
  - A Clean Slate Approach to High School CS

- **Dan Garcia**
  - CS10: The Beauty and Joy of Computing
  - BYOB based on Scratch demo
A Clean Slate Approach to High School CS

Jan Cuny
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3/12/2009
Why High School?
Where the girls are
Where the boys are
Intention to major in CS compared to degrees granted

CS’ share of all bachelor’s degrees granted
Share of Freshman listing CS as a possible major 4 years earlier

Sources: UCLA at HERI and NSF SRS
CRA: Vegso
Change in Percentage of Women and URMs Obtaining Associate's, Bachelor's, Master's and Doctorate Degrees 1986 - 2005

- CS & IT
- Engineering
- Life Sciences
- Mathematics
- Physical Sci
- Psychology
- Social Sci

Percentage

Source: National Center for Education Statistics, Digest of Education Statistics
Why High School?

1. Things are really bad there.
2. Without the HS piece, anything we do for middle school will be lost.
3. Without the HS piece, anything we do at the college level will be insufficient.
Why is NSF focusing on AP?

- Often the only CS course that carries college prep credit
- Attractive to students & schools
- 2,000 CB-audited teachers
- Single point of national leverage
What’s wrong with the current AP course?

- Doesn’t appeal to many students (particularly women and minorities)
AP test takers (2008)

- 14,529 students took AP CS A
  - 204,564 Calculus AB
  - 141,321 Bio
  - 96,282 Statistics

- AP CS had the worst gender balance of any of the AP tests
  - 18.3% CS A
  - 48.7% Calculus AB
  - 50.2% Statistics
What’s wrong with the current AP course?

- Doesn’t appeal to many students (particularly women and minorities)
- Inaccessible to students without previous experience
- Fails to introduce the fundamental concepts of CT
- Doesn’t teach the breadth of application or “magic” of computing
Math and Science in U.S. High Schools (NRC, 2002)

- AP courses should
  - Reflect what we know about how students learn
  - Build students’ transferable, conceptual understanding and inquiry skills
  - Convey the content and unifying concepts of a discipline

- AP courses should not be designed solely to replicate introductory college courses (which are not typically exemplary models)
Chemistry, Biology, Physics, and Environmental Science are leading the way.

(ESI-0525575)
Physics Domain Analysis

Beneath the seven big ideas of content lie forty enduring understandings whose scope has been defined.

- Models
- Systems
- Continuity and Change
- Scale
- Structure/Function
- Science Explains the Real World

Unifying Concepts

Integrated Knowledge

Course Goal

Big Ideas of Physics

- Objects and systems have properties such as mass, charge, and internal structure.
- Fields existing in space can be used to explain interactions.
- The interactions of one object or system with another are described by dynamics.
- The interactions of one object or system with another can be described by conservation laws.

Scientific Inquiry and Reasoning

- The evolution of a complex system is determined by the probability of its configuration.
- The interactions of one system with another system can be mediated by waves.
- Interactions among systems can result in changes to those systems.
AP GSC

- Engaging, accessible, inspiring, rigorous
- Focused on the fundamental concepts of computing (CT)
- A target for K-8 course development
- An impetus for college curriculum reform
- Available nationwide (IB as well)
AP Commission: Owen Astrachan

AP Advisory Group

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
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<tr>
<td>Deepak Kumar</td>
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<td>Tom Cortina</td>
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<td>Cameron Wilson</td>
<td>ACM</td>
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What do we need?

- A new HS curriculum
  - PreAP course
  - New, Gold-Standard AP course (AP GSC)
  - Existing (maybe modified) AP CS A

- 10,000 teachers

- Entrée into schools (especially under-resourced schools)
How far have we gotten?

In progress:
- Framework: First two levels (Big ideas & Key concepts)

Still to come:
- Framework: Third level (Enduring understandings)
- Curriculum/Materials
- Test
1. Computing is a creative activity that draws on a wide variety of fields, such as natural sciences, mathematics, engineering, social sciences, business, and the arts.

