Elementary Science Instruction in the US: Warning Signs and Ways Forward

NARST
APRIL 16, 2020

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P. Sean Smith
Peggy J. Trygstad
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+, 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
- How instructional resources are distributed
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
Interpreting Results

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

Why should you care?

The sampling and weighting processes mean that the results are national estimates of schools, teachers, and classes—not characteristics of the respondents.
Several reports and other products are available on our website, including:

- Technical report
- Highlights report
- Compendium of Tables
- Trends report
- Novice teacher report

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Trends in Elementary Science Instruction from 2012 to 2018

Eric R. Banilower
Teacher Characteristics

The 2018 NSSME+ collected data on:

- Gender
- Race/ethnicity
- Age
- Years of teaching experience
- Content background (courses and degrees)
- Preparedness
- Beliefs
Female Teachers

2012: 94%
2018: 94%

Percent of Teachers
Race/Ethnicity

Percent of Teachers

- **White**: 92% (2012), 88% (2018)
- **Hispanic or Latino**: 8% (2012), 9% (2018)
- **Black or African American**: 6% (2012), 8% (2018)
- **Asian**: 2% (2012), 2% (2018)
- **American Indian or Alaskan Native**: 1% (2012), 1% (2018)
- **Native Hawaiian or Other Pacific Islander**: 1% (2012), 1% (2018)

**2012** | **2018**
Degrees Earned

<table>
<thead>
<tr>
<th>Degrees Earned</th>
<th>Percent of Teachers</th>
</tr>
</thead>
</table>
Feelings of Preparedness

Very Well Prepared

Percent of Teachers

Life science* 29 24
Earth/space science* 26 20
Physical science* 17 13
Engineering 4 3

2012 2018

NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Horizon Research, Inc.
Feelings of Preparedness

Very Well Prepared

- Assess student understanding at end of unit: 2012 - 32%, 2018 - 46%
- Monitor student understanding during unit: 2012 - 33%, 2018 - 46%
- Implement designated instructional materials: 2012 - 32%, 2018 - 39%
- Anticipate student difficulties: 2012 - 22%, 2018 - 28%
- Elicit student ideas: 2012 - 31%, 2018 - 38%

Percent of Classes

2012  2018

NSSME - THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION
Amount of Science-Related PD in Previous Three Years

<table>
<thead>
<tr>
<th>Category</th>
<th>2012</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>41</td>
<td>43</td>
</tr>
<tr>
<td>&lt; 6 hours</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>6–15 hours</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>16–35 hours</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>&gt; 35 hours</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Percent of Teachers
Types of Science-Related PD in Previous Three Years

- Attended a professional development program/workshop: 84% in 2012, 89% in 2018
- Participated in a professional learning community/lesson study/teacher study group*: 42% in 2012, 55% in 2018
- Received assistance or feedback from a formally designated coach/mentor: 28% in 2012, 24% in 2018
- Attended a national, state, or regional science teacher association meeting: 12% in 2012, 8% in 2018
Instructional Arrangements

Students pulled out from science for instruction in other subjects
- 2012: 22%
- 2018: 28%

Students receive instruction from science specialist in addition to regular teacher
- 2012: 16%
- 2018: 15%

Students receive instruction from science specialist instead of regular teacher
- 2012: 10%
- 2018: 7%

Percent of Classes

2012  2018
Frequency of Science Instruction: Self-Contained Classrooms

Grades K–3

<table>
<thead>
<tr>
<th>Frequency of Instruction</th>
<th>Percent of Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>All/most days, every week</td>
<td>20 (2012) 17 (2018)</td>
</tr>
<tr>
<td>Three or fewer days, every week</td>
<td>39 (2012) 40 (2018)</td>
</tr>
<tr>
<td>Some weeks, but not every week</td>
<td>41 (2012) 43 (2018)</td>
</tr>
</tbody>
</table>
**Frequency of Science Instruction: Self-Contained Classrooms**

**Grades 4–6**

<table>
<thead>
<tr>
<th>Frequency of Instruction</th>
<th>2012</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>All/most days, every week</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Three or fewer days, every week</td>
<td>33</td>
<td>36</td>
</tr>
<tr>
<td>Some weeks, but not every week</td>
<td>32</td>
<td>29</td>
</tr>
</tbody>
</table>

