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NATIONAL INITIATIVE FOR CYBERSECURITY EDUCATION

Cybersecurity in K-12 Formal Education

Jan Cuny and Jim Hamos, National Science Foundation

NICE Strategic Plan: Formal Education (Goal 2)

Broaden the pool of skilled workers capable of supporting a cyber-secure nation.

2.1 Early focus on STEM curriculum
2.2 High school focus shift to CS courses

NICE Strategic Plan: Early STEM focus

Objective 2.1: Improve K-12 STEM education emphasizing the important role of mathematics and computational thinking.

Outcomes:

- Within the next decade, U.S. students will move from the middle to the top of the pack in international assessments. (President Obama's Goal)

NICE Strategic Plan: Early STEM focus

Strategies

- Align Federal K-12 STEM education efforts
- Align formal Federal cybersecurity education budgets with the NICE strategic plan
- Assist private entities who produce CS and cybersecurity instructional materials, tools, and resources for K-12 STEM instruction
- Help the cybersecurity workforce to partner with local schools, thus providing content expertise to teachers and role models to students.

NICE Strategic Plan: Objective 2.1

Strategies (cont.)

- Assist corporations and foundations with
  - Organizing around formal computer science education efforts at the state level,
  - Educating their employees/partners about the needs for better education in general and computer science education in particular, and
  - Becoming better at making evidence-based contributions to STEM education reform.

NICE Strategic Plan: CS in HS

Objective 2.2: Increase the quantity and quality of academic computer science courses in high schools.

Outcomes:

- By 2018, 50% of high schools nationwide will offer rigorous academic computer science courses taught by well-prepared teachers.
- By 2018, there will be an increase in the number of students pursuing majors in computing at the postsecondary level.
- By 2018, 25% of the states will adopt national cybersecurity education standards for K-12.

NICE Strategic Plan: CS in HS

Strategies

- Provide access to curriculum, materials and assessments for HS computing courses, across a variety of "delivery trajectories" (e.g. 4th year mathematics courses, CTE, and the proposed, new AP course, CS Principles)
- Partner federal agencies with corporations and foundations to prepare and support high school computer science teachers for rigorous courses such as the proposed, APCS Principles course

Computing in the Core?

Outline

- Status 
- Using the Math Model
- The CS 10K Project

The percentage of U.S. students taking STEM courses has increased over the last 20 years for all STEM disciplines *except* computer science, where participation dropped from 25% to 19%.

