High School Computer Science as a National Imperative: Why the U.S. Needs to Be More Like Israel

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Teachers Association

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Agenda

- The State of High School Computer Science in the United States
- CSTA Research Results
- The Computer Science Teachers Association
- CSTA Programs and Resources
- Conclusion

The State of High School Computer Science in the U.S.

The Current Challenge

- The United States is facing an anticipated shortage of qualified candidates for 1.5 million IT/CS jobs by 2012
- The lack of adequate computer science education in high schools is a major factor contributing to the seriously falling enrollments in university computer science programs
- The national educational programs aimed at improving U.S. competitiveness in high tech and innovation ignore computer science completely
- There is a widely-held misperception in the K-12 curriculum that technology is Powerpoint and the Web

"The United States, a nation once proud of its leadership in education, is sitting quietly on the sidelines while other countries make improvements to ensure that their graduates will be ready to meet the demands of tomorrow's high tech society."

The New Educational Imperative: Improving High School Computer Science Education, 2006

Computing as a Discipline

- Definition difficulties:
  - Computing is a new area within a very old educational cannon
  - Computing as a field is evolving so quickly that it is difficult even for computer scientists to define its contents and delimit its boundaries
  - Deciding what students need to know in this field is like trying to hit a moving target
- What we know for sure:
  - Computing science is a scientific discipline and not just a technology that supports learning in other areas
  - There are recurring concepts and principles that students need to know (abstraction, complexity, modularity, and reusability)
  - Computing is a discipline with a core set of scientific principles that can be applied to solve complex real-world problems and promote higher-order thinking
- Many people within education (and in funding bodies) do not understand the difference between having computers in schools and teaching computing as an academic discipline

Why Enrollment Is Dropping

- **Students and their parents do not understand the incredible scope of educational and career opportunities that computing provides**
- Students want to be part of a discipline that is solving real problems, and they do not understand that computing is at the root of all of the new sciences
- Students' schedules are so jammed packed that they do not have time to take elective courses
- The emphasis on standardized testing in core areas is pulling emphasis, funding, and good teachers away from computing

Issues Identified by Research

- Shrinking pipeline
- Underrepresented populations
- No national curriculum standards
- Inappropriate and ineffective teacher certification
- Teachers feeling isolated and in need of community
- No opportunities for skills upgrading
- A feeling of disconnect between K-12 CS educators and their university colleagues
- No strong voice to educate administrators, legislators, and congressional committees about the link between supporting K-12 computer science education and international economic issues

Decentralized Decision-Making

The decision-making authority for publicly funded schools in the U.S. is exceedingly complex, but it is safe to generalize in the following ways:

- Decisions regarding the distribution of federal funding are made at the federal (national) level but these primarily affect low-income urban schools
- Most of the funding for schools is determined locally, so the quality of individual schools varies enormously based on the wealth of the school community
- Decisions regarding teacher qualifications and teacher certification are made at the state level and the rules differ markedly from state to state
- Decisions about curriculum are made at the local level (there are no national curriculum standards for any academic discipline) and so what students learn varies enormously from school to school and even from classroom to classroom

Federal Legislation

The No Child Left Behind Legislation

- This legislation was originally envisioned as a way of ensuring that states/schools set and meet rigorous educational standards for all students
- Under this legislation, federal funding is withdrawn from schools where students fail to reach specified performance levels in math and reading
- Evaluation is based upon student performance on high-stakes standardized tests
- Noble idea exceedingly poorly implemented
  - Seriously under-funded, causing a burden on already poor schools and shifting resource from other key programs
  - No consideration given for the extremely heterogeneous population of U.S. schools
  - Punative nature of the legislation has meant that bad schools get worse rather than better

- This year, the No Child Left Behind legislation was implemented in high schools
  - Non-core courses are being cancelled
  - Funds are being withdrawn from other programs
  - CS teachers are being pulled out of their classrooms to teach remedial mathematics (the Los Angeles example)

