CS Education in K-12 at the National Scale

Moderator:
Jan Cuny

Panelists:
Jeanne Century
Dan Garcia
Susanne Hambrusch

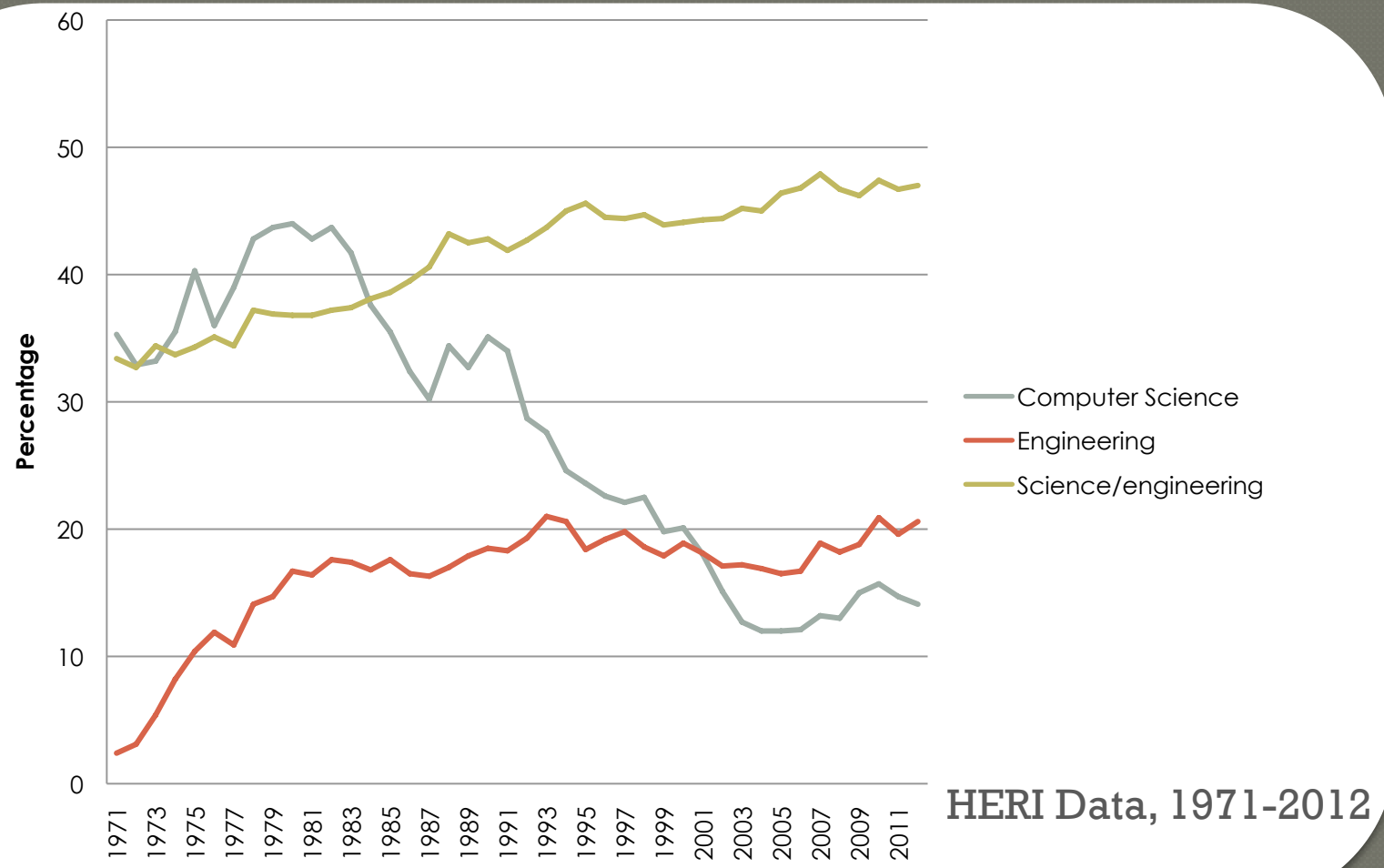
NSF's Education Goals

- Maintain a robust research community
- Train a globally competitive workforce
- Prepare a computationally savvy citizenry

Broadening Participation

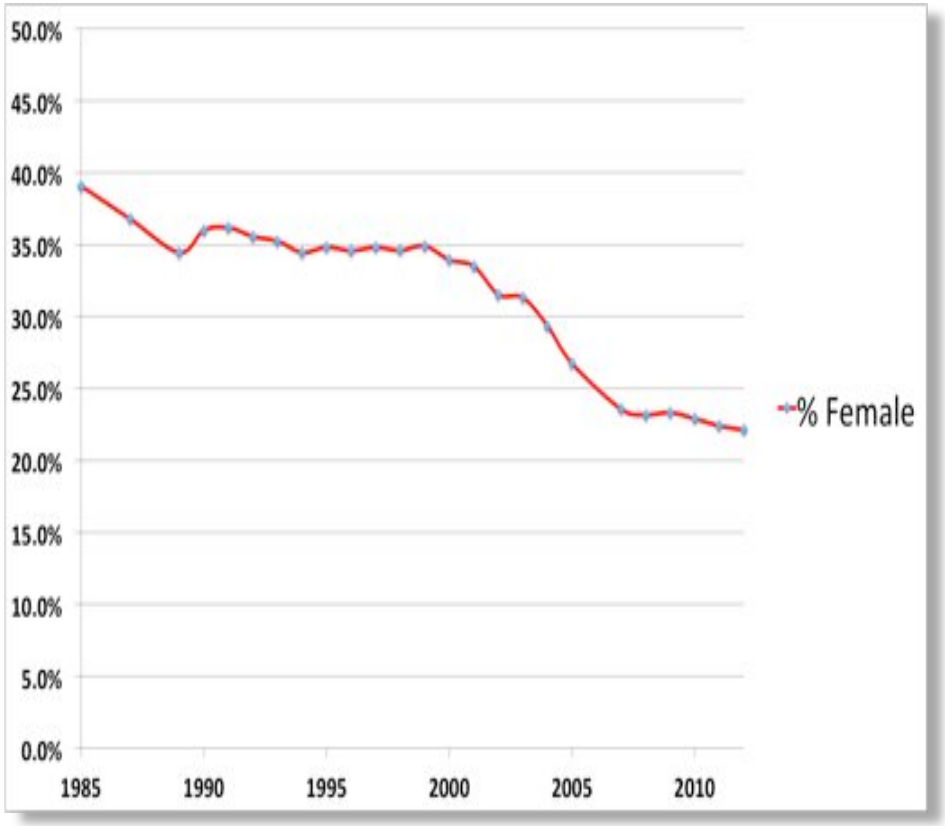
2005: "We are interested in undergraduate and graduate education. We don't do K-12."

