Computer Science Education: Challenges and Directions

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CE21 Advisory Board Meeting
UMBC, November 2, 2012
Overview and Welcome

- Challenges in Computer Science Education
  (and what we’re trying to do about it...)
  - Broadening the classroom view of CS
  - Broadening the diversity of CS students
  - Broadening the pool of qualified CS teachers
  - Broadening access to CS education through curricular reform

- Recommendations for Action
CS Education: A National Crisis

- We need many trained computer scientists
  - There will be more new jobs in computing than in all other areas of STEM combined

- We are not producing enough computer scientists
  - Enrollment in computing majors dropped dramatically in the 2000s
  - Recently, enrollments have increased, but not nearly enough

- Our pool of computer scientists is not sufficiently diverse
  - Women, African-Americans, and other ethnic minorities choose CS at a much lower rate than white males

- We don’t have enough highly qualified K-12 CS teachers

- We don’t have a strong K-12 CS curriculum
Lack of Gender Diversity in CS*

- In 2008, women earned:
  - 57% of all Bachelor’s degrees
  - 61% of Master’s degrees
  - 51% of Doctoral degrees

- But in 2008, women earned:
  - 12% of Bachelor’s degrees in CS (the lowest percentage ever recorded)
  - 26% of MS degrees in CS
  - 21% of PhD degrees in CS

- Women are underrepresented in CS by a factor of more than 2 at the grad level, and by a factor of more than 4 at the undergrad level!

* Statistics for CS, CE, and IS combined
Source: CRA Taulbee Survey
Lack of Racial Diversity in CS

- In 2008, of Bachelor's degrees in CS:
  - 4.9% went to African-Americans (9.8% of all Bachelor's)
  - 6.8% to Hispanics (7.9% of all Bachelor's)

- In 2008, of Master's degrees in CS:
  - 2.7% went to African-Americans (10% of all Master's)
  - 2.4% went to Hispanics (5.9% of all Master's)

- In 2008, of PhD degrees in CS:
  - 1.6% went to African-Americans (6.1% of all PhDs)
  - 1% to Hispanics (3.6% of all PhDs)

- Minorities are underrepresented by a factor of 4 at the grad level

Source: CRA Taulbee Survey
Challenges in Teacher Preparation

- In most states (including Maryland!!):
  - Certification requirements are unclear
  - Current certifications do not meet the needs of the discipline
  - Teachers without CS certification are often asked to teach CS classes (often due to a lack of certified/qualified teachers)
  - There is inadequate in-service professional development to keep teachers abreast of new trends and knowledge
Challenges in K-12 Curriculum

- In most states (including Maryland!):
  - Very few of the CSTA-identified K-12 CS standards are part of the standard curriculum*
  - Computer science classes are not required for graduation, and in most cases do not count towards any graduation requirement
  - Many schools do not offer computing courses beyond the level of keyboarding schools, and even fewer offer college preparatory CS courses

* CSTA data on Maryland standards:
  31 out of 35 Level I standards; 3 out of 10 Level II standards; 1 out of 10 Level III standards.
Teacher Survey: What We Learned

- Who is teaching?
- What are they teaching?
- Who are they teaching?
- What are their challenges?
- What do they need?
In which Maryland public school district is your high school located?

- Montgomery County: 18.6% (18)
- Baltimore County: 11.3% (11)
- Harford County: 9.3% (9)
- Frederick County: 8.2% (8)
- Howard County: 8.2% (8)
- Prince Georges County: 8.2% (8)
- Baltimore City: 7.2% (7)
- Anne Arundel County: 6.2% (6)
- Cecil County: 6.2% (6)
- Charles County: 4.1% (4)
- All Other Responses: 12.4% (12)
Under what department(s) is CS offered in your school? (Check all that apply.)

- Business: 63.5% (47)
- Technology: 47.3% (35)
- Computing: 13.5% (10)
- Other (please specify): 10.8% (8)
- Math: 9.5% (7)
- Science: 4.1% (3)
Teacher Certification

In which of the following areas are you certified to teach in Maryland?

- Technology Education
- Computer Science
- Business Education
- Mathematics
- Other (please specify)
- Family and Consumer Sciences
- Social Studies
- Biology
- Chemistry
- English
- All Other Responses

Legend:
- Orange: Urban
- Blue: Suburban
- Purple: Rural
Which of the following are offered at your high school? (Check all that apply.)

- An introductory computer science course (pre-AP): 68.8% Suburban, 52.4% Rural, 50.0% Urban
- Advanced Placement Computer Science (AP): 62.5% Suburban, 52.4% Rural, 43.8% Urban
- Other CS/IT courses: 56.3% Suburban, 14.3% Rural, 43.8% Urban
- Keyboarding: 37.5% Suburban, 42.9% Rural, 31.3% Urban
- Cisco Academy: 27.1% Suburban, 4.8% Rural, 25.0% Urban
- None of the above: My school does not offer CS/IT courses: 28.6% Suburban, 2.1% Rural, 6.3% Urban
- Oracle Academy: 6.3% Suburban, 2.1% Rural, 6.3% Urban
What content is covered in introductory CS? (Check all that apply.)