Teacher Certification

- Certification requirements vary enormously from state to state
- Many states require CS teachers to hold multiple certifications with CS as secondary to some other discipline
- Some states require CS teachers to take and pass praxis exams in other disciplines (math, business, vocational technology)
- Teachers are ill-informed as to the requirements in their own state
- Many state Department of Education people responsible for certification are ill-informed as to the requirements in their own state (primarily because they do not know what computer science is)
- In some states where there are clearly stated requirements, there is no way for them to be met (the Florida example)

Classroom Realities

- Class sizes
- The number of teaching periods per day
- Requirement to teach students of vastly different learning levels in a single class
- Requirement to teach all students, not just those who like or are good at computer science
- Feeling like the only CS teacher in the world
- The battle for respect
- The battle for funding
- Playing politics

In Contrast to Israel's…

- Nationalized curriculum (ensure the basic quality of education for every student in the country)
- A rigorous, scientific curriculum (math centered)
- Teacher preparation program that actually contains computer science content
- Teacher certification requirements that cover both content and pedagogical knowledge
- A nationally-supported computer science teachers organization

- But…the battle to solidly embed computer science in the high school curriculum never seems to be completely won.

CSTA Research Results

Introductory CS Courses

- 72% of schools teach an introductory computer science course
- 31% of schools require all students to take this course

Topic	%
Problem solving	60.8%
Hardware	58.1%
Graphics	57.3%
Programming	54.3%
Ethical and social issues	54.2%
Databases and information retrieval	41.9%
Productivity software	41.9%
Computer security	38.0%
Web development	37.2%
Networks	21.0%
Logic	15.9%

Other Computing Courses

Course Name	%
Web design	74.8%
Computer graphics	51.3%
Computing communications/media	41.5%
Programming	39.2%
Applications	13.0%
Hardware/repair/maintenance	2.9%
Certification	2.4%
Desktop publishing	2.2%
Word processing/keyboarding	1.0%
Robotics	O.8%
Game design	0.5%

Enrollment Figures

Enrollment	%
Remained steady	49.6%
Decreased	26.7%
Increased	23.6%

76.7% of teachers report that there are a significant number of qualified students not taking CS courses for the following reasons

Reason	%
No room in schedule	71%
Elective courses less important	44%
Greater interest in other subjects	40%
Subject matter too difficult	28%
Perceived as male dominated	19%
Perceived as too geeky	18%
Perception of limited job opportunities	8%

Greatest Challenges

Teaching Challenges	%
Rapidly changing technology	41%
Lack of student interest	33%
Lack of administrative support	31%
Lack of resources (hardware/software)	25%
Difficult subject matter	23%
Lack of curriculum resources	22%
Lack of student subject knowledge	20%
Lack of teacher subject knowledge	15%

Professional Development Challenges	%
Time	65%
Opportunities	61%
Cost	60%
Facilities	48%

What If We Don't Change?

- U.S. students will fail to receive the education they require to compete in an increasingly technological global economy
- U.S. Businesses and industries will continue to be unable to find the people with the skills they need for the jobs that exist now and in future
- U.S. economic power as a nation depends upon our ability to build the tools the rest of the world needs and while computer science education languishes in the U.S., other countries are driving toward the future by providing computer science education for their students
- The computing sciences are driving innovation in every single field of science and the U.S. will continue to lose the innovation edge

The Computer Science Teachers Association

Brief History

- 1999 Discussion at NECC regarding possible support ACM could provide to high school CS educators
- 2000 ACM Forms the K-12 Education Task Force
- 2000 first CS&IT Symposium held for high school teachers (hosted by ACM and ISTE in Atlanta)
- 2002 Curriculum Task Force begins meeting: Chaired by Allen Tucker
- 2002 Survey of AP high school teachers to determine OO learning needs
- 2002 JETT workshop project launched in partnership with universities
- 2003 Task Force publishes *ACM Model Curriculum for K-12 Computer*
- *Science Education.*
- 2004 Task Force conducts first National Survey of High School Computer Science Education to determine current issues in high school CS education
- 2005 CSTA launched as a membership organization representing K-12 computer science

Why CSTA

- ACM members were expressing concern about K-12 computer science education and wished ACM to take a larger role
- The K-12 Education Task Force had uncovered a series of systemic problems that required immediate attention
- There was no existing body that spoke to the issue of K-12 computer science education from the perspective of the practitioners
- It was clear that pre-computer science education was under attack and at risk of disappearing if action was not taken to address core concerns
- There was a profound need for both action and advocacy

What Is CSTA?