—2009 NAEP High School Transcript Study

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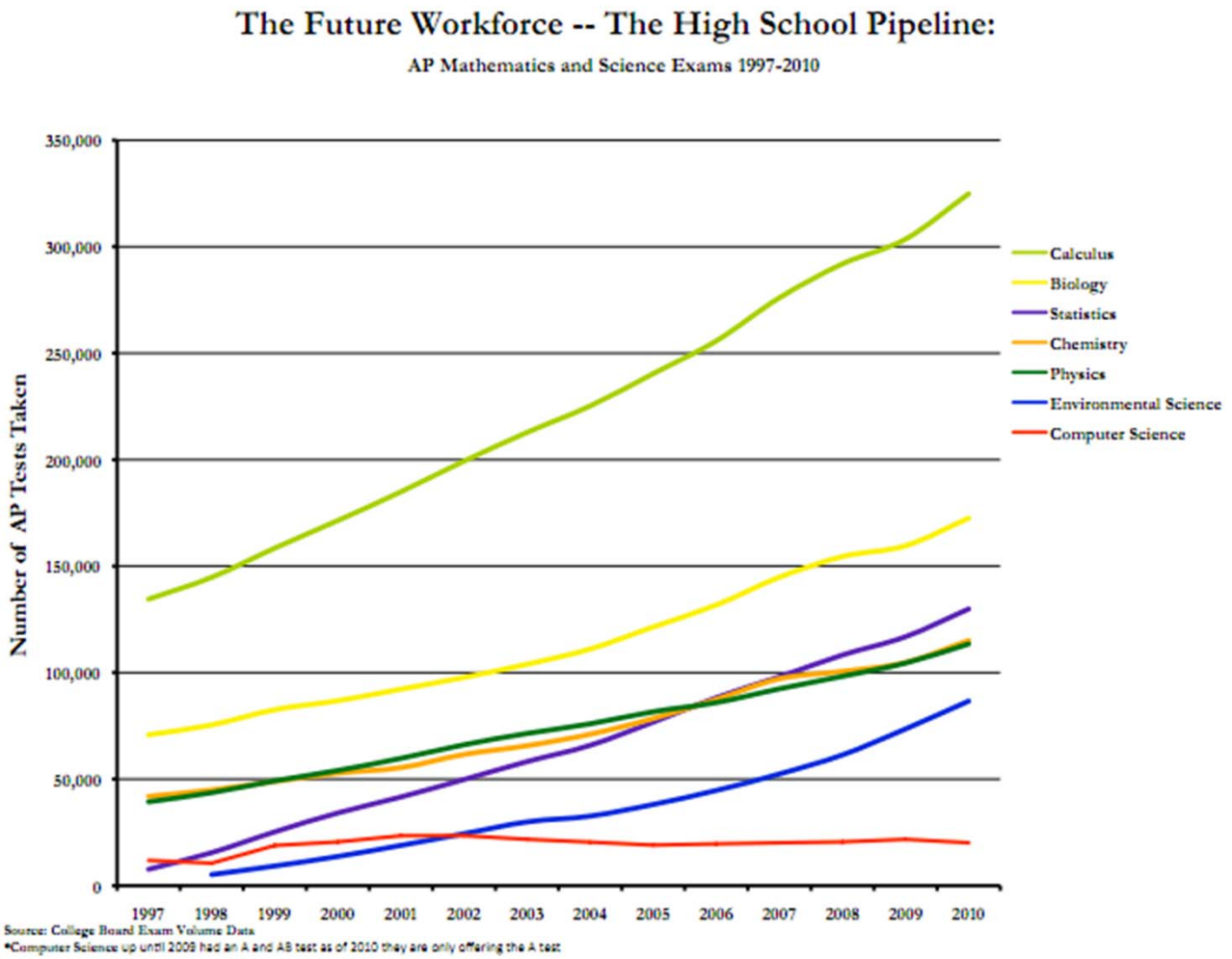
HS Participation in AP STEM Disciplines