% Female Intended Majors



HERI Data, 1971-2012

% Female CS Degrees



NCES Data, retrieved May 2014; College Board 2013

Broadening Participation

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

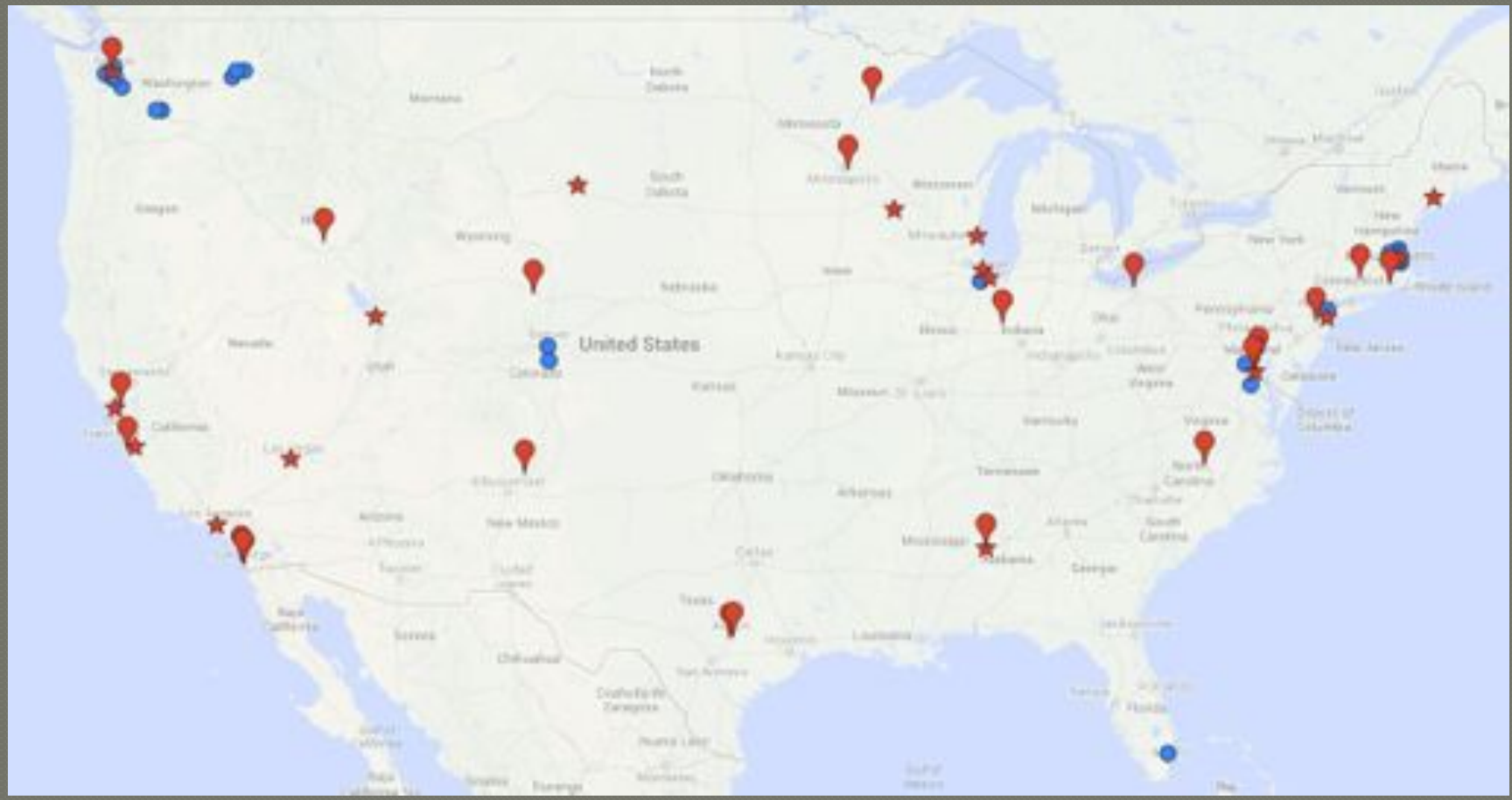
- Inclusive
- Relevant/Engaging
- Rigorous
- Academic

CS 10K

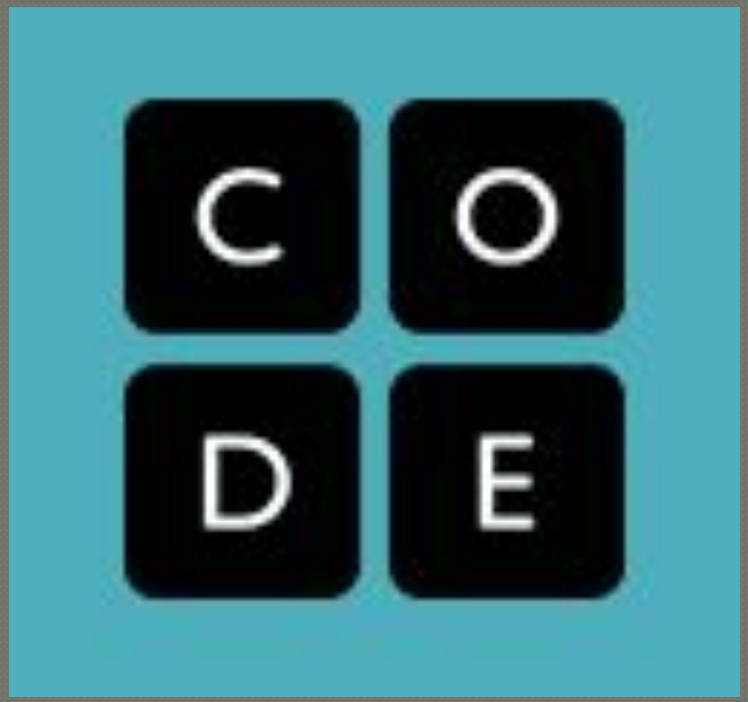
10,000 teachers
10,000 schools
2016

CS 10K

- 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


C O
D E

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 WG

"… schools are a quagmire."

