Diversity and Equity in Science Education: A Research Agenda and Role for NARST

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Topics

1. Diversity
   • Changing demographics
   • Persistent science achievement gaps

2. National Initiatives
   • Next Generation Science Standards
   • Understanding Language

3. A Research Agenda and Role for NARST
Diversity: Changing Demographics

Race
Poverty
Language
Race

According to the 2010 U.S. Census:

- 36% of the U.S. population are minorities
- 45% of the U.S. population under 19 years old are minorities

US Population Projections, 2000-2050 (under 19 years old)

- Majority (%)
- Minority (%)

- 2000: 39%
- 2022: 45%
- 2050: 38%

- 2000: 61%
- 2022: 51%
- 2050: 38%

Graph shows the percentage of the US population under 19 years old projected from 2000 to 2050, with a transition point in 2022.
Poverty

• Poverty gaps by race narrowed from 1970 to 2000
• Poverty gaps by race have persisted since 2000


Poverty by Race, 1960-2009

- Black
- Hispanic
- Asian and Pacific Islander
- White

Percent of population in poverty

Language

• Today, over 1 in 5 students (21%) speak a language other than English at home.

• Limited English Proficient (LEP) students (the federal term) have more than doubled from 5% in 1993 to 11% in 2007.

Spoke Language Other than English at Home, 1980-2009

- Spoke only English at home
- Spoke a language other than English at home

Percentage of student population

Year

Percentage of Public School Students Identified as LEP

- 1993-1994: 5%
- 1999-2000: 7%
- 2003-2004: 11%
- 2007-2008: 11%
Diversity: Persistent Achievement Gaps

National Assessment of Educational Progress (NAEP) in Science

- 4th grade
- 8th grade
- 12th grade

Review

- School-aged students from racial or ethnic minority backgrounds will soon become the majority in terms of number, although they are likely to remain minorities in terms of status.
- Achievement gaps persist.
- We have kept pace, but how can we get ahead of the curve (i.e., close the gaps)?
National Initiatives:

1. Next Generation Science Standards
2. Understanding Language
Next Generation Science Standards (NGSS)
Lots of Work Completed, Underway, and Left To Do

Completed

Underway

Left To Do

Assessment

Curricula

Instruction

Teacher Development
Next Generation Science Standards (NGSS)

- Achieve, Inc. is overseeing the development
- The design team consists of classroom teachers, state and district supervisors, faculty from higher education institutions, and representatives from the private sector
- Currently, 26 states have signed with state teams to provide feedback to the NGSS design team
- There will be public release of drafts for feedback
- The first draft of NGSS is expected in early 2013
Shifts in the NGSS

1. Standards as performance expectations
2. Science and engineering practices and crosscutting concepts are continuums
3. Greater focus on understanding and application of content as opposed to memorization of scientific facts
4. Science concepts build over K-12
5. Integration of science and engineering
6. Coordination with Common Core State Standards in English language arts (ELA) and math
Science and Engineering Practices

1. Ask questions (for science) and define problems (for engineering)
2. Develop and use models
3. Plan and carry out investigations
4. Analyze and interpret data
5. Use mathematics and computational thinking
6. Construct explanations (for science) and design solutions (for engineering)
7. Engage in argument from evidence
8. Obtain, evaluate, and communicate information
Crosscutting Concepts

1. Patterns
2. Cause and effect
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change
Disciplinary Core Ideas

- Physical sciences
- Life sciences
- Earth and space sciences
- Engineering, technology and applications of science
Diversity and Equity: All Standards, All Students (Tentative Title)

• **Standards Statements**
  - To reflect diversity and equity issues
  - To avoid bias

• **Stand-alone Chapter**
  - Context (demographics, achievement, policy)
  - Implementation (classroom/school, home/community)
  - Teacher professional development

• **Vignettes of Specific Student Groups**
  - Story
  - Context
  - Implementation: Effective strategies
Implications for Diversity and Equity: For Example, Engineering

Reinterpret a traditional view of epistemology and history of science:

The recommendations in this chapter focus on the development of science, mathematics, and technology in Western culture, but not on how that development drew from earlier Egyptian, Chinese, Greek, and Arabic cultures. (Science for All Americans, AAAS, 1989, p. 136)
Implications for Diversity and Equity: For Example, Practices

- From *hands-on science*, to *science inquiry*, to *science and engineering practices*
- Inter-related to one another in the sense-making process
- Relatively unfamiliar to most science teachers today and require shifts for teaching
- Language intensive
- Common across English language arts (ELA), math, science, and other subjects
Understanding Language Project: Three Goals

1. Engage in a healthy public dialogue around what the CCSS and NGSS imply for English language learners (ELLs)

2. Develop exemplars of what CCSS and NGSS-aligned instruction looks like

3. Develop a vibrant, inquisitive, engaging online community

Note: This portion of the presentation was prepared by Martha Inez Castellon at Stanford University
http://ell.stanford.edu
Dimensions of ELA Standards