**Percent of Classes**
Instructional Time: Self-Contained Classrooms

Grades K–3

Minutes per Day

<table>
<thead>
<tr>
<th>Subject</th>
<th>2012</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading/LA</td>
<td>89</td>
<td>89</td>
</tr>
<tr>
<td>Mathematics*</td>
<td>54</td>
<td>57</td>
</tr>
<tr>
<td>Science</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>Social Studies</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION
Instructional Time: Self-Contained Classrooms

Grades 4–6

- Reading/LA: 2012 - 83, 2018 - 82
- Mathematics: 2012 - 61, 2018 - 63
- Science*: 2012 - 24, 2018 - 27
- Social Studies: 2012 - 21, 2018 - 21
Class Activities: At Least Once a Week

Engage the whole class in discussions: 90% (2012) to 90% (2018)
Explain science ideas to the whole class: 88% (2012) to 85% (2018)
Have students work in small groups: 72% (2012) to 75% (2018)
Focus on literacy skills*: 48% (2012) to 60% (2018)
Have students do hands-on/laboratory activities: 55% (2012) to 53% (2018)
Have students write their reflections: 44% (2012) to 43% (2018)
Have students read from a textbook, module, or other material in class*: 37% (2012) to 48% (2018)

Percent of Classes

2012 2018

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Horizon Research, Inc.
Classes in Which Teachers Feel Various Resources are Adequate

- Instructional technology (e.g., calculators, computers, probes/sensors): 33% in 2012, 49% in 2018
- Facilities (e.g., lab tables, electric outlets, faucets and sinks): 35% in 2012, 39% in 2018
- Equipment (e.g., thermometers, magnifying glasses, microscopes, beakers, photogate timers, Bunsen burners): 32% in 2012, 38% in 2018
- Consumable supplies (e.g., chemicals, living organisms, batteries): 31% in 2012, 30% in 2018
School Science/Engineering Enrichment Programs

- Encourage students to participate in summer programs/camps*: 50% (2012) to 68% (2018)
- Hold family science/engineering nights*: 26% (2012) to 44% (2018)
- Offer science clubs*: 20% (2012) to 36% (2018)
- Offer after-school programs for enrichment*: 17% (2012) to 32% (2018)
- Offer engineering clubs*: 7% (2012) to 28% (2018)
- Teams participate in engineering competitions*: 11% (2012) to 24% (2018)
- Teams participate in science competitions*: 13% (2012) to 17% (2018)
Conclusions

Continued problem areas, including:

- Lack of diversity in teaching force
- Lack of teacher preparation to teach science
- Limited participation in science-related professional learning opportunities
- Limited instructional time devoted to science
- When science is taught, lecture and discussion are the primary pedagogies used
Novice Elementary Science Teachers

Peggy J. Trygstad
The 2018 NSSME+ collected data on:

- Sex
- Race/ethnicity
- Age
- School Contexts
- Content background (certification and coursework)
- Beliefs
- Preparedness
Characteristics of the Elementary Science Teaching Force

<table>
<thead>
<tr>
<th></th>
<th>Percent of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Novice</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>96</td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>88</td>
</tr>
<tr>
<td>Black or African-American</td>
<td>10</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>10</td>
</tr>
<tr>
<td>Asian</td>
<td>5</td>
</tr>
<tr>
<td>American Indian/Alaskan Native</td>
<td>1</td>
</tr>
<tr>
<td>Native Hawaiian/Other Pacific Islander</td>
<td>0</td>
</tr>
</tbody>
</table>
Characteristics of the Elementary Science Teaching Force

Teacher Age*

Novice
- 61+ (3)
- 51-60 (15)
- 41-50 (25)
- 31-40 (56)
- ≤ 30 (5)

Veteran
- 61+ (6)
- 51-60 (26)
- 41-50 (34)
- 31-40 (29)
- ≤ 30 (5)

Percent of Teachers

NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION
## School Contexts

<table>
<thead>
<tr>
<th>School Type</th>
<th>Percent of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Novice</td>
</tr>
<tr>
<td>Catholic</td>
<td>4</td>
</tr>
<tr>
<td>Non-Catholic Private</td>
<td>5</td>
</tr>
<tr>
<td>Public</td>
<td>92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Community Type</th>
<th>Percent of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Novice</td>
</tr>
<tr>
<td>Rural</td>
<td>20</td>
</tr>
<tr>
<td>Suburban</td>
<td>49</td>
</tr>
<tr>
<td>Urban</td>
<td>31</td>
</tr>
</tbody>
</table>
School Contexts

School Spending Per Pupil on Science Resources*

<table>
<thead>
<tr>
<th>School Spending Per Pupil</th>
<th>Novice</th>
<th>Veteran</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$2.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Certification

