Where Are We Now? Results from a National Study of Computer Science Teachers and Teaching

FEBRUARY 28, 2019

Eric R. Banilower
Evelyn M. Gordon
Session Overview

- About the 2018 NSSME+
- Current Status of Computer Science Instruction
- The Computer Science Teaching Force
- Professional Development Experiences
Current reports:
- Technical report
- Highlights report
- Compendium of Tables

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About the 2018 NSSME+

- The 2018 NSSME+ is the sixth in a series of surveys dating back to 1977.

- It is the only survey specific to STEM education that provides nationally representative results.

- The 2018 NSSME+ includes a new focus on computer science education.
The 2018 NSSME+, and this presentation, is based upon work supported by the National Science Foundation under Grant No. DGE-1642413. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the National Science Foundation.
Topics Addressed

Six different survey instruments

• Characteristics of the science/mathematics/computer science teaching force:
  – demographics
  – preparation for teaching
  – beliefs about teaching and learning
  – perceptions of preparedness

• Instructional practices

• Factors that shape teachers’ decisions about content and pedagogy

• Use of instructional materials

• Opportunities teachers have for professional growth
Who’s In the Sample

Two-stage random sample that targeted:

- 2,000 schools (public and private)
- Over 10,000 K–12 teachers

Very good response rate:

- 1,273 schools participated
- 86 percent of program representatives
- 78 percent of sampled teachers
Endorsing Organizations

- American Association of Chemistry Teachers
- American Association of Physics Teachers
- American Federation of Teachers
- Association of Mathematics Teacher Educators
- American Society for Engineering Education
- Association of State Supervisors of Mathematics
- Association for Science Teacher Education
- Council of State Science Supervisors
- Computer Science Teachers Association
- National Association of Biology Teachers
- National Association of Elementary School Principals
- National Association of Secondary School Principals
- National Council of Supervisors of Mathematics
- National Council of Teachers of Mathematics
- National Earth Science Teachers Association
- National Education Association
- National Science Education Leadership Association
- National Science Teachers Association
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- National Earth Science Teachers Association
- National Education Association
- National Science Education Leadership Association
- National Science Teachers Association
Interpreting Results

After data collection, design weights were computed, adjusted for nonresponse, and applied to the data.

Why does this matter?

The sampling and weighting processes mean that the results are national estimates of schools, teachers, and classes—not characteristics of the respondents.
Computer Science Instruction*

Who has access to computer science instruction?

Are students experiencing the kind of computer science instruction we hope for?

Why might instruction look the way it does?
Computer Science Instruction

About what percentage of high schools offer computer science courses?

A. 25%
B. 50%
C. 75%
D. 100%
Schools Offering Computer Science Instruction

<table>
<thead>
<tr>
<th></th>
<th>Percent of Schools/Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary</strong></td>
<td>26 26</td>
</tr>
<tr>
<td><strong>Middle</strong></td>
<td>38 44</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>53 70</td>
</tr>
</tbody>
</table>

- Blue: Schools Offering
- Gray: Students with Access
Equity Analysis: Schools Offering Computer Science Instruction

- Largest Schools: 43%
- Smallest Schools: 23%
- Low FRL Schools: 44%
- High FRL Schools: 26%
High Schools Offering Computer Science and Technology Courses

- **47%** offer computer technology courses that do not include programming.
- **36%** offer introductory courses that include programming.
- **21%** offer specialized/elective courses with programming as a prerequisite.
- **35%** offer courses that might qualify for college credit.

-NSSME THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION
High Schools Offering AP Computer Science Courses

Percent of High Schools

<table>
<thead>
<tr>
<th>Course Type</th>
<th>Percent of High Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CS AP Courses</td>
<td>79</td>
</tr>
<tr>
<td>AP CS-A</td>
<td>16</td>
</tr>
<tr>
<td>AP CS Principles</td>
<td>14</td>
</tr>
<tr>
<td>Both CS AP Courses</td>
<td>9</td>
</tr>
</tbody>
</table>
Equity Analysis: High Schools Offering One or Both AP CS Courses

- Low FRL Schools: 33%
- High FRL Schools: 15%
- Suburban Schools: 28%
- Urban Schools: 30%
- Rural Schools: 8%
Equity Analysis: High School Students Taking CS Courses