Jeanne Century

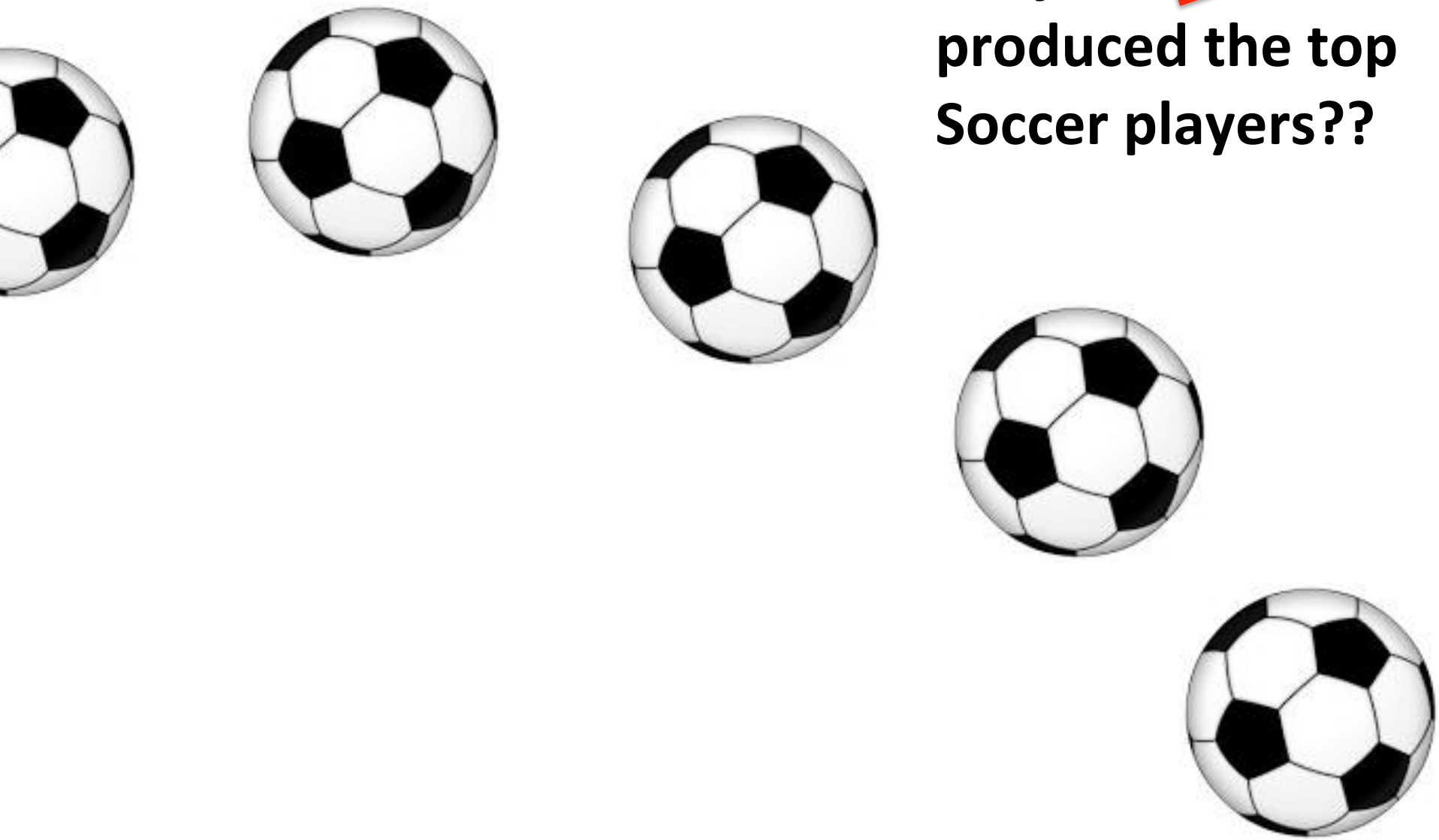

FIRST THE
BAD
NEWS
THEN THE
GOOD
NEWS


Computer Science Education
In School

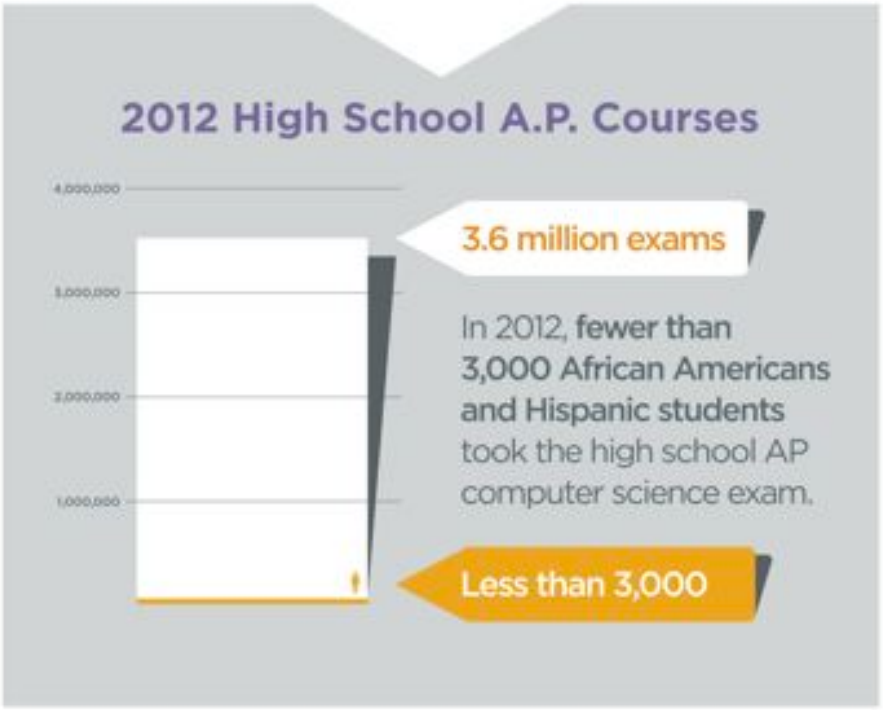


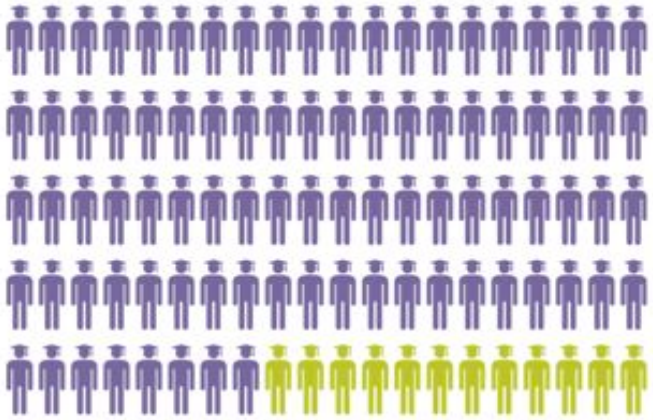
Germany

Why has ~~Brazil~~ produced the top Soccer players??



Why These Numbers?





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.

CODE

The New York Times

CHICAGO PUBLIC SCHOOLS

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.

GOOD NEWS

We know from research what some of the problems are, and they are solvable.

Problems

Solutions

To scale, we need alignment and coherency.

BE CLEAR:

