STEM Equity and Needs of Disadvantaged Students in Rural Areas

STEM Education Equity:
Polices to Create Opportunities in Rural Iowa
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Student Diversity: Nationally

- **Poverty:** “ Majority of U.S. public school students are in poverty” (51%), *New York Times*, January 16, 2015

- **Race and ethnicity:** “U.S. school enrollment hits majority-minority milestone” (this fall), *Education Week*, February, 1, 2015

- **Disabilities:** 12% of students received special education services in 2011

- **English language:**
  - 21% of students spoke a language other than English at home in 2011
  - 9% of students participated in ELL programs in 2011
In this 2008 file photo, traffic on Interstate 380 slows in Cedar Rapids, Iowa.
Diversity in Iowa


• **Poverty:** 41.0%
• **Race and ethnicity:** 21.7% Non-White
  ➢ White – 78.3%
  ➢ Hispanic – 10.0%
  ➢ Black – 5.5%
• **Students with disabilities:** 12.6%
• **English language learners:** 5.3%

General Population (3,046,355 according to 2010 Census)

• **White** – 91.3%
• **Urban areas** – 64%
• **Rural areas** – 34%
Challenges to Rural Education in Iowa

• Declining populations mean declining enrollments – declining funding coupled with higher per pupil costs
• Retention of high quality teachers in STEM areas
• Geographic isolation – summer and weekend programs are needed in areas that are difficult to reach
• Connectivity – Students may have access to technology and distance learning at school but may have limited access at home
• Resources needed to help increasing diversity in rural schools

Acknowledgement: Mark McDermott, University of Iowa
Next Generation Science Standards (NGSS) for Diversity and Equity

3-Dimensional Learning

- To explain phenomena (science) and design solutions to problems (engineering)
- To occur in local contexts (e.g., homes and communities) that capitalize on students’ everyday language and experience
Dimension 1: 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
Dimension 2: 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
Dimension 3: Disciplinary Core Ideas

Physical Sciences
- PS 1: Matter and its interactions
- PS 2: Motion and stability: Forces and interactions
- PS 3: Energy
- PS 4: Waves and their applications in technologies for information transfer

Life Sciences
- LS 1: From molecules to organisms: Structures and processes
- LS 2: Ecosystems: Interactions, energy, and dynamics
- LS 3: Heredity: Inheritance and variation of traits
- LS 4: Biological Evolution: unity and diversity

Earth and Space Sciences
- ESS 1: Earth’s place in the universe
- ESS 2: Earth’s systems
- ESS 3: Earth and human activity

Engineering, Technology, and the Applications of Science
- ETS 1: Engineering design
- ETS 2: Links among engineering, technology, science, and society
<table>
<thead>
<tr>
<th>7 Case Studies</th>
<th>Grade/Subject</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economically Disadvantaged:</td>
<td>Grade 9 Physical Science</td>
<td>Developing Conceptual Models to Explain Chemical Processes</td>
</tr>
<tr>
<td>Racial and Ethnic Groups:</td>
<td>Grade 8 Life science</td>
<td>Constructing Explanations to Compare the Cycle of Matter and the Flow of Energy through Local Ecosystems</td>
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<td>Disabilities:</td>
<td>Grade 6 Space Science</td>
<td>Using Models of Space Systems to Describe Patterns</td>
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<tr>
<td>English Language Learners:</td>
<td>Grade 2 Earth Science</td>
<td>Developing and Using Models to Represent Earth’s Surface Systems</td>
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<td>Girls:</td>
<td>Grade 3 Engineering</td>
<td>Defining Problems with Multiple Solutions within an Ecosystem</td>
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<td>Alternative Education:</td>
<td>Grade 10 &amp; 11 Physical Science</td>
<td>Constructing Explanations about Energy in Chemical Processes</td>
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<tr>
<td>Gifted and Talented:</td>
<td>Grade 4 Life Science</td>
<td>Constructing Arguments about the Interaction of Structure and Function in Plants and Animals</td>
</tr>
<tr>
<td>Demographic Groups</td>
<td>Student Engagement</td>
<td>Classroom Support Strategies</td>
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<td>----------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Economically Disadvantaged Students</td>
<td>students’ sense of place</td>
<td>project-based learning</td>
</tr>
<tr>
<td>Racial and Ethnic Groups</td>
<td>multimodal experiences</td>
<td>multiple representations; culturally relevant pedagogy</td>
</tr>
<tr>
<td>Students with Disabilities</td>
<td>accommodations and modifications</td>
<td>differentiated instruction; Universal Design for Learning; Response to Intervention</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>discourse practices</td>
<td>language and literacy support</td>
</tr>
<tr>
<td>Girls</td>
<td>relevance; real-world application</td>
<td>curricular focus</td>
</tr>
<tr>
<td>Students in Alternative Education</td>
<td>safe learning environment</td>
<td>individualized academic support</td>
</tr>
<tr>
<td>Gifted and Talented Students</td>
<td>strategic grouping; self-direction opportunities</td>
<td>fast pacing; challenge level</td>
</tr>
</tbody>
</table>
1) The investigation is carried out by a class of 2nd grade students with 80% English language learners.