- CSTA is an international membership organization
- CSTA is a learning community
- CSTA is an advocacy organization
- CSTA is a provider of professional development for teachers
- CSTA is a research body
- CSTA is a provider of resources
- CSTA is many things to many people

What Is CSTA's Mission?

The Computer Science Teachers Association is a membership organization that supports and promotes the teaching of computer science and other computing disciplines. CSTA provides opportunities for K-12 teachers and students to better understand the computing disciplines and to more successfully prepare themselves to teach and learn.

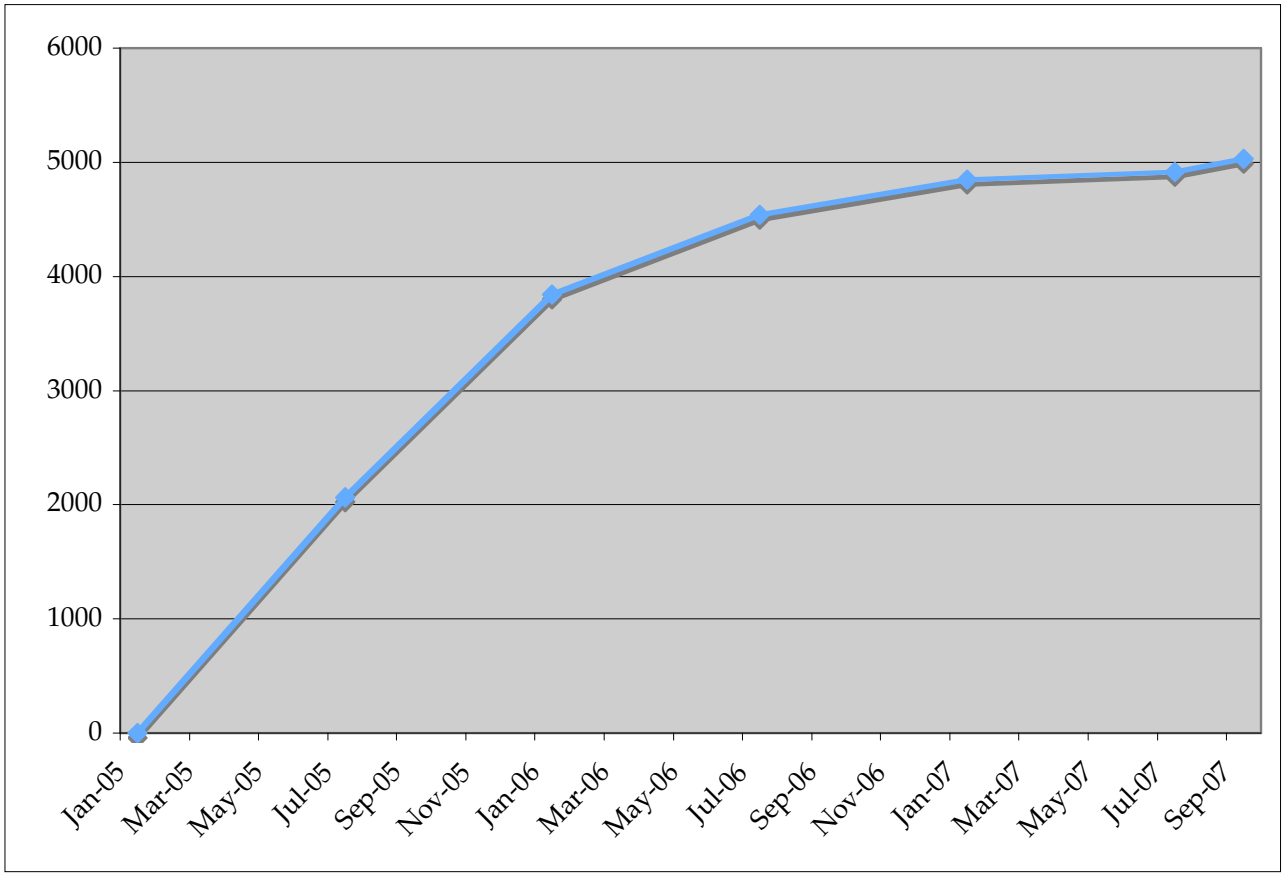
CSTA's Goals and Objectives

Creating a community of individuals and organizations working together to address critical issues in K-12 computer science education.

- **Promote a Better Understanding of Computer Science**: Provide visibility, influence policy, and generate resources that illuminate computer science as an essential academic discipline.
- **Develop Research and Resources**: Conduct original research and serve as a direct-to-practitioner channel for the dissemination of research and resources that address current knowledge gaps.
- **Support National Standards**: Facilitate the implementation of national curriculum and teacher certification standards to support consistent excellence in learning and teaching.
- **Support Teacher Excellence:** Provide multiple levels of professional development to improve teachers' technical knowledge and pedagogical skills.
- **Opportunities**: Promote computer science as a field of study and as a career destination that provides a wealth of opportunities to students regardless of their gender, race, or socio-economic status.

CSTA Membership

Total: 5,243
Individual: 5052
Institutional: 191



CSTA Resources and Programs

Curriculum Solutions

- *The ACM Model Curriculum for K-12 Computer Science* (2nd Ed.)
  http://csta.acm.org/Curriculum/sub/ACMK12CSModel.html

- Online resource materials to support the ACM Model Curriculum: The Outlines and Objectives Documents
  http://csta.acm.org/Curriculum/sub/ACMK12CSModel.html