Agree on what constitutes quality computer science education.

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

SUPPORT SCALING:

Comprehensive Instructional resources and quality professional development.

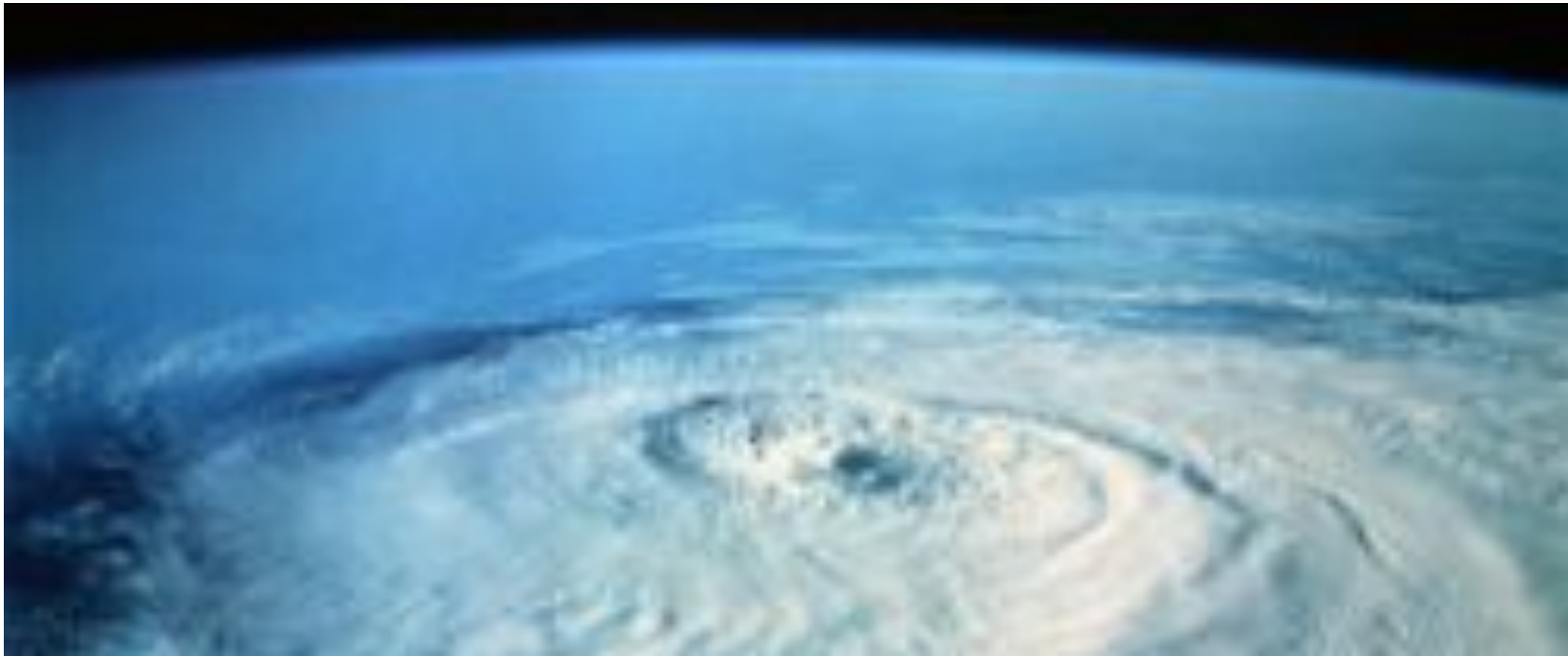
We don't know what is working (and what isn't).

LEARN:

Support the development of computer science education researchers.

GOOD NEWS

This is an opportunity. The time is now..



outlier
RESEARCH & EVALUATION
CEMSE | UNIVERSITY OF CHICAGO

Jeanne Century jcentury@uchicago.edu

Supporting K-12 CS

Dan Garcia

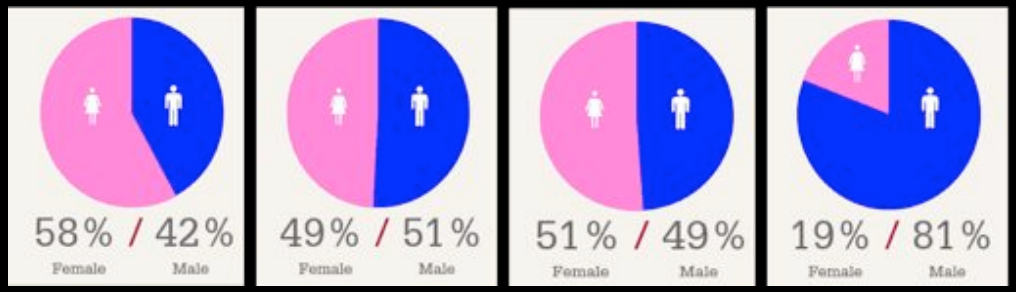
UC Berkeley Senior Lecturer SOE

What Universities Are Doing and Can Do!

