CS Education in K-12 at the National Scale
NSF’s Education Goals

• Maintain a robust research community
• Train a globally competitive workforce
• Prepare a computationally savvy citizenry
2005: “We are interested in undergraduate and graduate education. We don’t do K-12.”
% Female Intended Majors

HERI Data, 1971-2012
% Female CS Degrees

NCES Data, retrieved May 2014; College Board 2013
2005: “We are interested in undergraduate and graduate education, stay out of K-12.”

2006: “Outreach to K-12 is OK, but keep it informal, the schools are a quagmire.”
Engagement
Capacity
Continuity

Eric Jolly, Campbell, and Perlman, 2004
Broadening Participation & Education

2010: CISE education and broadening participation efforts are joined, and formal K-12 education becomes a focus:

- Inclusion
- CS education research
- CS in high school

2013: STEM-CP
ECS & AP CS Principles

- Inclusive
- Relevant/Engaging
- Rigorous
- Academic
CS 10K

10,000 teachers
10,000 schools
2016
• Assessments
• Course materials
• Models of scalable PD
• Online delivery of pre- and in-service teacher training
• CS teacher certification/master’s programs
• Online communities of practice
CS 10K Projects & Code.org districts
Who’s in?

Faculty, Teachers

ACM, CSTA, NCWIT

CSTA Chapters, CS4HS

e.g. CSNYC, MAssCan

NMSI (A+ College Ready), PLTW, TFA, NSF’s Math & Science Partnerships

Clinton Global Initiative Initiative WG
“… schools are a quagmire.”
FIRST THE
BAD NEWS
THEN THE
GOOD NEWS
Computer Science Education
In School
Why has Brazil produced the top Soccer players??

Germany
Why These Numbers?

2012 High School A.P. Courses

In 2012, fewer than 3,000 African Americans and Hispanic students took the high school AP computer science exam.

Less than 3,000

While 57% of bachelor’s degrees are earned by women, just 12% of computer science degrees are awarded to women.

Source: Code.org
9 out of 10 schools don’t even offer computer programming classes.

Source: Code.org
BUILDING AN OPERATING SYSTEM FOR
Computer Science Education

http://outlier.uchicago.edu/computerscience/OS4CS
This is not done; it is only just beginning.

To progress, we need coherency and alignment.
Computer science education is getting more attention than ever before.

Attention does not equal quality.
Bringing lasting change to schools is very difficult because....

...changing our schools is about changing people.

People don’t like to change.
We know from research what some of the problems are, and they are solvable.
Problems

To scale, we need alignment and coherency.

There are insufficient supports for new and developing computer science teachers.

We don’t know what is working (and what isn’t).

Solutions

BE CLEAR:
Agree on what constitutes quality computer science education.

SUPPORT SCALING:
Comprehensive Instructional resources and quality professional development.

LEARN:
Support the development of computer science education researchers.
This is an opportunity. The time is now.
This has barely gotten started.

Attention does not equal quality or success.

Change is difficult.

We know how to solve some of the problems.

Now is the time.

Jeanne Century jcentury@uchicago.edu
Supporting K-12 CS

Dan Garcia
UC Berkeley Senior Lecturer SOE

What Universities Are Doing and Can Do!
Why worry about high schools? It’s bad!

- Underproduction
- Underrepresentation

Gender % of HS AP Stem Exams

- Biology: 58% Female, 42% Male
- Statistics: 49% Female, 51% Male
- Calculus: 51% Female, 49% Male
- CS: 19% Female, 81% Male

- CS courses often...
  - Only coding, or MS Office
- CS Teachers often...
  - Alone, with no PD available

Supporting K-12 CS: What Universities Are Doing and Can Do!
Connecting with Ed Schools

- Can offer CS certification and endorsements
  - Aman Yadav @ Purdue, CS faculty and Ed school working together for online just-in-time PD for teachers
  - Illinois state and Boise state develop teacher certification and MS program in Ed School
  - ECS came out of Ed School, with involvement of CS folks
  - NSF funds MSP and involve school districts & Ed Schools
Industrial Support… Google’s CS4HS

- Google’s CS4HS funded PD for HS Teachers
  - Offered by Universities
- From 2009 to date…
  - CS4HS has trained more than 12K teachers
  - Reached an estimated 613K students in 230 locations worldwide
Inspirational Programs: CS4Alabama

- Jeff Gray @ U Alabama
  - Connected with local teachers in Alabama
  - NSF CE21 grant to offer PD, and created online PD MOOC
    - Master teachers drove much of the curriculum development
  - Was key in state legislation
    - Online report highlights success
Inspirational Programs: UI Chicago

- Dale Reed @ UI Chicago
  - Connected with local teachers in Chicago
    - Once he found 4 key teachers, everything took off.
  - Helped usher ECS into the entire city (first outside LA)

- ½ of “teaching credit” is his year-round HS PD
  - He drives around the city, meets w/teachers, admins
Our Story @ UC Berkeley

- Our ~$15K/yr CS4HS funding in 2010 started it!