Paths to Certification*

Percent of Teachers

Novice

Veteran

- No teaching credential
- Master's
- Post-baccalaureate
- Undergraduate

Percentages:

Novice:
- 15% No teaching credential
- 8% Master's
- 5% Post-baccalaureate
- 75% Undergraduate

Veteran:
- 25% No teaching credential
- 13% Master's
- 0% Post-baccalaureate
- 62% Undergraduate
Content Preparation

Coursework Related to NSTA Preparation Standards

Percent of Teachers

Novice
- Courses in all 3 areas: 19%
- Courses in 2 of 3 areas: 40%
- Courses in 1 of 3 areas: 31%
- Courses in 0 of 3 areas: 9%

Veteran
- Courses in all 3 areas: 25%
- Courses in 2 of 3 areas: 35%
- Courses in 1 of 3 areas: 35%
- Courses in 0 of 3 areas: 5%
Teachers Agreeing With Various Reform-Oriented Teaching Beliefs

- Teachers should ask students to support their conclusions with evidence
  - Novice: 96%
  - Veteran: 94%

- Most class periods should provide opportunities for students to share their thinking and reasoning
  - Novice: 95%
  - Veteran: 96%

- Students should learn science by doing science
  - Novice: 95%
  - Veteran: 95%

- Students learn best when instruction is connected to their everyday lives
  - Novice: 94%
  - Veteran: 96%

- Most class periods should provide opportunities for students to apply scientific ideas to real-world...
  - Novice: 92%
  - Veteran: 94%

- It is better for science instruction to focus on ideas in depth, even if it means covering fewer topics*
  - Novice: 68%
  - Veteran: 78%

Percent of Teachers

Novice  Veteran
Teachers Agreeing With Various Traditional Teaching Beliefs

- Students learn best in classes with students of similar abilities
- Hands-on/laboratory activities should be used to reinforce ideas students have already learned
- Teachers should explain an idea to students before having them consider evidence related to the idea*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Novice</th>
<th>Veteran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students learn best in classes with students of similar abilities</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>Hands-on/laboratory activities should be used to reinforce ideas students have already learned</td>
<td>54</td>
<td>60</td>
</tr>
<tr>
<td>Teachers should explain an idea to students before having them consider evidence related to the idea*</td>
<td>29</td>
<td>43</td>
</tr>
</tbody>
</table>
Beliefs About Teaching and Learning

- **Reform-Oriented Beliefs**
  - Novice: 87
  - Veteran: 86

- **Traditional Beliefs**
  - Novice: 59
  - Veteran: 54
Preparedness to Teach Various Science Disciplines

**Life Science**
- Novice: 19 Very Well, 29 Fairly Well, 6 Somewhat, 3 Not
- Veteran: 26 Very Well, 50 Fairly Well, 21 Somewhat, 3 Not

**Physical Science**
- Novice: 10 Very Well, 34 Fairly Well, 18 Somewhat, 9 Not
- Veteran: 15 Very Well, 42 Fairly Well, 34 Somewhat, 9 Not
Preparedness to Teach Various Science Disciplines

**Earth/Space Science**

- Novice: 18% Very Well, 44% Fairly Well, 30% Somewhat, 8% Not
- Veteran: 21% Very Well, 49% Fairly Well, 25% Somewhat, 5% Not

**Engineering**

- Novice: 2% Very Well, 29% Fairly Well, 55% Somewhat, 33% Not
- Veteran: 14% Very Well, 14% Fairly Well, 33% Somewhat, 50% Not

The percentages indicate the level of preparedness of novice and veteran teachers in teaching Earth/Space Science and Engineering.
Very Well Prepared for Instructional Tasks

- Encourage participation of all students
- Use formative assessment
- Encourage students' interest in science/engineering
- Differentiate science instruction
- Develop students' conceptual understanding
- Develop students' abilities to do science
- Provide instruction that is based on students' ideas
- Incorporate students' cultural backgrounds
- Develop students' awareness of STEM careers

Percent of Classes

Novice  Veteran
Very Well Prepared to Monitor and Address Student Understanding in Most Recent Unit

- **Find out what students thought or already knew about key science ideas**
  - Novice: 27%
  - Veteran: 33%

- **Monitor student understanding**
  - Novice: 26%
  - Veteran: 35%

- **Assess student understanding at the end of the unit**
  - Novice: 26%
  - Veteran: 34%