- *The New Educational Imperative: Improving High School Computer Science Education*: a comprehensive white paper based upon international research to provide practical solutions for achieving long-term systemic improvement
  http://csta.acm.org/Publications/sub/Documents.html

Teacher Preparation Solutions

- JETT: Java Engagement for Teacher Training workshops offered in partnership with colleges and universities across the country (60 workshops held to date)

  http://jett.acm.org/

- TECS: Teacher Engagement for Computer Science introductory CS workshops offered in partnership with colleges and universities (11workshops held to date)

  http://tecs.acm.org/

- The annual Computer Science and Information Technology Symposium (professional development for more than 700 teachers). 8th CSIT Symposium: June 28th in Atlanta

  www.csitsymposium.org

Resource Solutions

- The Teacher Certification database: a state-by-state list of computer science teacher certification requirements and contacts
  http://csta.acm.org/ComputerScienceTeacherCertification/sub/TeacherCertificationRequi.html

- The CSTA web repository: A national repository of resources and learning materials http://csta.villanova.edu

- National research initiatives providing cutting edge data on the state of K-12 computer science education
  http://csta.acm.org/Research/sub/CSTANationalSurvey2004.html

- Careers in Computing Resources (poster, brochure, lesson plan)
  http://csta.acm.org/Careers/sub/ClassroomCareersResources.html

CSTA Resource Solutions cont.

- The CSTA *Voice*: a quarterly newsletter focusing on key issues and resources for computer science educators

  http://csta.acm.org/Publications/Publications.html#ptop

- CSTA *Advocate* Blog: a informal space for discussion of key organizational issues and programs

  http://blog.acm.org/csta/

- CSTA Information brochure for policy-makers

Conclusion

An International Community

- Sharing research
- Sharing knowledge, experiences, history
- Sharing resources
- Sharing solutions
- Working together to promote computer science
- Building an international community of practitioners

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