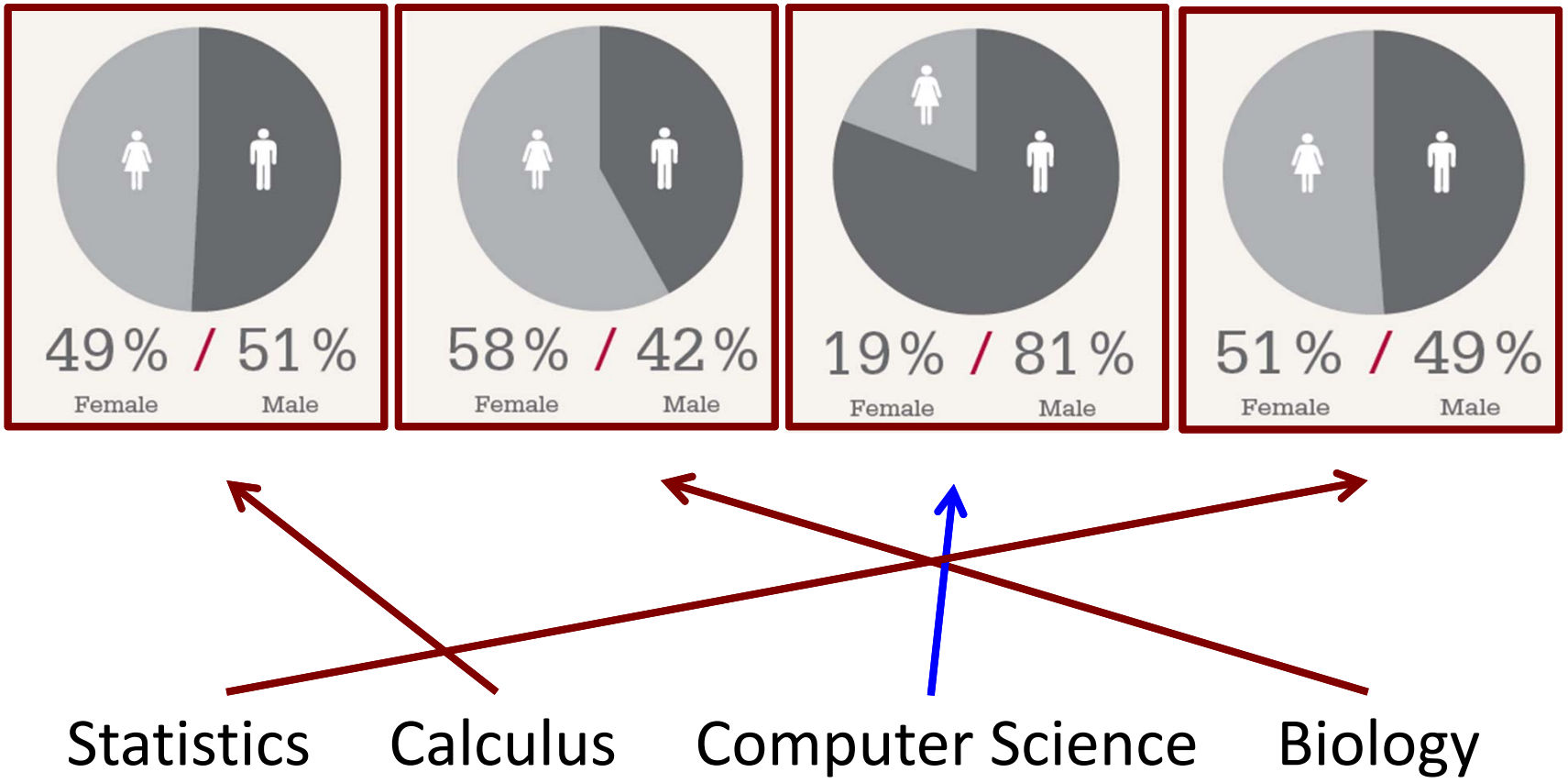


— Chris Stephenson, CSTA, 2010

Challenges

- Low student interest
- Dismal engagement of minorities, women & persons with disabilities

2010 AP Gender Gap



—College Board, 2010

Challenges

- Low student interest
- Dismal engagement of minorities, women & persons with disabilities
- Negligible presence in K-12
  - Lack of an educational research base
  - Academic computing not available in most high schools

Computing in the Core?

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Computing & Computer Science in the K-12 Curriculum

- Although computer science is an established discipline at the undergraduate and graduate levels, it has not had a natural home in the already crowded K-12 curriculum
- Notions of core K-12 curriculum –
  - for science, driven by biology, chemistry and physics
  - for mathematics, driven by algebra and calculus

Education Research in STEM Disciplines

The basis for making educational commitments

- Mathematics – long-standing, but much argued
- The Sciences – fractured across disciplines, with various strengths
- Engineering – rapidly moving forward and finding a home
- Computer Science – almost non-existent

The (abridged) Story of Mathematics in K-12 Education

A core K-12 subject for two centuries, but still evolving

Mathematics Education

A core discipline in U.S. school mathematics since late 1700s

- Ben Franklin: arithmetic, geometry, astronomy, classics, accounts, gardening, good breeding
- Mathematics “to enhance mental discipline”
- Committee of Ten (1893): justification “for mental discipline, life, and college entrance”

(Kliebard & Franklin, 2003)

Research About Mathematics Teaching and Learning for a Century

~1900: Grew out of psychology, first mathematics education research dissertations at Teachers College, Columbia University

1967: National conference on needed research in mathematics education (University of Georgia)

- Patrick Suppes: suggested serious work on building theories of mathematics learning
- Tom Romberg and M. Vere DeVault: research needed on mathematics curriculum
- Bob Davis: grades 1-9 curriculum on discovery approach

1970: *Journal for Research in Mathematics Education*

Where does this research happen?

