STEM Equity and Needs of Disadvantaged Students in Rural Areas

STEM Education Equity:
Policies to Create Opportunities in Rural Iowa
October 19, 2015

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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

Student Diversity: Iowa

1989

In this 2008 file photo, traffic on Interstate 380 slows in Cedar Rapids, Iowa.

Diversity in Iowa

Student Population (2014-2015)

- **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%

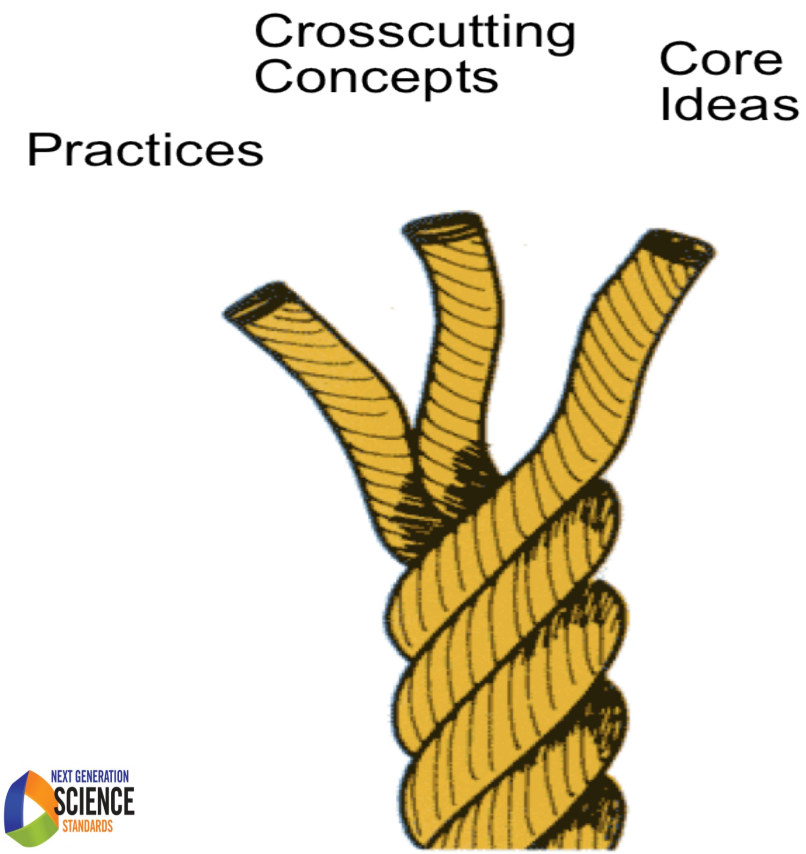
Challenges to Rural Education in Iowa

- 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

7 Case Studies

Economically Disadvantaged: Grade 9 Physical Science	• Developing Conceptual Models to Explain Chemical Processes
Racial and Ethnic Groups: Grade 8 Life science	• Constructing Explanations to Compare the Cycle of Matter and the Flow of Energy through Local Ecosystems
Disabilities: Grade 6 Space Science	• Using Models of Space Systems to Describe Patterns
English Language Learners: Grade 2 Earth Science	• Developing and Using Models to Represent Earth's Surface Systems
Girls: Grade 3 Engineering	• Defining Problems with Multiple Solutions within an Ecosystem
Alternative Education: Grade 10 & 11 Physical Science	• Constructing Explanations about Energy in Chemical Processes
Gifted and Talented: Grade 4 Life Science	• Constructing Arguments about the Interaction of Structure and Function in Plants and Animals

Demographic Groups	Student Engagement	Classroom Support Strategies	School Support Systems	Home and Community Connections
Economically Disadvantaged Students	students' sense of place	project-based learning	school resources and funding	students' funds of knowledge
Racial and Ethnic Groups	multimodal experiences	multiple representations; culturally relevant pedagogy	role models and mentors	community involvement; culturally relevant pedagogy
Students with Disabilities	accommodations and modifications	differentiated instruction; Universal Design for Learning; Response to Intervention	accommodations and modifications	family outreach
English Language Learners	discourse practices	language and literacy support	home language support	home culture connections
Girls	relevance; real-world application	curricular focus	school structure	relevance; real-world application
Students in Alternative Education	safe learning environment	individualized academic support	after-school opportunities; career & technology opportunities	family outreach
Gifted and Talented Students	strategic grouping; self–direction opportunities	fast pacing; challenge level	school identification programs	Family outreach