Why worry about high schools? It's bad!

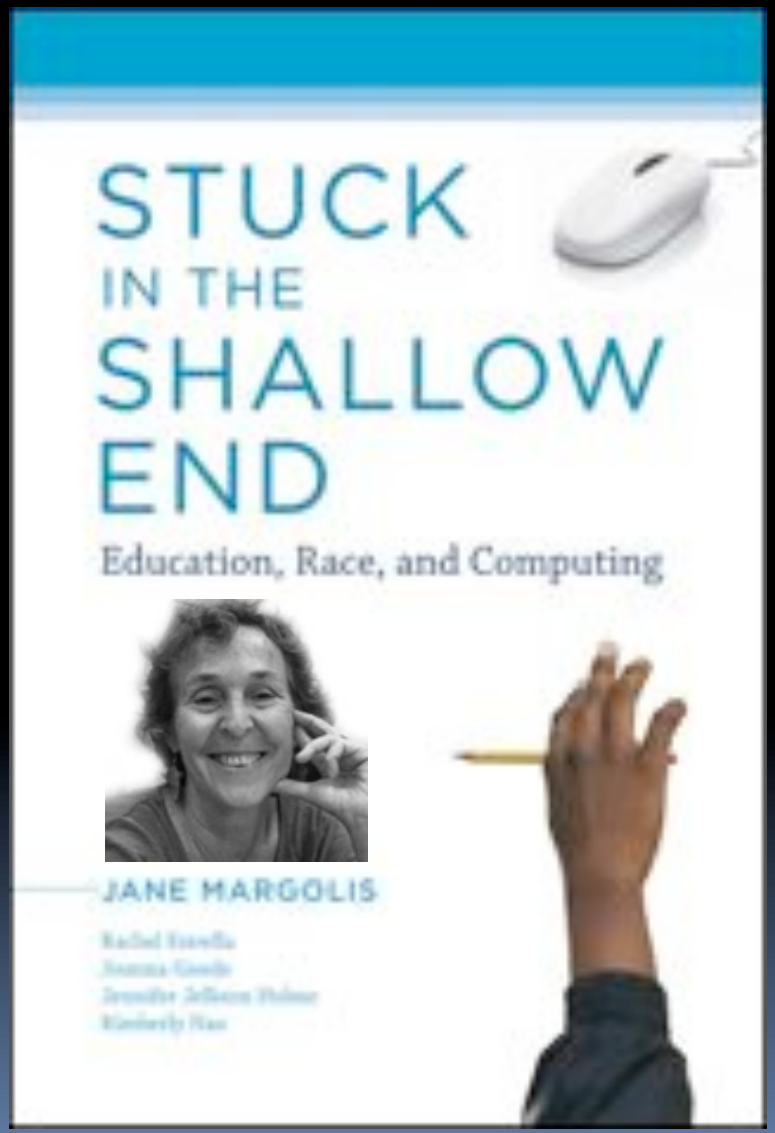
- **Underproduction**
- **Underrepresentation**

Gender % of HS AP Stem Exams



Biology Statistics Calculus **CS**

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



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 cerfification 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

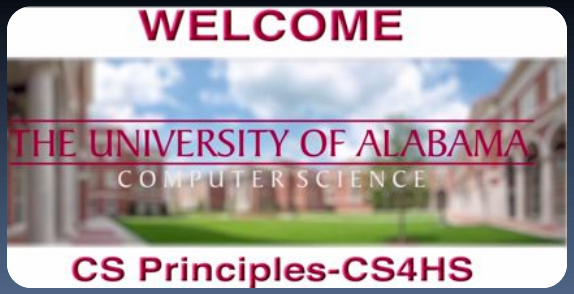
Industrial Support… Google's CS4HS

- **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

Google Computer Science for High School

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

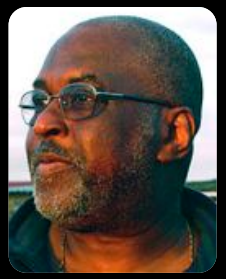


Inspirational Programs: UI Chicago

- **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

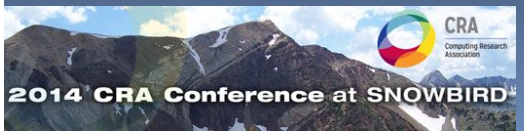
- **Our ~$15K/yr CS4HS funding in 2010 started it!**



We formed a CSTA chapter "Golden Gate" for Bay Area

csta Computer Science Teachers Association

  - 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



UC Berkeley's BJC
The Beauty and Joy of Computing

LOCKHEED MARTIN | UC Online | AP CS Principles | UC Berkeley presents Bears Breaking Boundaries Contest