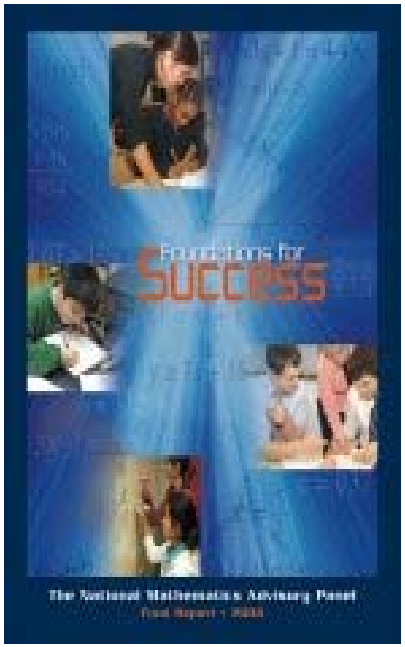
73 Ph.D. programs in mathematics education across the U.S.*

- 18 in Departments of Mathematics
- 50 in Schools and Colleges of Education
- 5 Cross-listed

*http://sigmaa.maa.org/rume/phd.html

Debates Within Mathematics Education

Late 1990s – present: "Math Wars"



2008: National Mathematics Advisory Panel

(National Mathematics Advisory Panel Final Report: *Foundations for Success*)

2009: Common Core State Standards in Mathematics

(state-led effort coordinated by the National Governors Association Center for Best Practices and the Council of Chief State School Officers

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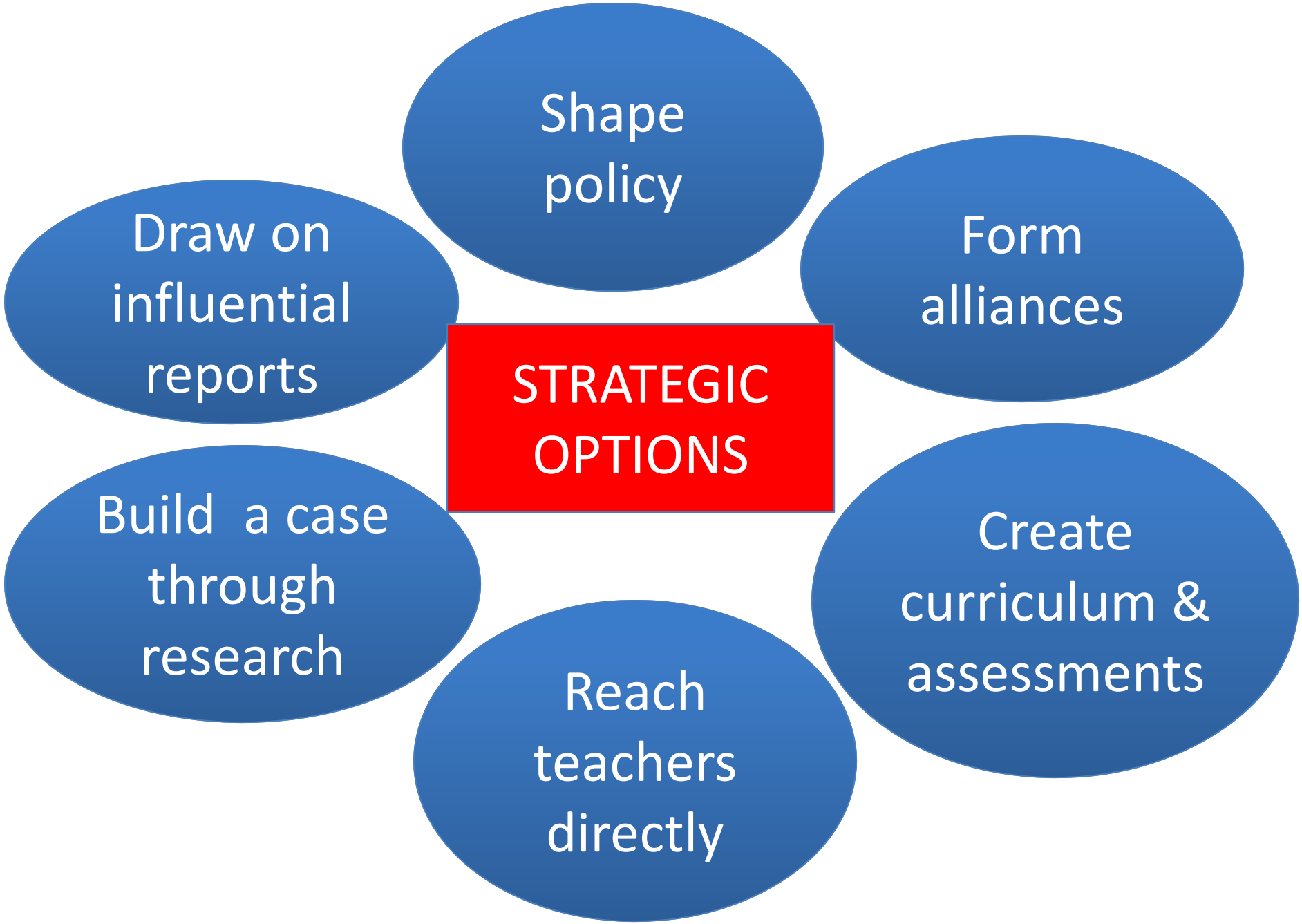
ASSUMPTION: The computing, computer science and cybersecurity community is committed to seeing serious attention to their field in the K-12 curriculum.