ELL Case Study

English Language Learners: Grade 2 Earth Science

Developing and Using Models to Represent Earth's Surface Systems

Emily Miller, NGSS Diversity and Equity Team Member

ELL Case Study: Is All Soil the Same?

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.


Tom
EXTREME

ELL Case Study: Is All Soil the Same?

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.

Making Home Language and Culture Connections

Npe Leo Xiong Niamtxiv: Wacha

Lus Nug txog Av:

Nug Koj li Niamtxiv

Tag nrho av puas zoo ib yan (Is all soil the same)?

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.

ELL Case Study: Is All Soil the Same?

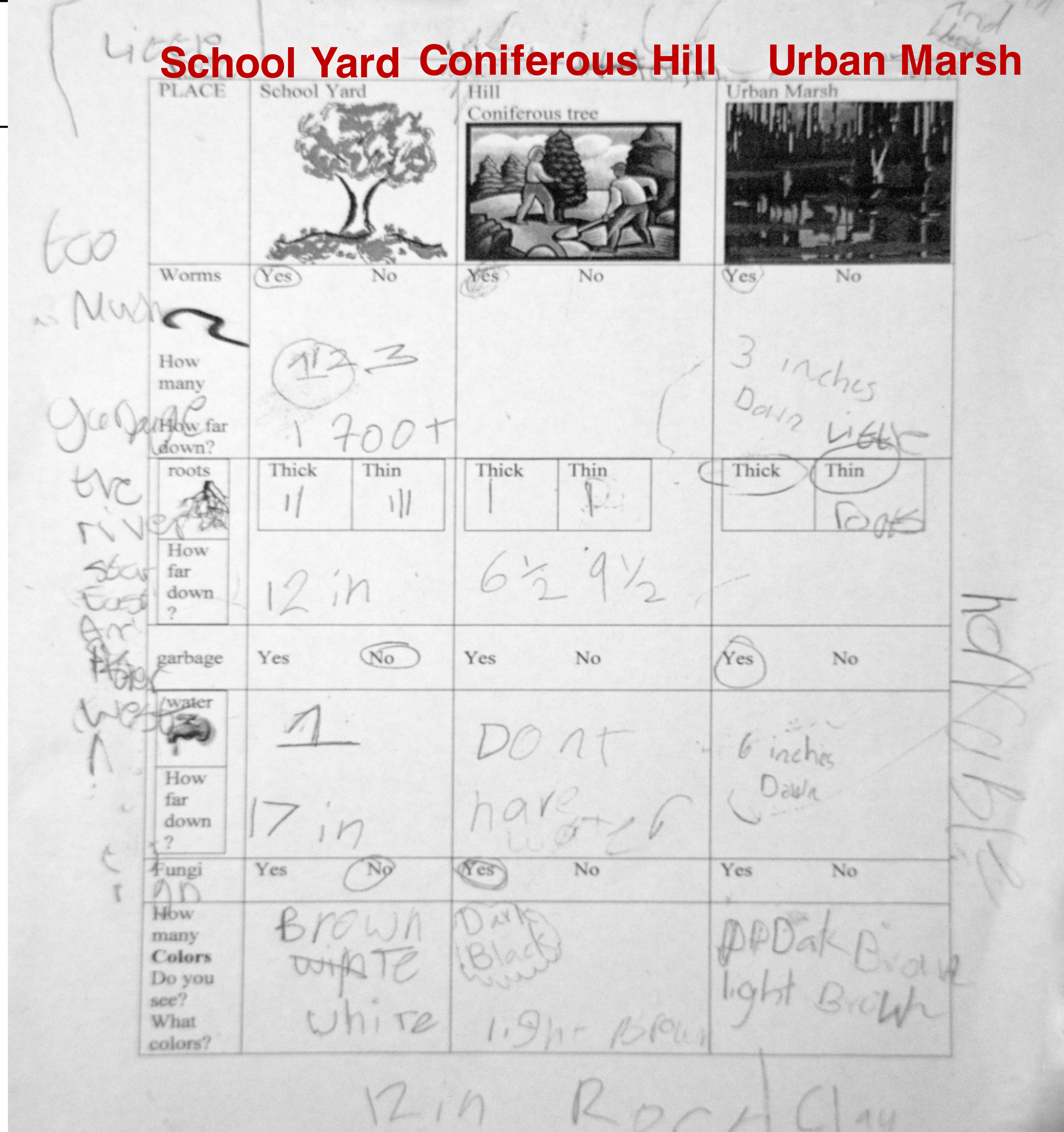
3) Based on the evidence that soil is different around the world, the students wonder if soil is different in the neighborhood.