- **Implement instructional materials**
  - Novice: 24%
  - Veteran: 35%

- **Anticipate student difficulties with science ideas/procedures**
  - Novice: 15%
  - Veteran: 25%

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NSSME | The National Survey of Science & Mathematics Education
Elementary Science Instruction
Frequency of Instruction

**Grades K-3**

- Novice: 19
- Veteran: 16

**Grades 4-6**

- Novice: 39
- Veteran: 37

**Legend**

- Blue: All/Most days every week
- Teal: ≥ 3 days every week
- Green: Some weeks but not every week
Minutes Per Day on Instruction

Grades K-3

Number of Minutes

Grades 4-6

Reading/ELA
Mathematics
Science
Social Studies
Heavy Emphasis on Instructional Objectives

- Understanding science concepts: Novice 48, Veteran 47
- Learn science vocabulary/facts: Novice 27, Veteran 27
- Increasing students' interest in science/engineering: Novice 28, Veteran 25
- Learning how to do science: Novice 28, Veteran 25
- Learning test-taking skills/strategies: Novice 21, Veteran 19

Percent of Classes

Novice  
Veteran
Heavy Emphasis on Instructional Objectives

- Learning about real-life applications of science/engineering: Novice 20, Veteran 20
- Developing students' confidence for science/engineering careers: Novice 9, Veteran 24
- Learning about different fields of science/engineering: Novice 8, Veteran 9
- Learning how to do engineering: Novice 6, Veteran 9
Incorporating Engineering into Science Instruction

![Chart showing percent of classes for Novice and Veteran levels]

- All/Almost All: Novice - 2%, Veteran - 1%
- Often: Novice - 25%, Veteran - 10%
- Sometimes: Novice - 52%, Veteran - 27%
- Rarely: Novice - 15%, Veteran - 15%
- Never: Novice - 0%, Veteran - 0%

NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Horizon Research, Inc.
Support for Novice Teachers
Participation in Science PD in Previous Three Years

Percent of Teachers

Novice: 57
Veteran: 58
More Than 35 Hours of Science PD in Previous Three Years

- 3 Novice
- 6 Veteran

Percent of Teachers
Duration of Formal Induction Programs

Percent of Novice Teachers

- None: 19
- ≥ 1 year: 37
- 2 years: 22
- 3+ years: 22
Supports Provided as Part of Formal Induction Programs

- Orientation meeting: 92%
- Formally assigned school-based mentors: 85%
- PD opportunities: 84%
- Common planning time with experienced teachers: 82%
- Release time to observe other teachers: 81%
Takeaways

Some key differences between novices and veterans:

• Content preparedness
• Pedagogical preparedness
• Instructional beliefs

Many commonalities which suggest room for professional growth

• PD data suggest elementary teachers are not getting the support they need to “mature” as professionals throughout their teaching careers
Takeaways

Given the large percentage of novice elementary teachers that participate in induction programs, perhaps it is possible to leverage induction program supports:

• School-based mentors might devote time to helping novices increase their science content knowledge or diversify their science teaching practices

• School leaders may strategically choose teachers for novices to observe when they are given release time to do so
Factors That Predict the Extent to Which Elementary Teachers' Engage Students in the Science Practices

Laura M. Craven
Analytic Approach

The 2018 NSSME+ collected data about the nature of instruction in elementary science classes.

Study also collected tons of data about teachers, schools, and instructional resources.

This analysis looked at school, class, and teacher characteristics that are associated with instructional practices.
Outcomes

Composite variables measuring:

1. Reform-oriented instructional objectives
2. Extent instruction engages students with the practices of science
Reform-Oriented Instructional Objectives

How much emphasis each would receive over the entire course:

1. Understanding science concepts
2. Learning about different fields of science/engineering
3. Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)
4. Learning how to do engineering (e.g., identify criteria and constraint, design solutions, optimize solutions)
5. Learning about real-life applications of science/engineering
6. Increasing students’ interest in science/engineering
7. Developing students’ confidence that they can successfully pursue careers in science/engineering
Engagement in Science Practices

How often students are engaged in aspects of the science practices:

1. Asking questions/defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations/designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
Independent Variables

Schools
- School size
- Community type
- Public vs. private school
- Spending per pupil
- Extent factors are problematic

Teachers
- Self-contained
- Years of K-12 science teaching experience
- Minutes of instruction
- Perceptions of preparedness
- Teaching beliefs
- Science-related job before teaching
- Amount of science PD
- Race/sex