  We formed a CSTA chapter “Golden Gate” for Bay Area

  CS4HS workshops 2010-2014
  - 2 days, PD, networking
  - Teachers paid a stipend
  - We invited administrators

  We meet every month, hosted on campus

  100 members on mailing list, ~50 @ yearly, ~20 @ monthly

Supporting K-12 CS: What Universities Are Doing and Can Do!
UC Berkeley’s BJC
The Beauty and Joy of Computing

- 2009Fa: 16 students (pilot)
- 2010Fa: 90 students
- 2011Sp: 90 students
- 2011Su: ~25 HS teachers in BJC Family!
- 2011Fa: 250 Students
- 2012Sp: 250 Students
- 2012Su: ~100 HS teachers online!
- 2012Fa: 250 Students & 60 UCB online pilot
- 2013Sp: 250 Students
- 2013Su: ~175 HS teachers in BJC Family!
- 2013Fa: 360 Students
- 2014Sp: 250 Students
- 2014Su: ~250 HS teachers (~10 faculty) in BJC Family

bjc.berkeley.edu
Use graphical language for non-majors!
BJC Award-winning BYOB Projects being demonstrated at CS Ed Day 2010 @ Cal
CS Ed Day @ Cal
(during CS Education Week, first week every December)
The class is incredibly engaging. The atmosphere is unlike anything I've ever experienced before. The lectures were really interesting, and I really got into computing because of this class. Now I'm really interested in computing and being an engineer. Anyone even remotely interested in computers should take it.

Justin: "The class is incredibly engaging. The atmosphere is unlike anything I've ever experienced before. The lectures were really interesting, and I really got into computing because of this class. Now I'm really interested in computing and being an engineer. Anyone even remotely interested in computers should take it."

Supporting K-12 CS: What Universities Are Doing and Can Do!
CS10: Beauty & Joy of Computing

Highest % Women in intro CS… ever! (over 50%)
Supporting the growth of women in computing and universities evolving and embracing diversity...
Recognition for BJC’s Diversity success

Supporting K-12 CS: What Universities Are Doing and Can Do!
BJC Future: edX SPOC for HS!

- **SPOC: “Small Private Online Course”**
  - Hybrid MOOC
    - Online course with teacher in room at all times to help
  - Think of SPOC = ebook
  - Teacher signs up class, picks parts they want
    - The forum discussions are self-contained
  - Teacher gets analytics of only their students
  - Teacher is in control
Connecting All CS10K Teachers Online

- NSF funded “CS10K Community of Practice”
  - Connects CS10K teachers
    - ECS & CSP both
  - We use it to connect and share & remix resources & curricula & pedagogy
  - CE21 Facilitators brought community & curric online
  - Beta 2013, full launch 2014

Supporting K-12 CS: What Universities Are Doing and Can Do!
Suggest TEALS to your graduates!

“We are taking the kids farther than I could do,” said Michael Braun, a teacher who is working with the Microsoft volunteers.

By NICK RINGFIELD
Published: September 23, 2013
172 Comments

SEATTLE — Leandre Nsahi, a senior at Rainier Beach High School here, received some bluntly practical advice from an instructor recently.
Teach For America (TFA) is doing CS

- Tell your students they could/should consider teaching as a career
- Students can jump to teaching at all levels
  - Undergrads could do TFA or code + TEALS
  - Graduates (like me) can be teaching faculty
  - Opportunities for doing CS Education Research

Supporting K-12 CS: What Universities Are Doing and Can Do!
Summary … more K-12 outreach!

- Work with Ed Schools
- Support Local CSTA
  - Usu starts w/teaching fac
  - Be an institutional member
- Host yearly teacher conf
  - Bring admins & teachers in
- CS education week
  - Highlight “beauty and joy”
- CSPify non-majors class
  - No need to reinvent … BJC?
- TEALS, TFA for graduates
  - Also CS Ed Research!
Computing Education Research for pre-K to life-long learning

Susanne Hambrusch
Purdue University
What is computing education research (CER)?

CER asks questions like

- How do people learn

- How to teach computational thinking, programming, algorithmic and computational concepts in an age and background appropriate way

- How to assess that students have learned the material

- How to build effective educational tools; e.g., tools that generate questions based on the student’s mistake and assess knowledge

- How to assess the effectiveness of different teaching methods

- How to deliver effective professional development

- How to increase the participation of members of underrepresented groups
What happens in other fields?

- Math education, biology education, physics education, chemistry education, and engineering education exist as distinct research disciplines within the content area.
  - Integration of domain discipline and education fields can vary
- A few schools have separate Engineering Education departments
  - Purdue, Texas A&M, Virginia Tech, Vanderbilt, Utah State
- Models for tenure and promotion exist
- Interest from students exists
A Computing Education Researcher does not necessarily ....