Introductory CS courses that include programming

Specialized/elective CS courses with programming as a prerequisite

CS courses that might qualify for college credit

Female Students

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory CS</td>
<td>30</td>
</tr>
<tr>
<td>Specialized/elective CS</td>
<td>27</td>
</tr>
<tr>
<td>CS courses that might qualify for college credit</td>
<td>25</td>
</tr>
</tbody>
</table>

HUS Students

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</tr>
<tr>
<td>CS courses that might qualify for college credit</td>
<td>23</td>
</tr>
</tbody>
</table>
### CS in Science and Mathematics Instruction

#### Classes that Incorporate Coding “At All”

<table>
<thead>
<tr>
<th></th>
<th>Science</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>Middle</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>High</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

**Source:** The National Survey of Science & Mathematics Education
Instructional Objectives

In the ideal, what percentage of high school computer science classes would have a heavy emphasis on students learning how to “do” computer science?

A. 0-25%
B. 26-50%
C. 51-75%
D. 76-100%
Objectives Receiving a Heavy Emphasis

- Learn how to do CS: 60%
- Understand CS concepts: 55%
- Develop student confidence: 52%
- Increasing student interest: 50%
- Learn about real-life applications: 39%
- Learn vocabulary/program syntax: 33%
Instructional Activities

In the ideal, how often should students be engaged in programming activities on a computer?

A. Daily
B. Once or twice a week
C. Once or twice a month
D. A few times a year
Instructional Activities: Weekly

- Programming activities on computer: 97%
- Teacher explains ideas: 84%
- Explain and justify problem-solving method: 63%
- Compare and contrast problem-solving methods: 41%
- Write reflections: 32%
- Programming activities that do not use a computer: 21%
Engagement in Computer Science Practices

The 2018 NSSME+ included a series of items asking how often students were engaged in aspects of the computer science practices:

1. Fostering an inclusive computing culture
2. Collaborating around computing
3. Recognizing and defining computational problems
4. Developing and using abstractions
5. Creating computational artifacts
6. Testing and refining computational artifacts
7. Communicating about computing
Engagement in Computer Science Practices

Students are often engaged in aspects of computer science related to developing computational artifacts
Developing Computational Artifacts: Weekly

- Create computational artifacts: 75%
- Write comments within code to document purposes or features: 72%
- Consider how a program can be separated into modules/procedures/objects: 62%
- Identify and adapt existing code to solve a new problem: 60%
Engagement in Computer Science Practices

Students are often engaged in aspects of computer science related to developing computational artifacts.

Students tend not to be engaged very often in aspects of computer science related to communicating with end-users or considering diverse needs.
Considering End Users: Weekly

Create instructions for an end-user: 30%
Create a computational artifact designed to be used by someone else: 22%
Get input on an artifact or design from people with different perspectives: 21%

Percent of HS CS Classes
# Instructional Materials Used (Weekly)

<table>
<thead>
<tr>
<th>Source of Instructional Materials</th>
<th>Percent of Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-developed units or lessons</td>
<td>64</td>
</tr>
<tr>
<td>Units or lessons from websites that are free</td>
<td>43</td>
</tr>
<tr>
<td>Self-paced online courses or units</td>
<td>32</td>
</tr>
<tr>
<td>Units or lessons from other sources (e.g., conferences or colleagues)</td>
<td>28</td>
</tr>
<tr>
<td>Commercially published textbooks (printed or online)</td>
<td>26</td>
</tr>
<tr>
<td>Lessons or resources from websites that have a subscription fee or cost</td>
<td>9</td>
</tr>
<tr>
<td>State, county, district, or diocese-developed unit or lessons</td>
<td>7</td>
</tr>
</tbody>
</table>
Factors Perceived as Problems

<table>
<thead>
<tr>
<th>Factor</th>
<th>Percent of HS CS Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>School restrictions on Internet content</td>
<td>37</td>
</tr>
<tr>
<td>Lack of support to maintain technology</td>
<td>34</td>
</tr>
<tr>
<td>Lack of functioning computing devices</td>
<td>27</td>
</tr>
<tr>
<td>Lack of reliable access to the Internet</td>
<td>19</td>
</tr>
<tr>
<td>Insufficient power sources for devices</td>
<td>14</td>
</tr>
</tbody>
</table>
Computer Science Instruction: Our Take-Aways

Only about half of high schools offer computer science; it is less common in smaller schools, high-poverty schools, and rural schools.