- Programming: 97.8%
- Problem solving: 86.7%
- Logic: 64.4%
- Ethics and social issues: 51.1%
- Hardware: 48.9%
- Information about computing/IT careers: 48.9%
- Graphics: 28.9%
- Game programming: 26.7%
- Web development: 17.8%
- Information about computing/IT majors: 17.8%
- All Other Responses: 8.6%
2011-2012 Enrollment: Intro CS & AP

How many students enrolled in introductory CS this year at your high school?

- 11-25: 34.3%
- 26-50: 28.3%
- 51-100: 17.4%
- 101+: 15.2%
- 1-10: 4.3%

How many students take AP CS each year?

- 5: 25.0%
- 10: 62.1%
- 15: 12.6%
- 20: 10.4%
Percentage Girls: Intro CS and AP

What approximate percentage of students enrolled in introductory CS are female?

- 87.3%
- 1-20%: 62.9%
- 21-40%: 26.1%
- 41-60%: 4.3%
- 61-80%: 0%
- 81-99%: 0%
- 100%: 0%

What percentage of students enrolled in AP CS are female?

- 10.4%
- 1-20%: 77.1%
- 21-40%: 10.4%
- 41-60%: 2.1%
- 61-80%: 0%
- 81-99%: 0%
- 100%: 0%
Percentage Minorities: Intro CS & AP

What approximate percentage of students enrolled in introductory CS are members of an ethnic minority?

- 0%: 2.2%
- 1-20%: 26.1%
- 21-40%: 10.9%
- 41-60%: 8.7%
- 61-80%: 6.3%
- 81-99%: 6.3%
- 100%: 6.3%

What percentage of students enrolled in AP CS are members of an ethnic minority?

- 0%: 8.3%
- 1-20%: 12.5%
- 21-40%: 8.3%
- 41-60%: 8.3%
- 61-80%: 6.3%
- 81-99%: 6.3%
- 100%: 6.3%
What are some of the reasons why your school does not offer more computer science courses? (Check all that apply.)

- CS is not a graduation requirement: 62.7%
- Budget restrictions: 52.0%
- CS is not a priority for the school system: 50.7%
- Insufficient student interest: 46.7%
- CS is not a priority for my high school: 42.7%
- Lack of qualified teachers: 41.3%
- Other (please specify): 12.0%
What do you perceive as the greatest challenges in teaching CS?
(Please rate each challenge.)

- Lack of student interest/enrollment
- Rapidly changing technology
- Difficult subject matter
- Lack of support/interest by school staff
- Lack of student subject knowledge
- Lack of curriculum resources
- Lack of hardware/software resources
- Lack of teacher subject knowledge

Legend:
- Great Challenge
- Moderate challenge
- Minor/no challenge
### Other Reported Challenges

*Not on CSTA Survey*

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Lack of parental encouragement for students to take CS</td>
<td>89%</td>
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<td>Lack of guidance staff knowledge about importance of CS</td>
<td>88%</td>
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<tr>
<td>Lack of student math preparation</td>
<td>88%</td>
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<tr>
<td>Lack of parental knowledge about the importance of CS</td>
<td>87%</td>
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<td>Inability to attract women and minorities to CS classes</td>
<td>75%</td>
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<td>Being asked to teach multiple CS related courses in the same classroom at the same time</td>
<td>74%</td>
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<td>Lack of support/interest by school leadership</td>
<td>74%</td>
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<td>Lack of a professional community of other CS instructors</td>
<td>71%</td>
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<td>Lack of internships for students</td>
<td>68%</td>
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<td>Lack of professional development opportunities</td>
<td>65%</td>
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<td>Creating a curriculum that satisfies district and state</td>
<td>63%</td>
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<td>Understanding state curriculum standards</td>
<td>57%</td>
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What do you perceive as the greatest professional development needs?

- Time for training
- Sufficient training opportunities
- Training cost (and lack of reimbursement)
- Training facilities and resources
- Sufficient training opportunities nearby
- Readily available information about upcoming training opportunities
- Timely information about training opportunities
- More training at convenient times during school year
- More training offered during the summer
What do you believe to be the most effective methods for delivering professional development to CS teachers? (Please rank each.)

- Workshops/seminars
- Online resources
- Networking with others
- Computer-based tutorials
- Professional conferences
- College courses

[Bar chart showing rankings for each method]
Please rank your preference/the convenience of each of the following times for your participation in professional development activities?

- After school 4:30-6:00 pm
- Saturday morning during school year
- Saturday afternoon during school year
- Summer-weekdays in June immediately after school ends
- Summer-weekdays in July
- Summer-weekdays in early August
- Summer-Saturdays

Colors indicate:
- Orange: Most prefer/most convenient
- Blue: Prefer slightly/Somewhat convenient
- Purple: Definitely not/Not convenient
Recommendations

1. Continue to grow the computer science education network in Maryland.

2. Educate the broader community about the CS education crisis.

3. Increase the availability of high-quality CS courses for all Maryland high school students.

4. Provide effective professional development opportunities and develop certification programs to expand the number of highly qualified high school CS teachers.
Discussion Questions

- Does our snapshot of HS CS education seem accurate and complete?
  - What do we still need to know?

- Do you agree with our recommendations for action?
  - Where should we be headed with regard to HS CS education as a state?

- What should our priorities be?
  - Through September 2013 (the term of the CE21-Maryland project)?
  - Beyond September 2013?