   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

Field Notes

School Yard | Coniferous Hill | Urban Marsh



PLACE	School Yard	Hill Coniferous tree	Urban Marsh
Worms	Yes No	Yes No	Yes No
How many / How far down?	1 2 3 / 1 700+		3 inches Down
roots	Thick 11 / Thin 111	Thick 1 / Thin 1	Thick / Thin roots
How far down?	12 in	6 1/2 9 1/2	
garbage	Yes No	Yes No	Yes No
water / How far down?	1 / 17 in	Dont have water	6 inches Down
Fungi	Yes No	Yes No	Yes No
How many Colors Do you see? What colors?	Brown ~~white~~ white	Dark Black light Brown	Dark Brown light Brown

12 in Rock Clay

ELL Case Study: Is All Soil the Same?

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

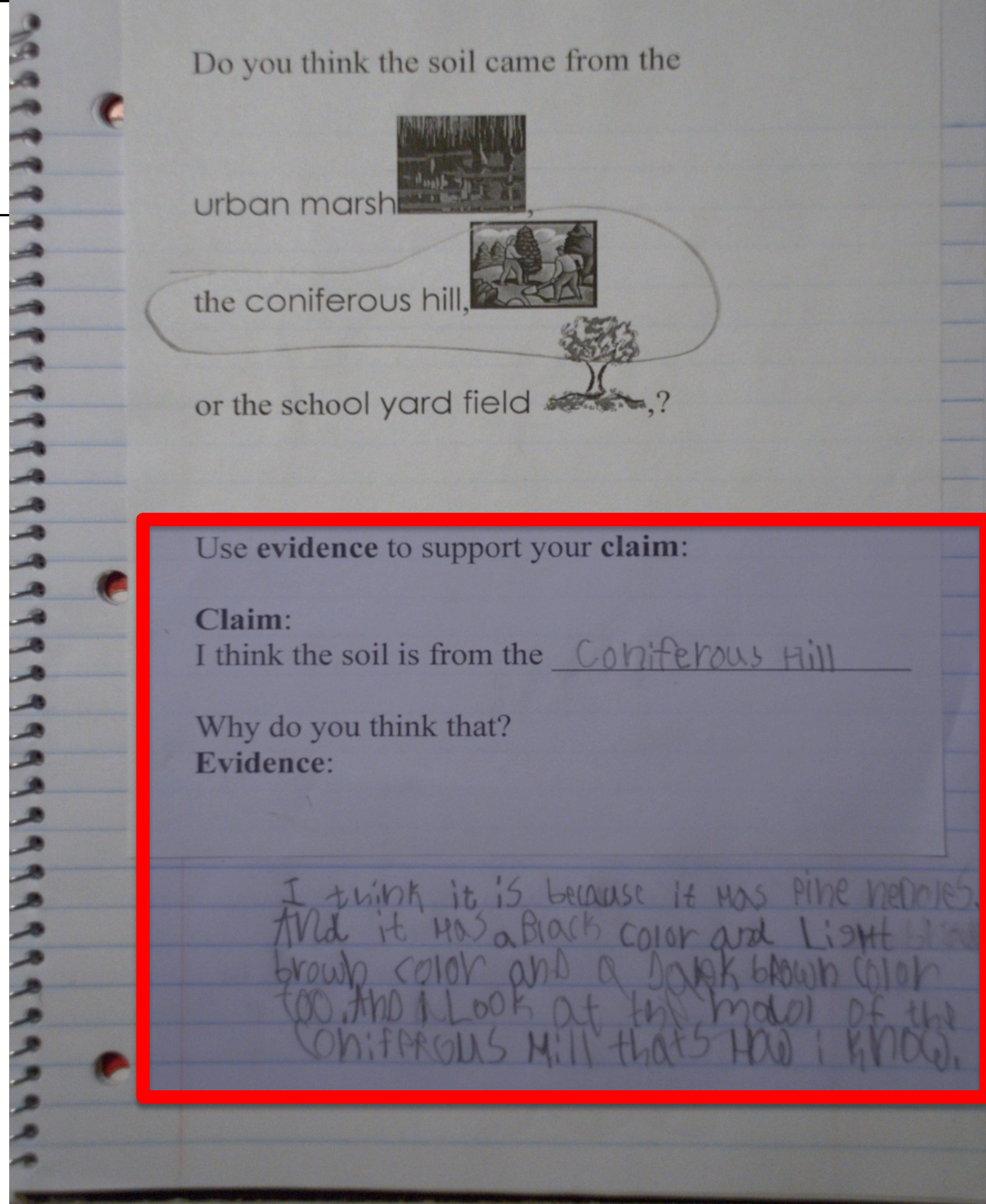
ELL Case Study: Is All Soil the Same?