- win all the teaching awards and is liked by all students
- teach only the intro and service courses
- have a higher teaching load than regular faculty
- have all the answers related to retention, time to graduation, impact of gatekeeper courses
Why think about CER now?

- Huge interest in K-12 CS education
  - Efforts focused on the role of computing in high schools and the pipeline
  - CSTA, NCWIT, CS4HS, Code.org, PLTW, …

- Increased undergraduate recruiting and retention efforts
  - Do we understand how to teach the material so we retain qualified students?

- Increased undergraduate enrollments
  - Many departments are exploring teaching faculty positions

- MOOCs
  - democratize higher education
  - provide large data sets on learning material and arising challenges
  - allow researchers to try out new approaches on a large scale and explore transformation of delivery
  - high percentage of courses in computing related
  - pedagogical challenges are magnified at the existing scale
What are some of the Grand Challenges?

- Teaching great ideas of CS/programming in an age and interest appropriate way (K-12, undergraduates, lifelong learners)
- Introducing computational thinking into other disciplines, especially the humanities
- Preparing K-12 teachers with diverse background to be effective CS teachers
- Broadening participation and making computing accessible to all
- Assessing and evaluating students’ understanding/mastering computing concepts
- Developing learning progressions for computer science
- Principles of effective on-line and MOOCs like education in computing
Models for departments interested in building up CER

Prerequisite

- Understand what your education school, math department, and other relevant units are doing
- Build relationships on topics of joint research

CER faculty

- Joint appointments between CS and X
  - X = Education, Learning Sciences, Psychology, Sociology, Informatics, etc.
  - Home department choice is critical
- Faculty of Practice (academic ranks, but no tenure)
- Instructor position (tenured or tenure-like)
- More senior faculty have moved into the education field
Education research funding @ NSF

- Education programs in CISE and EHR
- NSF Graduate Research Fellowships
  - STEM Education and Learning Research is a primary field (the disciplines are its fields of study)
- CISE Careers Proposals
  - can be on Computer Science Research in Education
- CISE’s Expedition in Computing Program
  - compelling, transformative research agendas that promise disruptive innovations in computing for years to come
My own experience

- Experienced huge undergraduate enrollment drop as Head of CS in the early 2000

- NSF CPATH project to create pathways for undergraduate education majors to become computationally educated secondary teachers
  - Joint effort between CS and Education faculty

- NSF CE21 project to establish professional development to improve teachers' knowledge to teach computer science, with a focus on training of teachers having limited CS background.
  - Joint effort between CS and Education faculty and Project Lead The Way

- PLTW offers a CS Principles Course to be scaled up to 5,000 high schools
  [http://www.pltw.org/our-programs/computer-science](http://www.pltw.org/our-programs/computer-science)
QUESTIONS?

Related Workshops

2014 NSF Future Directions in Computing Education Summit, January and March 2014 (organized by Steve Cooper, Stanford)
What can you do? (1/3)

- Encourage and support departmental K-12 outreach activities.
  - Create opportunities for faculty to adapt activities so they represent a broader impact activity for NSF proposals
  - Involve students in service learning! It improves retention!
  - Have your department offers CS Ed Week activities

- Ensure that your faculty (especially those teaching the lower division), are aware of the CS AP Principles effort.
  - Give credit/placement for the CS AP Principles course
  - Offer a CS course that aligns with CS AP Principles
  - Raise the awareness of the course within your university
What can you do? (2/3)

- Support the CS high school teachers (and administrators) in your state. Opportunities:
  - Support a local CSTA chapter
  - Provide professional development opportunities for teachers; including help with ECS & CS Principles

- Computing Education Research
  - Partner with faculty in education related fields and support efforts to start joint research projects
  - Work with education faculty to include computational thinking in their own courses
  - Support a certificate or major in computing education for secondary teachers
  - Support CS faculty interested in computing education research
What can you do? (3/3)

- Support the national effort to have CS AP — either CS Principles or the CS A Java course — count as a fulfilling a Math or Science requirement for high school graduation AND admission to your university.
  
  • It is a major motivator for students to take CS in high school.

- Promote NSF with Bits & Bytes in your outreach activities and among faculty whose research can be considered for inclusion

- Ensure faculty & dept practices diversity and accessibility in all department’s including teaching, advising, and mentoring

- Ensure that faculty, staff, and advisers are aware of activities and efforts
  
  • code.org, CS10K, and the BPC Alliances, including NCWIT, AccessComputing, CAHSI, CRA-W/ CDC, IAAMCS, ECEP, and STARS.
  
  • Encourage them to participate!

- Advocate and actively support computing at state and local levels

- Support CS education efforts in all professional orgs, incl. CRA & ACM