Transforming K-12 CS
The Beauty and Joy of Computing

OVERVIEW
This is a brief description of the what is wrong with computing in US K-12, what people are doing all over the US to fix it, and how we’re moving the needle...

inst.eecs.berkeley.edu/~cs10/
Advocacy: code.org

Every student in every school should have the opportunity to learn to code.

If you agree, sign your name. Join 517,519 others:

- Enter your name
- Enter your email address
- Enter ZIP code or country
- I am a

Submit

Code.org is a non-profit foundation dedicated to growing computer programming education.

Learn more

Students: Learn in minutes

Teachers: Bring code to your school

UC Berkeley's CS10: The Beauty and Joy of Computing
President Obama says he wouldn’t mind seeing a curriculum requirement for American high school students to learn a programming language. “I think it makes sense, I really do … I want to make sure that (young people) know how to produce stuff using computers and not just consume stuff.”
Three big challenges for our future

The computing community in the U.S. faces three significant and interrelated challenges in maintaining a robust workforce.

1. Underproduction
2. Underrepresentation
3. Lack of a presence in K-12 education

– Source of first 10 slides: Jan Cuny, NSF Program Manager
Underproduction

United States: Number of Degrees Earned in CIS vs. Projected Average Annual Number of Computing Job Openings

- 144,500 Average Annual Openings
- 88,161 Annual Degrees Earned
  - 1,340 Doctoral
  - 17,312 Master’s
  - 39,701 Bachelor’s
  - 29,808 Associate’s

…and they’re good jobs
Yet student interest in computing is low

AP Exam Test-taking in STEM, 1997-

CSTA

Source: College Board Exam Volume Data
*Computer Science up until 2009 had an AP Exam, but in 2010 they are only offering as AP Capstone
Yet student interest in computing is low

Percent intending to major in CS

Data source: HERI, Slide: NCWIT
Underrepresentation: Women

- Gender % of HS Advanced Placement exams

<table>
<thead>
<tr>
<th>Subject</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>58%</td>
<td>42%</td>
</tr>
<tr>
<td>Statistics</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>Calculus</td>
<td>51%</td>
<td>49%</td>
</tr>
<tr>
<td>CS</td>
<td>19%</td>
<td>81%</td>
</tr>
</tbody>
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—Credits: NCWIT & the College Board
Underrepresentation: Ethnic Minorities

UC Berkeley’s CS10: The Beauty and Joy of Computing

URMs receive just:
10.6% of undergrad,
4.8% of masters, and
3.6% of Ph.D.
degrees in computing

(but are 28.5% of US Population)

—Taulbee Data, 2011
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
How can we get computing into K-12?

- **New Course: “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)

- **SINGLE SOURCE OF NATIONAL LEVERAGE!**

CollegBoard

csprinciples.org

UC Berkeley’s CS10 : The Beauty and Joy of Computing
Goal: get engaging, rigorous computing curricula into computing courses in 10,000 high schools, taught by 10,000 well-prepared teachers by 2016.
what is CS Principles?

7 big ideas

- Computing is a Creative activity.
- Abstraction reduces information and detail to facilitate focus on relevant concepts.
- Data and information facilitate the creation of knowledge.
- Algorithms are used to develop and express solutions to computational problems.
- Programming enables problem solving, human expression, and creation of knowledge.
- The Internet pervades modern computing.
- Computing has global Impacts.

check out the complete curriculum framework at: csprinciples.org
what is CS Principles?

6 computational thinking practices

- connecting computing
- developing computational artifacts
- abstracting
- analyzing problems and artifacts
- communicating
- collaborating

check out the complete curriculum framework at: csprinciples.org
5 Pilots chosen by CollegeBoard, map
UC Berkeley’s BJC
The Beauty and Joy of Computing

STATUS...

- 2009Fa : 16 students (pilot)
- 2010Fa : 90 students
- 2011Sp : 90 students
- 2011Su : 25 HS teachers online!
- 2011Fa : 250 Students
- 2012Sp : 250 Students
- 2011Su : 70 HS teachers online!
- 2012Fa : 250 Students & 60 UCB online pilot
- 2013Sp : 250 Students
- 2013Fa : 360 Students, 172 HS teachers in “BJC Family”!

inst.eecs.berkeley.edu/~cs10/
BJC curriculum leads

- Dan Garcia
  - Sr Lecturer SOE

- Luke Segars
  - TA, Grad Student (Now @ Google)

- Brian Harvey
  - Sr Lecturer SOE

- Colleen Lewis
  - TA, Grad Student (Now Prof @ Harvey Mudd)

...many others @ Cal!

Tiffany Barnes, NC State

UC Berkeley’s CS10: The Beauty and Joy of Computing

http://inst.eecs.berkeley.edu/~cs10/
BJC in one slide

- **Big Ideas of Programming**
  - Abstraction
  - Algorithms (2)
  - Recursion (2)
  - Functions-as-data, \( \lambda \) (2)
  - *Programming Paradigms*
  - *Concurrency*
  - *Distributed Computing*

- **Beauty and Joy**
  - All lab work in pairs
  - Two 3-week projects in pairs
    - Of their own choice!!
  - One 3-page paper/blog
    - Of their own choice!!

- **Big Ideas of Computing**
  - *HowStuffWorks*
    - 3D Graphics
    - Video Games
    - Computational Game Theory
  - Research Summaries
    - AI
    - HCI
  - Apps that Changed the World
  - Social Implications of Computing
  - Saving the World with Computing
  - How Twitter Works (guest lecture)
  - Cloud Computing
  - Limits of Computing
  - Future of Computing
is an incredible language

A creative learning community with 4,008,488 projects shared
BYOB/Snap! add functions, generic lists, $\lambda$

- **BYOB (Build Your Own Blocks) $\rightarrow$ SNAP!**
  - developed by Jens Mönig w/design input and documentation from Brian Harvey & others @ Cal
  - Leverages awesomeness of Scratch (design, simplicity, multi-media, community of users)
  - SNAP! Is in Javascript, in-the-browser (demo)

Building a For Loop and calling it. What other languages make it this easy?
Anyone even remotely interested in computers should take it!"

Justin: “The class is incredibly engaging. The lectures were interesting, the labs were fun, and building our own projects was great. Anyone even remotely interested in computers should take it!”
45% Women, ~57% of top 22 students!

Women GPA: 3.06
Men GPA: 2.87

Women in Top 22:
- 2008Fa CS3L: 2
- 2009Sp CS3L: 2
- 2010Fa CS10: 2
- 2011Sp CS10: 2

2013Sp: 50.5% women!
My CS Education Group (most here @ BID)

- Dan Armendariz
  - Zack MacHardy
  - Nonlinear MOOC
  - Adaptive form. assessment

- Omoju Miller
  - Culturally-relevant curricular unit on Big Data

- Jon McKinsey
  - Remote Pair-Programming

- Stephanie Rogers
  - Automatically grading code based on Style guide rubric
Summary

- High School CS is in trouble – CS10K solution
- CS10/BJC is our attempt to fix it
  - Successful, engaging f2f class, edX coming, 50%
  - We’ll continue to refine it with added tools
- AP CS is the future of HS computing, bright!
- You can help!
  - Be an advocate for CS in your HS! csprinciples.org