Classes
- Prior achievement level of students
- Class size
- Percent of students in class from race/ethnicity groups historically underrepresented in STEM
- Curriculum control
- Pedagogy control
- Number of instructional materials used often
- Adequacy of resources
- Extent effective instruction is promoted
Reform-Oriented Objectives Receiving a Heavy Emphasis

- Understanding science concepts: 47%
- Increasing interest in science/engineering: 27%
- Learning how to do science: 26%
- Developing confidence to pursue science/engineering careers: 23%
- Learning about real-life applications of science/engineering: 20%
- Learning about different fields of science/engineering: 8%
- Learning how to do engineering: 8%

NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Horizon Research, Inc.
Reform-Oriented Instructional Objectives Composite

Mean = 60.22
S.D. = 18.98
Engagement in Science Practices

Students are often engaged in aspects of science related to conducting investigations and analyzing data
Conducting Investigations and Analyzing Data: Weekly

- Conduct a scientific investigation: 36%
- Organize and/or represent data: 34%
- Determine what data need to be collected: 29%
- Analyze data using grade-appropriate methods: 27%

Percent of Classes
Engagement in Science Practices

Students are often engaged in aspects of science related to conducting investigations and analyzing data.

Students tend to not be engaged very often in aspects of science related to evaluating the strengths/limitations of evidence and the practice of argumentation.
Evaluating Evidence and Arguing: Weekly

- Pose questions about arguments: 14
- Identify strengths and limitations of a model: 12
- Evaluate strengths and weaknesses of competing explanations: 12
- Evaluate credibility of information: 8

Percent of Classes
Engaging Students in the Practices
Science Composite

Percent of Classes

Percent of Total Points Possible

Mean = 38.63
S.D. = 20.14
School Independent Variables
## School Independent Variables

<table>
<thead>
<tr>
<th></th>
<th>Elementary Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Number of Students</td>
<td>421</td>
</tr>
<tr>
<td>Average Spending Per Pupil</td>
<td>$6.43</td>
</tr>
</tbody>
</table>
# School Independent Variables

<table>
<thead>
<tr>
<th>Community Type</th>
<th>Percent of Elementary Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>24</td>
</tr>
<tr>
<td>Suburban</td>
<td>47</td>
</tr>
<tr>
<td>Urban</td>
<td>29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School Type</th>
<th>Percent of Elementary Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>83</td>
</tr>
<tr>
<td>Private</td>
<td>17</td>
</tr>
</tbody>
</table>
School Mean Scores for Factors Affecting Instruction Composites

- Supportive Context for Instruction: 54
- Extent Student Issues are Problematic: 24
- Extent a Lack of Resources is Problematic: 37
- Extent Teacher Issues are Problematic: 42
Teacher Independent Variables
Perceptions of Preparedness: Very Well Prepared to Teach Science Topics

- Life Science: 24%
- Earth Science: 20%
- Physical Science: 13%
- Engineering: 3%

NSSME | The National Survey of Science & Mathematics Education

Horizon Research, Inc.
Perceptions of Preparedness: Very Well Prepared to Use Student-Centered Pedagogies

- Encourage participation of all students in science and/or engineering: 31%
- Use formative assessment to monitor student learning: 28%
- Encourage students’ interest in science and/or engineering: 26%
- Develop students’ conceptual understanding: 23%
- Differentiate science instruction to meet the needs of diverse learners: 19%

Percent of Teachers
Perceptions of Preparedness: Very Well Prepared to Use Student-Centered Pedagogies

- Develop students’ abilities to do science: 17%
- Provide science instruction that is based on students’ ideas: 12%
- Incorporate students’ cultural backgrounds into science instruction: 11%
- Develop students’ awareness of STEM careers: 9%

NSSME
THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION
Perceptions of Preparedness: Very Well Prepared for Various Tasks in the Most Recent Unit

- Monitor student understanding: 33%
- Assess student understanding at the conclusion of the unit: 32%
- Implement the instructional materials to be used during the unit: 32%
- Find out what students thought or already knew about the key science ideas: 30%
- Anticipate student difficulties with science ideas/procedures: 22%

Percent of Teachers
Teachers Agreeing With Various Reform-Oriented Teaching Beliefs

- Most class periods should have students share their thinking and reasoning: 96% of teachers agree.
- Students learn best when instruction is connected to their everyday lives: 95% of teachers agree.
- Students should learn science by doing science: 95% of teachers agree.
- Teachers should ask students to support conclusions with evidence: 95% of teachers agree.
- It is better for instruction to focus on ideas in depth, even if it means covering fewer topics: 75% of teachers agree.