Shape policy
Draw on influential reports
Form alliances
STRATEGIC OPTIONS
Build a case through research
Create curriculum & assessments
Reach teachers directly

Introducing Students to Computing, Computer Science and Cybersecurity

- Fully developing cybersecurity education standards for K-12 and getting them adopted by states will be a long, if not impossible, haul
- Rather, at the start, support a meaningful Computer Science course for high school students and embed principles of cybersecurity concerns in as many other K-12 courses as possible

Introducing Students to Computing, Computer Science and Cybersecurity

Highlight…

- Issues of safety in the cyber world
- Awareness of the field of cybersecurity
- Careers in cybersecurity, including interactions with individuals in the field
- Computational thinking as an important 21st Century skill for all students
  - Need clarity regarding components of computational thinking and how these grow over time for students
  - Need teacher workforce with necessary knowledge & skills

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CS 10K Project

Develop an effective new high school computing curricula and get courses based on that curricula taught in 10,000 schools by 10,000 well-prepared teachers by 2015.

All new CS AP course, CS Principles

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Why 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
- Fidelity of replication

CS Principles

- Engaging, accessible, inspiring, rigorous
- Focused on the fundamental concepts of computing (CT)

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Slide: Owen Astrachan

Timeline

2009-2010

- ✓Big Ideas, CT Practices, Claims/Evidence

2010-11

- ✓Pilot I: Five colleges
- ✓College Survey
- ✓College attestation/support
- ✓Test item prototypes

2011-12

- – Pilot II: 9+ colleges, 10+ high schools

Exploring Computer Science

- LAUSD, Jane Margolis
- Piloted ECS 08/09
- ~20 LAUSD schools 10/11
- Spreading in CA, CALCSEPOL
- Complete, detailed curriculum & lessons plans on CSTA site
- MOBILIZE: CENS participatory science cell phone apps
- “G” credit and CTE credit
- San Jose, Oakland adoptions
- Chicago Connection

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ECS & CS Principles Pilot Sites 2011-12

Beyond the AP Curriculum

- Additional course models
- Standards & assessments
- Teacher preparation X 10,000
- Entrée into schools

CE21 Yikes!

Accomplishing this is beyond NSF's mission and resources

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What all do we need?

- Curricular materials
- CS Standards
- Teacher Certification
- Pre-service
  - Traditional
  - Alternative
- Online& Face-to-Face PD
- Coaching, Mentoring, Communities of Practice

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What else do we need?

- Engagement of Ed Schools, UTeach, TFA, MFA, etc.
- Engagement of Council of the Great City Schools, CCSSO, NSTA, NCTM, NASULGC, etc.
- Fundraising, fund raising
- Public/Private Partnership

Curricula and materials aligned with CSTA standards and CS Principles Framework

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Questions?

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