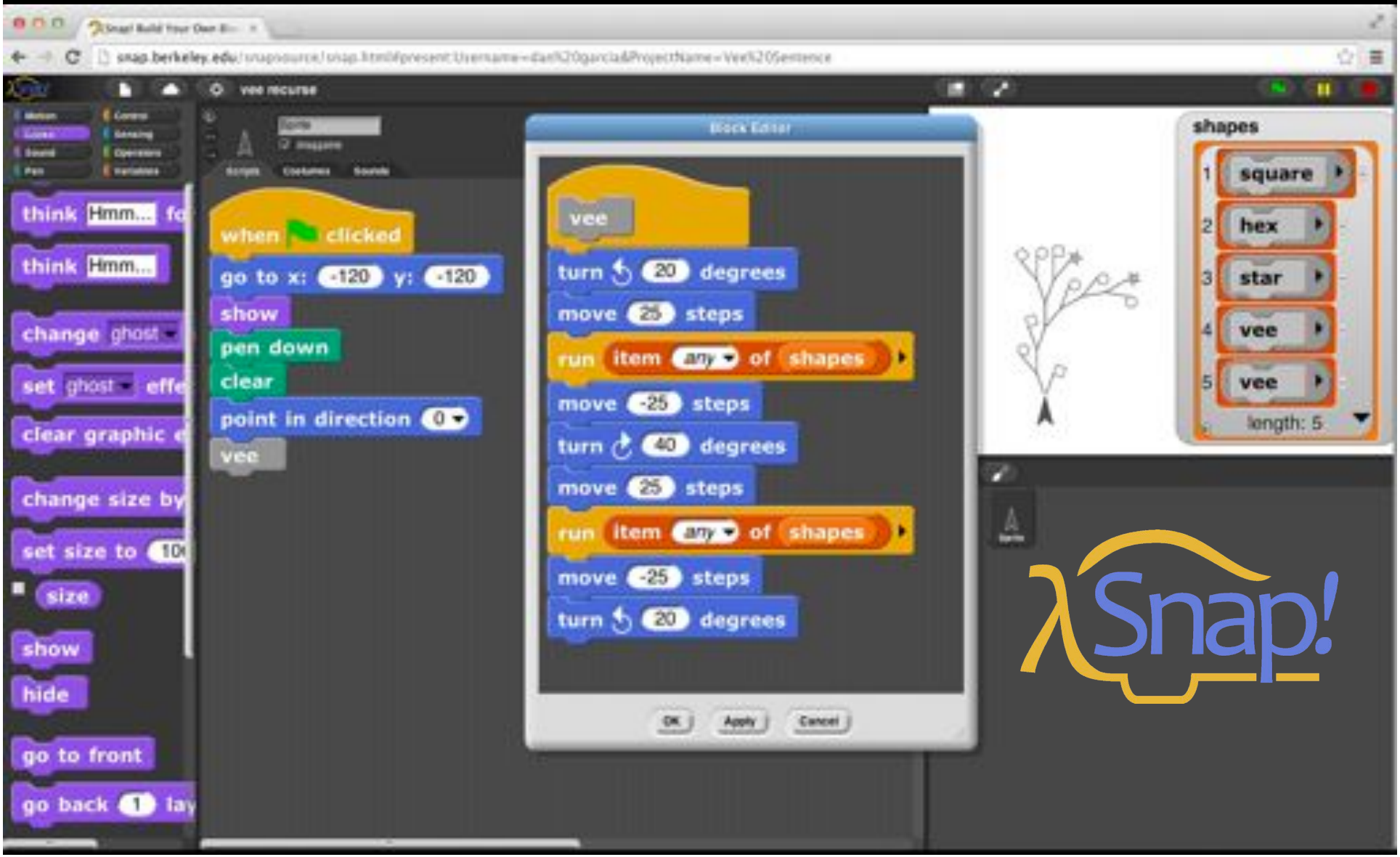
Grant Winner | Pilot | Pilot x3 | Award Winner

- 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

CS PRINCIPLES

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)

www.youtube.com/watch?v=6gUW_mEulx0

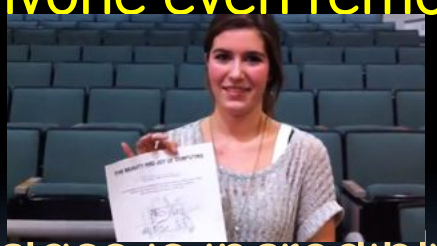
BJC Testimonials (x16)

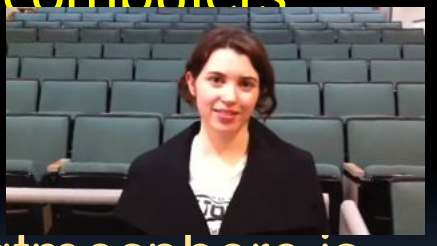


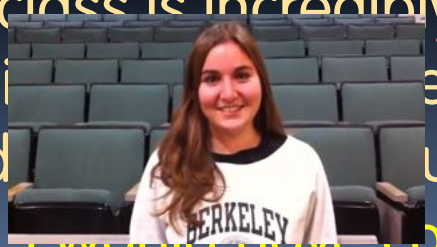










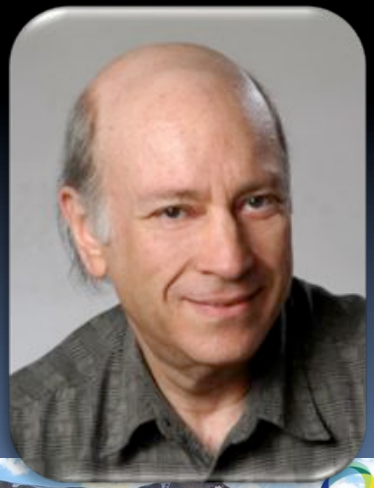
major. Anyone even remotely interested in computers