Percent of Teachers
Teachers Agreeing With Various Traditional Teaching Beliefs

- Students should be provided with vocabulary and definitions at beginning of instruction: 77%
- Hands-on/labs should be used primarily as reinforcement: 56%
- Teachers should explain ideas before students consider evidence: 33%
- Students learn best in classes with students of similar abilities: 25%

Percent of Teachers
Hours of Science PD in the Previous 3 Years

- 43% < 6 hours
- 33% 6-35 hours
- 20% 36+ hours
- 5% None
Teacher Characteristics

Percent of Teachers

<table>
<thead>
<tr>
<th>Gender</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>94</td>
</tr>
<tr>
<td>Male</td>
<td>6</td>
</tr>
</tbody>
</table>
Teacher Race/Ethnicity

American Indian/Alaskan Native: 1%
Asian: 2%
Black or African-American: 8%
Hispanic or Latino: 9%
Native Hawaiian or Other Pacific Islander: 1%
White: 88%
Class Independent Variables
Prior Achievement Grouping in Science Classes

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Percent of Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly low achievers</td>
<td>11</td>
</tr>
<tr>
<td>Mostly average/a mix of achievers</td>
<td>84</td>
</tr>
<tr>
<td>Mostly high achievers</td>
<td>6</td>
</tr>
</tbody>
</table>
Class Size

Number of Students in Class

Percent of Classes

2
31
61
4
1
0
<10
10-19
20-29
30-39
≥40

<10
10-19
20-29
30-39
≥40

2
31
61
4
1

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Classes in Which Teachers Feel Strong Control Over Curriculum

- Sequence in which topics are covered: 30%
- Amount of time spent on each topic: 21%
- Course goals and objectives: 17%
- Curriculum materials: 15%
- Content, topics, and skills to be taught: 13%
Classes in Which Teachers Feel Strong Control Over Pedagogy

- Amount of homework: 59%
- Teaching techniques: 48%
- Criteria for grading student performance: 41%

Percent of Classes
Number of Types of Instructional Materials Used Often

- None: 13
- One: 20
- Two or three: 44
- Four or more: 23
Classes in Which Teachers Feel Various Resources are Adequate

<table>
<thead>
<tr>
<th>Resource</th>
<th>Percent of Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>39</td>
</tr>
<tr>
<td>Facilities</td>
<td>38</td>
</tr>
<tr>
<td>Instructional Technology</td>
<td>49</td>
</tr>
<tr>
<td>Consumable Supplies</td>
<td>30</td>
</tr>
</tbody>
</table>
Class Mean Scores for Factors Promoting Effective Instruction Composites

Percent of Total Points Possible

<table>
<thead>
<tr>
<th>Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Support</td>
<td>62</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>68</td>
</tr>
<tr>
<td>Policy Environment</td>
<td>62</td>
</tr>
</tbody>
</table>
Path Model
## Total Effects on Student Engagement in Science Practices

<table>
<thead>
<tr>
<th>Factor</th>
<th>Total Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reform-Oriented Instructional Objectives</td>
<td>0.467</td>
</tr>
<tr>
<td>Perceptions of Preparedness</td>
<td>0.378</td>
</tr>
<tr>
<td>Minutes of science instruction</td>
<td>0.163</td>
</tr>
<tr>
<td>Traditional Teaching Beliefs</td>
<td>0.148</td>
</tr>
<tr>
<td>Class size</td>
<td>0.123</td>
</tr>
<tr>
<td>Curriculum Control</td>
<td>0.112</td>
</tr>
<tr>
<td>Pedagogy Control</td>
<td>-0.289</td>
</tr>
<tr>
<td>Adequacy of Resources for Instruction</td>
<td>0.279</td>
</tr>
<tr>
<td>Number of type of instructional materials used often (vs. none)</td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>0.018</td>
</tr>
<tr>
<td>Two or three</td>
<td>0.092</td>
</tr>
<tr>
<td>Four or more</td>
<td>0.139</td>
</tr>
</tbody>
</table>
Differences Between Self-Contained and Non-Self-Contained Elementary Science Classes

P. Sean Smith
Background

More than 90% of elementary teachers work in self-contained settings (i.e., they teach multiple subjects to one group of students).

• Affordances include deep understanding of students and possibilities for integrating core subjects.

• Challenges include depth of preparation and accountability pressures across multiple subjects.