Computer science instruction is relatively rare at elementary and middle schools.

On average, female students and students from race/ethnicity groups historically underrepresented in STEM make up less than a third of students in high school computer science classes.

Students work on creating computational artifacts often, but are not asked to attend to end-users’ needs nearly as often.

Teachers are often using self-developed units and lessons, and picking and choosing from other sources, raising questions about quality and coherence.
Availability and Nature of Instruction

Discussion:

1. What questions do you have about these data?
2. What do you see as the key findings?
3. What do you see as the main implications?
The Computer Science Teaching Force

The 2018 NSSME+ collected data about:

- Demographics of teachers
- College degrees and coursework
- Path to certification
- Feelings of preparedness
- Beliefs about teaching and learning
Teaching Experience

Percent of HS CS Teachers

- >20 years: 15
- 11-20 years: 32
- 6-10 years: 23
- 3-5 years: 19
- 0-2 years: 10

Any subject
Teaching Experience

Any subject

<table>
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<th>Experience</th>
<th>Percent of HS CS Teachers</th>
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</tr>
<tr>
<td>0-2 years</td>
<td>10</td>
</tr>
</tbody>
</table>

Computer science

<table>
<thead>
<tr>
<th>Experience</th>
<th>Percent of HS CS Teachers</th>
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</thead>
<tbody>
<tr>
<td>&gt;20 years</td>
<td>3</td>
</tr>
<tr>
<td>11-20 years</td>
<td>18</td>
</tr>
<tr>
<td>6-10 years</td>
<td>16</td>
</tr>
<tr>
<td>3-5 years</td>
<td>28</td>
</tr>
<tr>
<td>0-2 years</td>
<td>35</td>
</tr>
</tbody>
</table>
Certification

About what percentage of high school computer science teachers are certified to teach computer science?

A. 25%
B. 50%
C. 75%
D. 100%
College Degrees

About what percentage of high school computer science teachers have a degree in computer science, computer engineering, information science, or computer science education?

A. 25%
B. 50%
C. 75%
D. 100%
Degree in Computer Science/Related Field/CS Education

Percent of HS CS Teachers

- Computer Engineering, Computer Science, or Information Science: 24%
- Computer Science Education: 4%
Degree in Computer Science/Related Field/CS Education

Percent of HS CS Teachers

- Computer Engineering, Computer Science, or Information Science: 24%
- Computer Science Education: 4%
- Either or Both: 25%
CSTA/ISTE CS Teacher Preparation Recommendations

Similar recommended content knowledge for CS educators from CSTA and ISTE

Combined, they suggest teachers have coursework in four content areas:

- Programming
- Algorithms
- Data structures
- Computer systems or networks
Coursework Related to CSTA/ISTE Course-Background Standards

Percent of HS CS Teachers

- 46% (41) Courses in 3-4 areas
- 41% (13) Courses in 0 areas
- 13% Courses in 1-2 areas

Key:
- Courses in 0 areas
- Courses in 1-2 areas
- Courses in 3-4 areas

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Horizon RESEARCH, INC.
Perceptions of Preparedness

The 2018 NSSME+ included items about teachers’ feelings of preparedness to:

• Teach core computer science ideas
• Use student-centered pedagogies, e.g.:
  – Use formative assessment
  – Develop student abilities to do computer science
  – Encourage student interest in computer science
  – Differentiate instruction
  – Incorporate students’ cultural backgrounds into instruction
Perceptions of Preparedness: Very Well Prepared to Teach CS Topics

Percent of HS CS Teachers

- Algorithms and programming: 47%
- Impacts of computing: 35%
- Computing systems: 31%
- Data and analysis: 27%
- Networks and the Internet: 23%
Perceptions of Preparedness: Very Well Prepared to Use Student-Centered Pedagogy

- Encourage students’ interest in CS: 49%
- Develop students’ abilities to do CS: 48%
- Use formative assessment: 35%
- Provide instruction that is based on students’ ideas: 28%
- Differentiate instruction: 21%
- Incorporate students’ cultural backgrounds: 16%

Percent of HS CS Teachers
Teacher Beliefs

What percentage of high school computer science teachers believe that students should be asked to justify their solutions?