2. Abstraction is a central problem-solving technique in computer science.

3. Algorithms are the essence of computational problem solving.
4. Writing programs is an integral part of solving computational problems.
5. Theoretical and practical limitations affect what can be solved computationally.
6. Computing enables and empowers innovation, exploration, and creation of knowledge.
7. Computing drives and is driven by economics, culture, society, and ethics.
The new AP course will be coming to a school near you in 2015…

Getting it taught, well
10,000 Teachers / 10,000 Schools

- In-service preparation
- Pre-service preparation
- Ongoing professional development
- Entrée into schools
In-Service Preparation

- Significant and intensive training (stipends)
- High quality on-line options
- Partnerships with universities
- Recruiting, Classroom assistance
- Build on state-wide infrastructure, Train the trainers, Master teachers, Provide community
- Collaborations with other STEM programs e.g. MSP
Pre-service preparation

- Traditional and alternative certification
- Partnerships between CS & Ed Schools
- Computing methods courses
- Teacher Residency Programs
- UTEACH, TFA, MFA, Teaching Fellows, Transitions to Teaching (Troops to Teachers) …
On-going professional development

- CSTA
- National Writing Project-like, National Computing Project
- Coaching & mentoring for novice teachers (Teacher Residency Programs)
- In class assistance: GK-12, SLC-like Computing Corps, Retirees, Faculty (Adopt a Classroom)
- Collaborate with mathematics teachers associations
Entrée into the schools

- Hardware, Software, Connectivity, & Tech Support
- Extended hours & Out of school hours availability
- Help with teacher salaries / Stipends
- AP Incentives
- Maneuver patchwork of state standards, credit issues, certification requirements, etc.
Entrée into the schools

Good News: There are school districts that *REALLY* want us.
Clean slate …
but we can’t blow it.

We need the computing community to step up.
The course was piloted to 16 students in 2009Fa. Design will continue 2010Sp, a 90-person pilot in 2010Fa, with full launch (~300) in 2011Sp.

inst.eecs.berkeley.edu/~cs10/fa10/
Why rethink our non-majors course?

Change in Percentage of Women and URM's Obtaining Associate's, Bachelor's, Master's and Doctorate Degrees 1986 - 2005

- CS & IT
- Engineering
- Life Sciences
- Mathematics
- Physical Sci
- Psychology
- Social Sci

Percentage
-4 0 4 8 12

Source: National Center for Education Statistics, Digest of Education Statistics

Our advisory board, the college all ask that we work to “Broaden Participation”. Why not cast wider net?
Consensus is to start in high school

- Things are really bad there.
- Without the HS piece, anything we do for middle school will be lost.
- Without the HS piece, anything we do at the college level will be insufficient

-- Jan Cuny, NSF
In HS, AP CS is relatively small...
But it’s losing ground...

- The Computer Science exam is the only Advanced Placement exam that has shown declining student numbers in recent years.
And CS has the worst gender balance!

% of women taking AP exam (2008)

- Calculus AB: 48.7%
- Statistics: 50.2%
- CS A: 18.3%
AP Conclusion: A New course!

- “Gold Standard Course (GSC)”
  aka “Computer Science : Principles”
  - Engaging, accessible, inspiring, rigorous
  - Focused on the fundamental concepts of computing (Computational Thinking)
  - An impetus for college curriculum reform
  - Available nationwide (IB as well)

CollegeBoard
csprinciples.org

CS10 : The Beauty and Joy of Computing
http://inst.eecs.berkeley.edu/~cs10/fa10/
Computational Thinking Emerges

- Jeannette Wing (CMU, NSF) articulates vision
  
  "What if there were one course everyone should take to learn about computing, what would be in it?"