• Teachers have to make difficult choices about the amount of time they devote to each of the core subjects, and time for science often suffers.
Instructional Time in Self-Contained Elementary Classes

<table>
<thead>
<tr>
<th>Grades</th>
<th>Reading/LA</th>
<th>Mathematics</th>
<th>Science</th>
<th>Social Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-3</td>
<td>89</td>
<td>55</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>4-6</td>
<td>85</td>
<td>63</td>
<td>23</td>
<td>19</td>
</tr>
</tbody>
</table>
Interestingly, between grades 3 and 5, science is increasingly likely to be taught in non-self-contained (NSC) settings.

• By NSC, we mean a teacher who teaches science to more than one group of students.
• Most frequently, NSC classes occur within a team-teaching model.
• Teachers of NSC classes are referred to as elementary content specialists in emerging literature (Markworth et al., 2016).
Science Class Structure: Grades 3-5

Minutes Per Day

- 3rd Grade
  - Self-Contained: 82
  - Non-Self-Contained: 18

- 4th Grade
  - Self-Contained: 67
  - Non-Self-Contained: 33

- 5th Grade
  - Self-Contained: 59
  - Non-Self-Contained: 41

Self-Contained
Non-Self-Contained
Science Instructional Time: Grades 3-5

Science instructional time in NSC classes is almost twice that in SC settings.

Further, the additional time does not seem to come from mathematics instruction.
Science and Math Instructional Time: Grades 3-5

- Science: 24 minutes per day
- Math: 66 minutes per day

- Self-Contained: 46 minutes per day
- Non-Self-Contained: 78 minutes per day
Further Exploration

The sharp difference in time prompts questions about differences in other areas, including:

- Instruction
- Teacher Preparation
- School Context

Note: In the charts that follow, an asterisk indicates a significant difference (p < 0.05) between SC and NSC.
Instructional Objectives

NSC science classes are much more likely than SC classes to emphasize:

- Understanding science concepts
- Learning science vocabulary and/or facts
Objectives Receiving a Heavy Emphasis

- Understanding science concepts*: 71% (Self-Contained), 48% (Non-Self-Contained)
- Learning science vocabulary and/or facts*: 44% (Self-Contained), 22% (Non-Self-Contained)
- Learning how to do science: 35% (Self-Contained), 27% (Non-Self-Contained)
- Learning test-taking skills/strategies: 27% (Self-Contained), 24% (Non-Self-Contained)
Objectives Receiving a Heavy Emphasis (cont)

- Increasing students’ interest in sci/eng: 24% Self-Contained, 27% Non-Self-Contained
- Learning about real-life applications of sci/eng: 15% Self-Contained, 25% Non-Self-Contained
- Learning about different fields of sci/eng: 6% Self-Contained, 10% Non-Self-Contained
- Learning how to do engineering: 8% Self-Contained, 6% Non-Self-Contained

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Science Class Activities

NSC science classes are more likely than SC classes to do the following activities:

• Explain science ideas to the whole class
• Engage the whole class in discussions
• Have students work in small groups
Science Class Activities: Weekly

- Self-Contained: 86%
- Non-Self-Contained: 97%

- Self-Contained: 91%
- Non-Self-Contained: 96%

- Self-Contained: 76%
- Non-Self-Contained: 86%

* Have students work in small groups
* Engage the whole class in discussions
* Explain science ideas to the whole class
NSC science classes were less likely than SC classes to do the following activities:

- Engage the class in project-based learning activities
- Focus on literacy skills
Engage the class in project-based learning activities*

Focus on literacy skills*

Percent of Classes

Self-Contained  Non-Self-Contained

- Engage the class in project-based learning activities: 31% in Self-Contained, 19% in Non-Self-Contained
- Focus on literacy skills: 67% in Self-Contained, 45% in Non-Self-Contained
NSC science classes were more likely than SC classes to engage students in the following aspects of science practices:

- Generating scientific questions
- Organizing and/or representing data using tables, charts, or graphs
- Making and supporting claims with evidence
- Using multiple sources of evidence to develop an explanation
- Developing procedures for a scientific investigation to answer a scientific question
- Using data and reasoning to define a claim or refute alternative scientific claims about a real world phenomenon
- Determining what details about an investigation might persuade a targeted audience about a specific claim
Classes Engaging in Science Practices: Weekly

- Generating scientific questions*: 31% Self-Contained, 51% Non-Self-Contained
- Organizing and/or representing data using tables, charts, or graphs*: 30% Self-Contained, 48% Non-Self-Contained
- Making and supporting claims with evidence*: 30% Self-Contained, 48% Non-Self-Contained
- Using multiple sources of evidence to develop an explanation*: 27% Self-Contained, 45% Non-Self-Contained

Percent of Classes

Self-Contained Non-Self-Contained
Determining what details about an investigation might persuade a targeted audience about a specific claim*
Using data and reasoning to define a claim or refute alternative scientific claims about a real world phenomenon*
Developing procedures for a scientific investigation to answer a scientific question*
Teacher Preparation

Teachers of NSC science classes are quite similar to their SC counterparts in terms of course taking, but they are much more likely to perceive themselves as very well prepared.
Course Taking

Teacher has college courses in...