**Student Portraits**

1. Demonstrate independence
2. Build strong content knowledge
3. Respond to the varying demands of audience, task, purpose, and discipline
4. Comprehend as well as critique
5. Value evidence
6. Use technology and digital media strategically and capably
7. Understand other perspectives and cultures

**Key Features**

**Reading:** Text complexity and the growth of comprehension
1. Key ideas and details
2. Craft & structure
3. Integration of knowledge & ideas
4. Range of reading & level of text complexity

**Writing:** Text types, responding to reading, and research
1. Text types and purposes
2. Production and distribution of writing
3. Research to build and present knowledge
4. Range of writing

**Speaking & Listening:** Flexible communication & collaboration
1. Comprehension & collaboration
2. Presentation of knowledge & ideas

**Language:** Conventions, effective use, and vocabulary
1. Conventions of Standard English
2. Knowledge of language
3. Vocabulary acquisition and use
# Dimensions of Math Standards

## Mathematical Practices
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

## Core Ideas

### K-5
- Counting & Cardinality (K)
- Operations & Algebraic Thinking
- Number & Operations
  - Fractions (3)
- Measurement & Data
- Geometry

### 6-8
- Ratios & Proportional Relationships
- Number System
- Expressions & Equations
  - Functions (8)
- Geometry
- Statistics & Probability

### 9-12
- Number & Quantity
- Algebra
- Functions
- Modeling
- Geometry
- Statistics & Probability
### Scientific & Engineering Practices

1. Ask questions (for science) and define problems (for engineering)
2. Develop and use models
3. Plan and carry out investigations
4. Analyze and interpret data
5. Use mathematics and computational thinking
6. Construct explanations (for science) and design solutions (for engineering)
7. Engage in argument from evidence
8. Obtain, evaluate, and communicate information

### Crosscutting Concepts

1. Patterns
2. Cause and effect
3. Scale, proportion and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change

### Core Ideas

#### Physical Sciences
- PS1 Matter and its interactions
- PS2 Motion and stability: Forces and interactions
- PS3 Energy
- PS4 Waves and their applications in technologies for information transfer

#### Life Sciences
- LS1 From molecules to organisms: Structures and processes
- LS2 Ecosystems: Interactions, energy, and dynamics
- LS3 Heredity: Inheritance and variation of traits
- LS4 Biological evolution: Unity and diversity

#### Earth and Space Sciences
- ESS1 Earth’s place in the universe
- ESS2 Earth’s systems
- ESS3 Earth and human activity

#### Engineering, Technology and Applications of Science
- ETS1 Engineering design
- ETS2 Links among engineering, technology, science and society
MATH

M1. Make sense of problems & persevere in solving them
M2. Reason abstractly & quantitatively
M3. Construct viable argument & critique reasoning of others
M4. Model with mathematics
M5. Use appropriate tools strategically
M6. Attend to precision
M7. Look for & make use of structure
M8. Look for & express regularity in repeated reasoning

SCIENCE

S1. Ask questions & define problems
S2. Develop and use models
S3. Plan & carry out investigations
S4. Analyze & interpret data
S5. Use mathematics & computational thinking
S6. Construct explanations & design solutions
S7. Engage in argument from evidence
S8. Obtain, evaluate & communicate information

ELA

E1. Demonstrate independence
E2. Build strong content knowledge
E3. Respond to the varying demands of audience, talk, purpose, & discipline
E4. Comprehend as well as critique
E5. Value evidence
E6. Use technology & digital media
E7. Come to understand other perspectives & cultures
E8. Obtain, evaluate & communicate information

Source: Working Draft, 12-6-11 by Tina Cheuk, ell.stanford.edu
Promoting Both Science and Language Learning for ELLs

- ELLs can participate in classroom discourse focused on rich and exciting academic content.
- ELLs learn language best when they engage with academic content.
- Focusing on both text and discourse gives ELLs opportunities for extended engagement with complex ideas.
What Science Teachers Need to Know and Do with ELLs

- Literacy strategies for all students
- Language support strategies for ELLs
- Discourse strategies for ELLs
- Home language support
- Home culture connections
A Research Agenda and Role for NARST
Research Agenda

• In response to changing demographics (i.e., majority-minority in terms of number versus status), diversity and equity issues become part of the mainstream discourse

• Science education researchers contextualize research programs in relation to:
  ➢ changing demographics and persistent science achievement gaps
  ➢ initiatives with implications for diversity and equity issues
Role for NARST

• NARST supports research that can shape sound policy and practice

• NARST offers organizational resources for social networking and leadership for members, especially scholars of color, in the academy

• While this presentation highlights the U.S. context, international members may address a similar set of issues in their respective countries

• NARST provides a forum for U.S. and international members to engage in joint efforts in a global context
Take-Home Message

1. In response to changing demographics and persistent achievement gaps, science education researchers should become more actively involved in initiatives with implications for diversity and equity issues globally.

2. NARST supports research that can shape sound policy and practice regarding diversity and equity issues globally.
Thank you!