While observing the soil in the school yard, they ask if all soil is the same. Some students think that sand is an example of different soil. They develop a conceptual web and discuss how they would be able to find out.
2) The students ask their families the question in an interview for a homework assignment. In class, they discuss the soil in different parts of the country and home countries where they come from.

A grandmother from Laos visits the class and, through a school translator, describes the rich soil in the rice field and wonders how corn grows in the sandy soil in Wisconsin.
Lus Nug txog Av:

Nug Koj li Niamtxiv

Tag nrho av puas zoo ib yam
They are different
Some are rocky, some are dry
some are sandy.

Koj yuav paub tau li cas
(How do you know)?
We went to dig and
saw different types.

Peb yuav nrhiav tau li cas
(How can we find out)?
you can go look at the different lands.
you can even go and dig and feel them.
3) Based on the evidence that soil is different around the world, the students wonder if soil is different in the neighborhood.

Using an aerial map and a topographic map, they choose three different locations within walking distance of the school. They investigate whether soil is the same.
Using an Aerial Map and a Topographical Map in the Community
<table>
<thead>
<tr>
<th>Place</th>
<th>School Yard</th>
<th>Coniferous Hill</th>
<th>Urban Marsh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worms</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>How many</td>
<td></td>
<td>1700+</td>
<td></td>
</tr>
<tr>
<td>How far down?</td>
<td>Thick</td>
<td>Thin</td>
<td>Thick</td>
</tr>
<tr>
<td>Roots</td>
<td>12 in</td>
<td>6 1/2</td>
<td>9 1/2</td>
</tr>
<tr>
<td>Garbage</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>Do not</td>
<td>6 inches</td>
</tr>
<tr>
<td>How far down?</td>
<td>17 in</td>
<td>have 2</td>
<td>Down</td>
</tr>
<tr>
<td>Fungi</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>How many Colors</td>
<td>brown white</td>
<td>dark brown</td>
<td>light brown</td>
</tr>
<tr>
<td>Do you see?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What colors?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rock/Clay</td>
<td>12 in</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4) The students develop “expert groups,” and each group works on a soil profile model of one area in the neighborhood.

Each group investigates (a) what makes up the soil (sand, silt, clay, and organic materials) in the area and (b) how quickly the soil filters water.

The groups present their models to the whole class. They talk about patterns they observe across maps.
Modeling Soil Profiles to Explain Patterns

- Urban Marsh
- Coniferous Hill
- School Yard
5) The students are given three unidentified soil samples that came from sites within walking distance of the school.

They use the models to develop claims, based on evidence, as to where the soil came from.
Reasoning to Identify Soil Types
Do you think the soil came from the urban marsh, the coniferous hill, or the school yard field?

Use evidence to support your claim:

Claim: I think the soil is from the Coniferous Hill.

Why do you think that?

Evidence:

I think it is because it has pine needles and it has a black color and light brown color and a dark brown color too. And if I look at the model of the Coniferous Hill, that's how I know.
Writing Claims and Evidence on the Whiteboard

soil A is from UrbanMarsh
It is wet and I have a worm

B is from School

my evidence
6) One of the locations the students investigate is the mucky and smelly soil under a highway (urban marsh). It has a lot of trash and sand in it. They argue that the trash ends up in the soil because of the wind blowing the trash there and the sand is washed into the soil from the highways.