A. 25%
B. 50%
C. 75%
D. 100%
Teacher Beliefs

Students should learn CS by doing CS: 97%

Teachers should ask students to justify their solutions: 92%

Most class periods, students should share their thinking and reasoning: 91%

Students learn best when instruction is connected to their everyday lives: 90%

Most class periods, students should apply CS ideas to real-world contexts: 79%

Instruction should focus on ideas in depth, even if it means covering fewer topics: 58%
Teacher Beliefs

Students should be provided with vocabulary and definitions at beginning of instruction: 75%

Hands-on/manipulatives/programming activities should be used primarily as reinforcement: 71%

Students learn best in classes with students of similar abilities: 51%
Computer Science Teachers: Our Take-Aways

Sizeable proportion of the computer science teacher workforce is newer, or new to teaching computer science, and likely still honing their craft.

Many have limited preparation to teach computer science.

Teachers' beliefs about teaching and learning indicate only partial alignment with what is known about how students learn.
Computer Science Teachers

Discussion:

1. What questions do you have about these data?
2. What do you see as the key findings?
3. What do you see as the main implications?
Inservice Support

The 2018 NSSME+ asked about:

• School/district-offered induction programs
• School/district-offered professional development (workshops, study groups/PLCs, coaching)
• Teacher PD experiences
Professional Development

About what percentage of high school computer science teachers have had any computer science-related PD in the last three years?

A. 25%
B. 50%
C. 75%
D. 100%
Professional Development

Hours of PD in Last 3 Years

- None: 3
- <6 hours: 18
- 6-35 hours: 25
- 36+ hours: 54
Types of Professional Development in the Past Three Years

<table>
<thead>
<tr>
<th>Type of PD</th>
<th>Percent of HS CS Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD program/workshop</td>
<td>88</td>
</tr>
<tr>
<td>Teacher study group/PLC</td>
<td>62</td>
</tr>
<tr>
<td>Online course/webinar</td>
<td>59</td>
</tr>
<tr>
<td>CS teacher association meeting</td>
<td>35</td>
</tr>
<tr>
<td>Formal coach/mentor</td>
<td>29</td>
</tr>
</tbody>
</table>
## Characteristics of PD

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percent of HS CS Teachers Attending PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage in activities to learn computer science content</td>
<td>76</td>
</tr>
<tr>
<td>Experience lessons as students</td>
<td>62</td>
</tr>
<tr>
<td>Work with those teaching the same subject/grade level</td>
<td>51</td>
</tr>
<tr>
<td>Examine classroom artifacts</td>
<td>46</td>
</tr>
<tr>
<td>Apply what they learn in classroom and come back to discuss</td>
<td>39</td>
</tr>
<tr>
<td>Rehearse instructional practices</td>
<td>31</td>
</tr>
<tr>
<td>Work closely with other teachers in school</td>
<td>26</td>
</tr>
</tbody>
</table>
Emphasis of PD

Given what you know, what areas do you think PD for computer science teachers should emphasize?

1. Implementing instructional materials
2. Deepening computer science content knowledge, including programming
3. Deepening understanding of how computer science is done
4. Differentiating instruction
5. Making instruction culturally relevant
Emphasis of PD

**Topics Receiving Heavy Emphasis**

- Deepening CS content knowledge, including programming: 70%
- Learning how to use programming activities that require a computer: 64%
- Deepening understanding of how CS is done: 63%
- Implementing instructional materials: 50%
- Differentiating instruction: 29%
- Incorporating students’ cultural backgrounds: 25%

Percent of Teachers Who Attended PD
Inservice Support: Our Take-Aways

A relatively large proportion of HS CS Teachers have had substantial PD experiences in the last three years; still, many others have not.

PD is mostly engaging teachers in CS activities, often with the goals of increasing their own content knowledge.

Less emphasis on helping teachers improve their instructional practice or encourage and support students from diverse backgrounds.
Discussion

1. Across all of these data, what do you see as the biggest implications and for whom?

2. What are the most effective ways to share findings with these audiences?