- Why can’t CS10 be that course for Cal?
The “Passion, Beauty, Joy, Awe” theme

Grady Booch @ SIGCSE 2007
- Need to articulate, emphasize the “wonder and awe” of computing

PBJA₁ session @ SIGCSE 2008
- Andrew McGettrick, moderator
- Dan Garcia (2 others)

PBJA₂ session @ SIGCSE 2009
- Dan Garcia, moderator
- 4 others shared vision

PBJA₃ session @ SIGCSE 2010
- Dan Garcia, moderator
- 4 others will share vision

- Rebooting Computing Summit

Grady Booch @ SIGCSE 2007
comes around the corner
Summary: design constraints of CS10

- CS61A expects program experience, recursion
  - CS10 hits that in week 5, just about the same time as CS3
- What should ugrads know about computing?
  - History, CS+X, apps that changed the world, hot research
  - Computing is really fun
- Passion, Beauty, Joy & Awe
  - Take every step to make attractive to women, URM
- Make all resources free, available (Berkeley way)
  - Videos, notes, exercises, book!
Discussion: Out with CS3, In with CS10

- **CS3L**
  - Programming, programming, programming
    - Prog Ideas: Recursion, Functions-as-data
  - Scheme
    + Same as CS61A
    - some take CS3L for wrong reason
    - Never remix code
    - Maybe graphical, interactive by week 15
  - 1 big Final project

- **CS10**
  - Programming ½ story
    - Big ideas, HowStuffWorks, history, great applications, social implications too!
    - Prog Ideas: Recursion, Functions-as-data
  - Scratch
    - CS10,61[ABC] each in a different language
    - Graphical, interactive, musical by week 2
    - Share and upload code!
  - Two projects + essay
Format & Textbooks

- **Format**
  - Two 1-hr lectures / wk
  - Two 2-hr labs / wk
  - One 1-hr TA discussion/wk

- **Selected Reading**
  - Taken from recent books and papers
  - List on CS10 google doc
    - Love and Sex w/Robots?
    - Can Animals and Machines be People?

- Our course notes may make it into textbook
Peer Instruction

- Increase real-time learning in lecture, test understanding of concepts vs. details
- As complete a "segment" ask multiple choice question
  - 1-2 minutes to decide yourself
  - 2 minutes in pairs/triples to reach consensus. Teach others!
  - 2 minute discussion of answers, questions, clarifications
An Opportunity to Attract Students

- 657 female students enrolled in CS3
  - (Fall 2002 - Spring 2009; ~94 a year)
- 181 of those female students dropped

- The odds of a female student dropping CS3 are 32% higher (p=0.024, z=2.26)
  - Controlling for major, year in school, and semester

- Can we do better than CS3?
How has CS39n changed your interest in choosing CS or EECS as your major?

- More interested or a lot more interested
- Neither more nor less interested
- Less interested

Bar chart showing the distribution of responses by gender (M for male, F for female).

CS10: The Beauty and Joy of Computing
http://inst.eecs.berkeley.edu/~cs10/fa10/
Can Scratch challenge our students?
Responses to: “I found this course difficult”
Student comments about CS39n

- “It really gives you a general idea of the "beauty and joy" of computing. It's a good course to start and develop interest in computer science.”

- “I'm becoming more interested in computer science and programming. Before taking this course, I don't believe computer science can be both challenging and stimulating. While learning about Scratch, I find out that programming can be fun! And I'm actually thinking of taking a cs class next fall.”
5 Pilots chosen by CollegeBoard

- UC Berkeley: (people next slide)
  - CS10: The Beauty and Joy of Computing
- UNCC: Tiffany Barnes
  - The Beauty and Joy of Computing (Scratch + others)
- Metropolitan St College of Denver: Jody Paul
  - Living in a Computing World (Scratch + HTML)
- UCSD: Beth Simon
  - Taught to 900 students! (Alice + Excel)
- University of Washington: Larry Snyder
  - Python (based on his Fluency course)
5 Pilots chosen by CollegeBoard, map
CS39N Staff, CS10 curriculum leads

- Dan Garcia
  - Lecturer SOE

- George Wang
  - TA, Undergraduate

- Brian Harvey
  - Lecturer SOE

- Colleen Lewis
  - TA, Grad Student
High School Collaborators

- Raymond Pedersen
  - Albany HS
- Eugene Lemon
  - Ralph Bunche HS
- Josh Paley
  - Gunn HS