The students care about this soil because it is right next to the apartments where many students live.

This finding leads the students to consider solutions to this problem, which is engineering.
Engineering Solutions to Trash Problem

How can wind and rain change the soil?

When the wind comes, it reaches the trash.

In some urban marsh and when the rain comes, it changes the soil.

What can we do to STOP wind and rain from changing the soil?

We can make a house.

[Diagram of a house]
Take-Home Message

• The NGSS focus on explaining phenomena and designing solutions to problems

• Students engage in 3-dimensional learning by blending:
  ➢ science and engineering practices
  ➢ crosscutting concepts
  ➢ disciplinary core ideas

• Phenomena and problems occur in local contexts of students’ homes and communities

• Students use everyday language and experience to make sense of science
• What local, community-based phenomena are meaningful for students in Iowa?

• The phenomena need to be:
  ➢ Student-centered based on prior knowledge
  ➢ Based in the local context of home and community
  ➢ Generative over a period of instruction
Issues of Local Relevance in Iowa

- Protect Iowa’s rivers
- No bees, no food
- Go solar, Iowa
- Global warming solutions

Source: http://www.environmentiowa.org/issues
Issues of Local Relevance in Iowa

- Water quality; groundwater quality
- Food production and food security / safety
- Technology use in agriculture
- Genetically modified crops and products
- Alternative energy production and use
- Personal genomic medicine / health related research and careers

Acknowledgement: Mark McDermott, University of Iowa
NGSS and CCSS (Common Core State Standards)

- Raise the bar for content (academically rigorous)
- Raise the bar for language (language intensive)
- Call for a high level of classroom discourse (oral and written) across all content areas for all students, particularly English language learners
Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek ell.stanford.edu

Math

M1: Make sense of problems and persevere in solving them
M2: Reason abstractly & quantitatively
M6: Attend to precision
M7: Look for & make use of structure
M8: Look for & make use of regularity in repeated reasoning

Science

S1: Ask questions and define problems
S2: Develop & use models
S5: Use mathematics & computational thinking

S3: Plan & carry out investigations
S4: Analyze & interpret data
S6: Construct explanations & design solutions

M4: Models with mathematics

E1: Demonstrate independence in reading complex texts, and writing and speaking about them
E2: Build a strong base of knowledge through content rich texts
E3: Obtain, synthesize, and report findings clearly and effectively in response to task and purpose
E4: Construct viable arguments and critique reasoning of others
E5: Read, write, and speak grounded in evidence
E6: Use technology & digital media strategically & capably
E7: Come to understand other perspectives and cultures through reading, listening, and collaborations
E8: Obtain, evaluate, & communicate information

ELA

M3 & M4: Construct viable arguments and critique reasoning of others
S7: Engage in argument from evidence
S8: Obtain, synthesize, and report findings clearly and effectively in response to task and purpose

Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek ell.stanford.edu
How do content teachers work together to capitalize on the synergy of the NGSS and CCSS for all students?
If you build it, they will come.
The Next Generation Science Standards are now available. Twenty-six states and their broad-based teams worked together with a 40-member writing team and partners throughout the country to develop the standards.

There are three ways to view the standards:

- View the NGSS in Disciplinary Core Idea (DCI) Arrangements
- View the NGSS in Topic Arrangements
- View and Search the NGSS performance expectations individually

The NGSS are composed of the three dimensions from the NRC Framework. Click on the links to the left and see the videos below to learn more about the standards.
http://www.nextgenscience.org/resources

**Strategy Book: NGSS For All Students**

It’s challenging to teach science well to all students while connecting your lessons to the Next Generation Science Standards (NGSS). This unique book portrays real teaching scenarios written by the teachers on the NGSS Diversity and Equity Team. The seven authentic case studies vividly illustrate research- and standards-based classroom strategies you can use to engage seven diverse demographic groups.
Questions and Comments
Thank You!