<table>
<thead>
<tr>
<th>Course Areas</th>
<th>Self-Contained</th>
<th>Non-Self-Contained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth, life, and phys sci</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>2 of 3 areas</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>1 of 3 areas</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>0 of 3 areas</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>
Content Preparedness

Percent of Teachers Feeling Very Well Prepared

- **Life Science***: 22% Self-Contained, 41% Non-Self-Contained
- **Earth/Space Science***: 21% Self-Contained, 35% Non-Self-Contained
- **Physical Science***: 13% Self-Contained, 28% Non-Self-Contained

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Pedagogical Preparedness

- Encourage participation of all students in science and/or engineering*
  - Self-Contained: 26
  - Non-Self-Contained: 42

- Encourage students’ interest in science and/or engineering*
  - Self-Contained: 22
  - Non-Self-Contained: 37

- Develop students’ conceptual understanding of the science ideas you teach*
  - Self-Contained: 20
  - Non-Self-Contained: 32

- Use formative assessment to monitor student learning
  - Self-Contained: 26
  - Non-Self-Contained: 32

- Develop students’ abilities to do science
  - Self-Contained: 16
  - Non-Self-Contained: 22
Pedagogical Preparedness (cont)

- Differentiate science instruction to meet the needs of diverse learners
- Incorporate students’ cultural backgrounds into science instruction
- Provide science instruction that is based on students’ ideas about the topics you teach
- Develop students’ awareness of STEM careers

Percent of Teachers Feeling Very Well Prepared

- Self-Contained
- Non-Self-Contained
Participation in Science-Focused PD

Teachers of NSC science classes are much more likely than their SC counterparts to have participated in substantial science-focused PD.
Science PD Participation

Some PD in Last Year*

- Self-Contained: 37%
- Non-Self-Contained: 67%

No PD in Last 3 Years*

- Self-Contained: 44%
- Non-Self-Contained: 19%
School Context

Schools that teach science in NSC settings appear to be more supportive of science on several indicators than schools that teach science in SC settings.
Availability of Lab Facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Self-Contained</th>
<th>Non-Self-Contained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric outlets</td>
<td>92</td>
<td>95</td>
</tr>
<tr>
<td>Faucets and sinks</td>
<td>84</td>
<td>72</td>
</tr>
<tr>
<td>Lab tables*</td>
<td>18</td>
<td>45</td>
</tr>
</tbody>
</table>

*Lab tables*: excludes classroom and computer lab, which are sometimes considered as part of the lab space.
Factors Promoting Science Instruction

- Principal support: 59% (Self-Contained), 81% (Non-Self-Contained)
- Current state standards: 58% (Self-Contained), 79% (Non-Self-Contained)
- Students’ motivation, interest, and effort in science: 74% (Self-Contained), 75% (Non-Self-Contained)
- Amt of time for you to plan, individually and with colleagues: 49% (Self-Contained), 67% (Non-Self-Contained)
- Pacing guides: 44% (Self-Contained), 60% (Non-Self-Contained)
- Amt of instructional time devoted to science: 41% (Self-Contained), 52% (Non-Self-Contained)

Percent of Teachers
Factors Promoting Science Instruction (cont)

- Teacher evaluation policies: 30% (Self-Contained), 50% (Non-Self-Contained)
- Amt of time available for your professional development: 36% (Self-Contained), 50% (Non-Self-Contained)
- Students’ prior knowledge and skills: 28% (Self-Contained), 37% (Non-Self-Contained)
- Textbook/module selection policies: 31% (Self-Contained), 33% (Non-Self-Contained)
- Parent/guardian expectations and involvement: 30% (Self-Contained), 50% (Non-Self-Contained)
The data on NSC classes and teachers of those classes are very encouraging in terms of:

- Instructional time
- Instructional activities
- Teacher preparedness
- PD participation
- School context

Change is much more complex than simply shifting from SC to NSC classrooms.

The field needs a much better understanding of what happens in these classes and schools.
Reference List