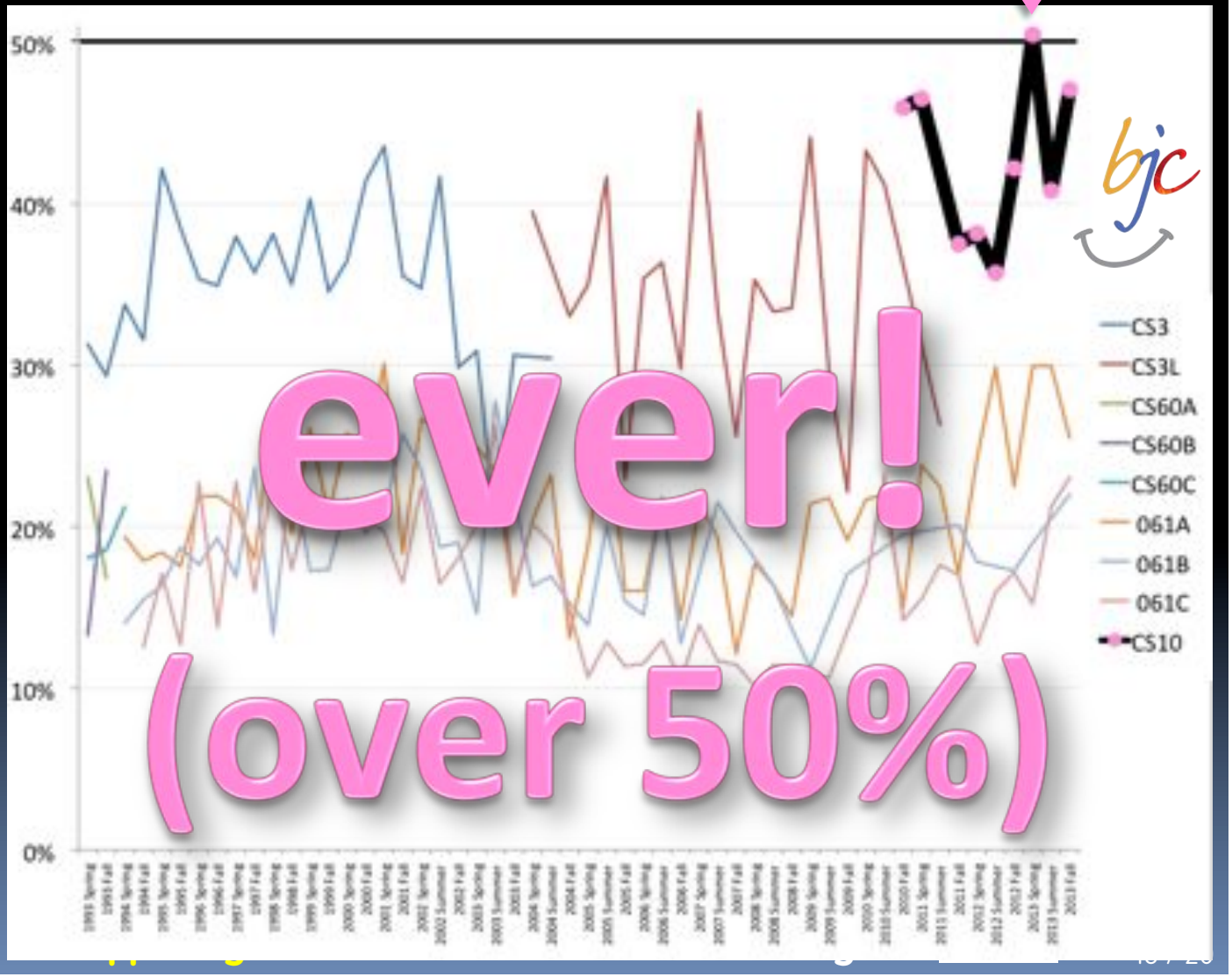
Justin: "The class is incredibly engaging. The atmosphere is

class earlier, I would have considered CS as a major."

CS10 : Beauty & Joy of Computing

Highest % Women in intro CS…





Recognition for BJC's Diversity success

Hacker News new | comments | ask | jobs | submit

▲ Women Outnumber Men For The First Time In Berkeley's Intro To Computer Science (techcrun

218 points by uladzislau 13 days ago | comments

San Jose Mercury News

NEWS

CS KickStart gives budding female computer scientists a window to the programming world

By Mike Cassidy

Mercury News Columnist

SFGate

Tech shift: More women in computer science class

Kristen V. Brown, San Francisco Chronicle

Updated 6:03 pm, Tuesday, February 18, 2014

For the First Time, Women Outnumber Men in a UC-Berkeley Computer Science Course

By Lily Hay Newman

Slate

Women Outnumb

Intro To Computer

San Jose Mercury News

MIKE CASSIDY

We need a moon shot to propel women into computer science careers

By Mike Cassidy

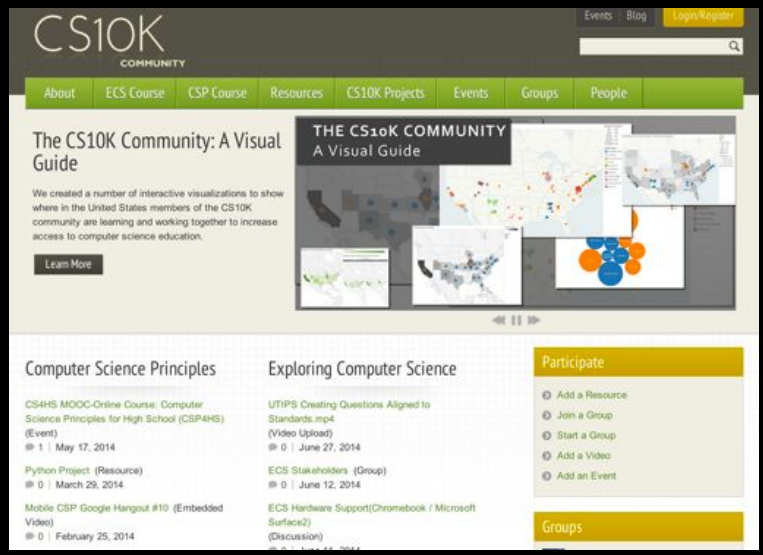
Mercury News Columnist

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



Suggest TEALS to your graduates!

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Fostering Tech Talent in Schools

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

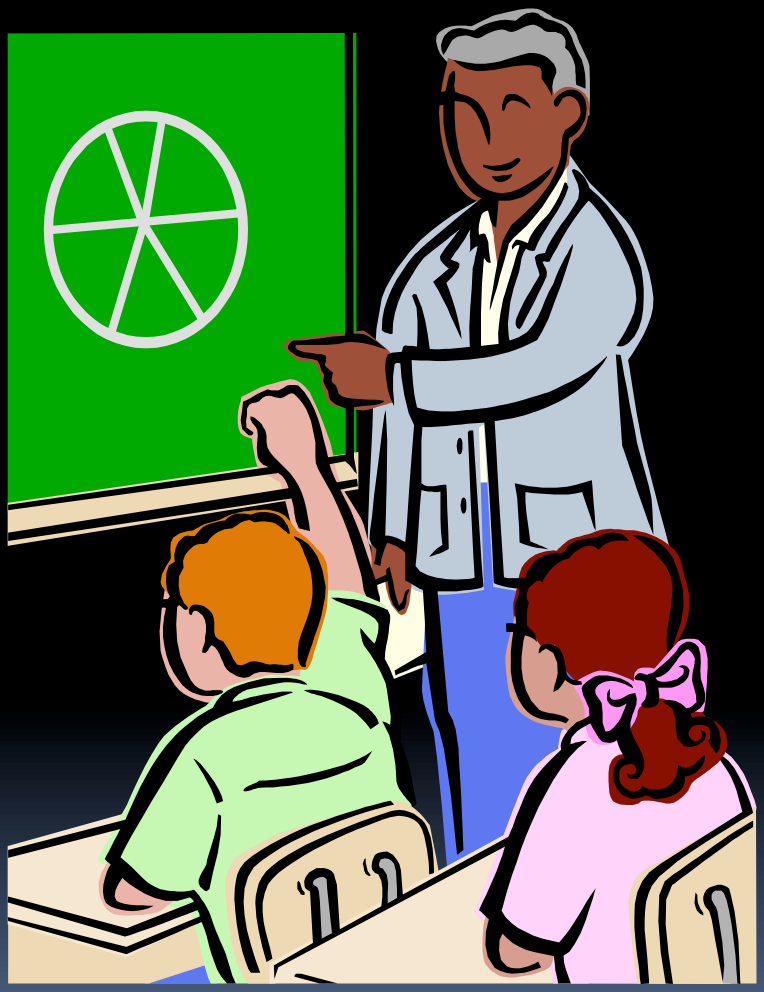
By NICK WINGFIELD
Published: September 30, 2012 172 Comments

SEATTLE — Leandre Nsabi, a senior at Rainier Beach High School here, received some bluntly practical advice from an instructor recently.

FACEBOOK
TWITTER
GOOGLE+

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



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!

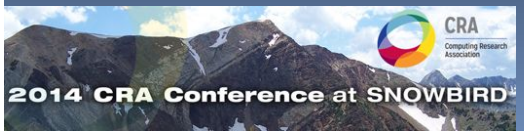
csta Computer Science Teachers Association

CS4 HS @ your U

Computer Science Education Week

CS PRINCIPLES bjc

TEALS



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 disciples, 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

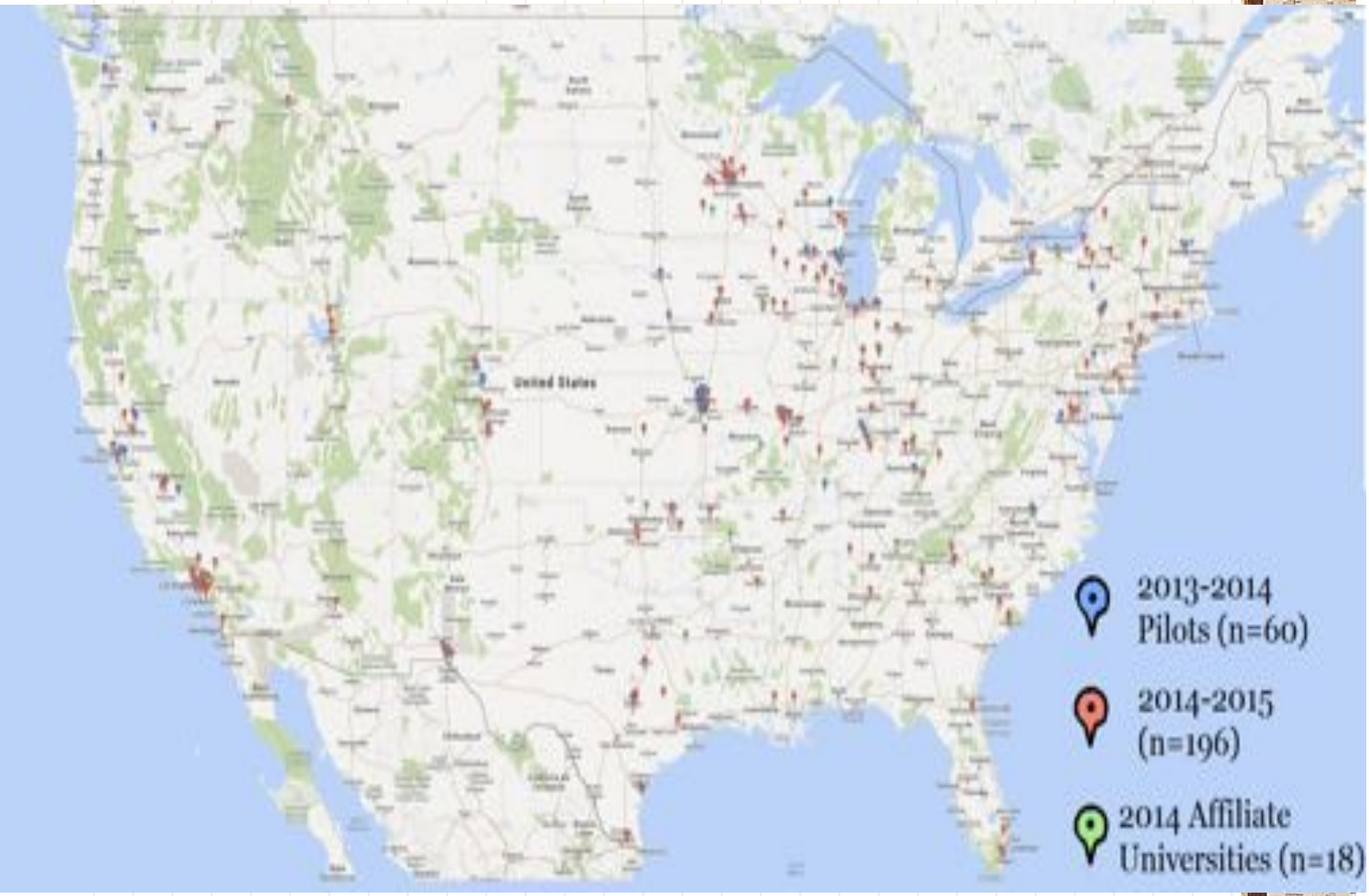
- Joint appointments between CS and X
  - X = Education, Learning Sciences, Psychology, Sociology, Informatics, etc.
  - Home department choice is critical
- Faculty of Practice (academic ranks, but no tenure)
- Instructor position (tenured or tenure-like)
- More senior faculty have moved into the education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


United States
2013-2014
Pilots (n=60)
2014-2015
(n=196)
2014 Affiliate
Universities (n=18)

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**