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

Using Evidence to Support Claims



Do you think the soil came from the

urban marsh,

the coniferous hill,

or the school yard field ,?

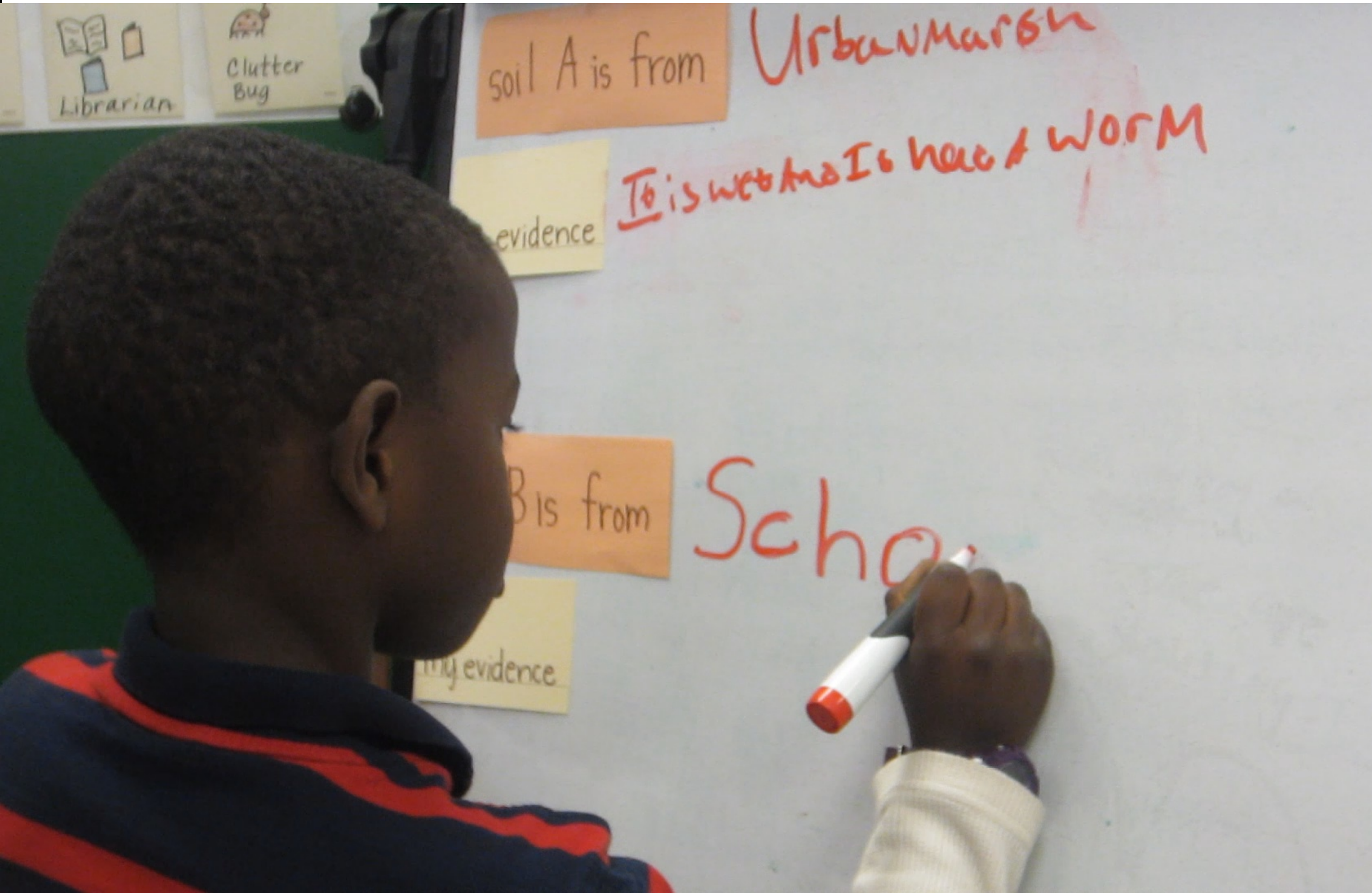
Use **evidence** to support your **claim**:

Claim:
I think the soil is from the Coniferous Hill

Why do you think that?
Evidence:

I think it is because it has pine neddles. And it has a Black color and Light brown color and a Dark brown color too. And i Look at the madol of the Coniferous Hill thats How i know.

Writing Claims and Evidence on the White board



ELL Case Study: Is All Soil the Same?

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.

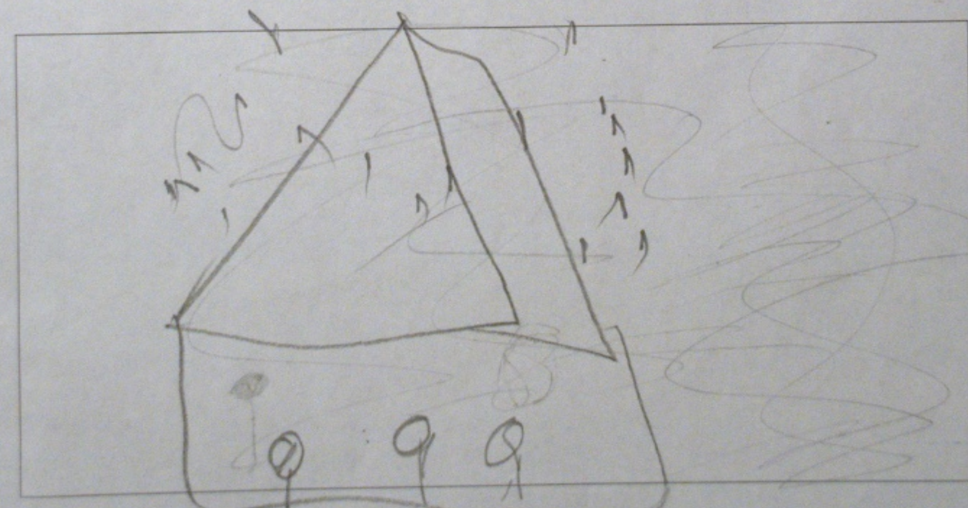
Engineering Solutions to Trash Problem

How can wind and rain *change* the soil?

when The wind come it trach The trach tome urban marsh and when The rain come it change The soil

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

we can make a hug house



ELL Case Study: Is All Soil the Same?

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

Issues of Local Relevance in Iowa

- 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

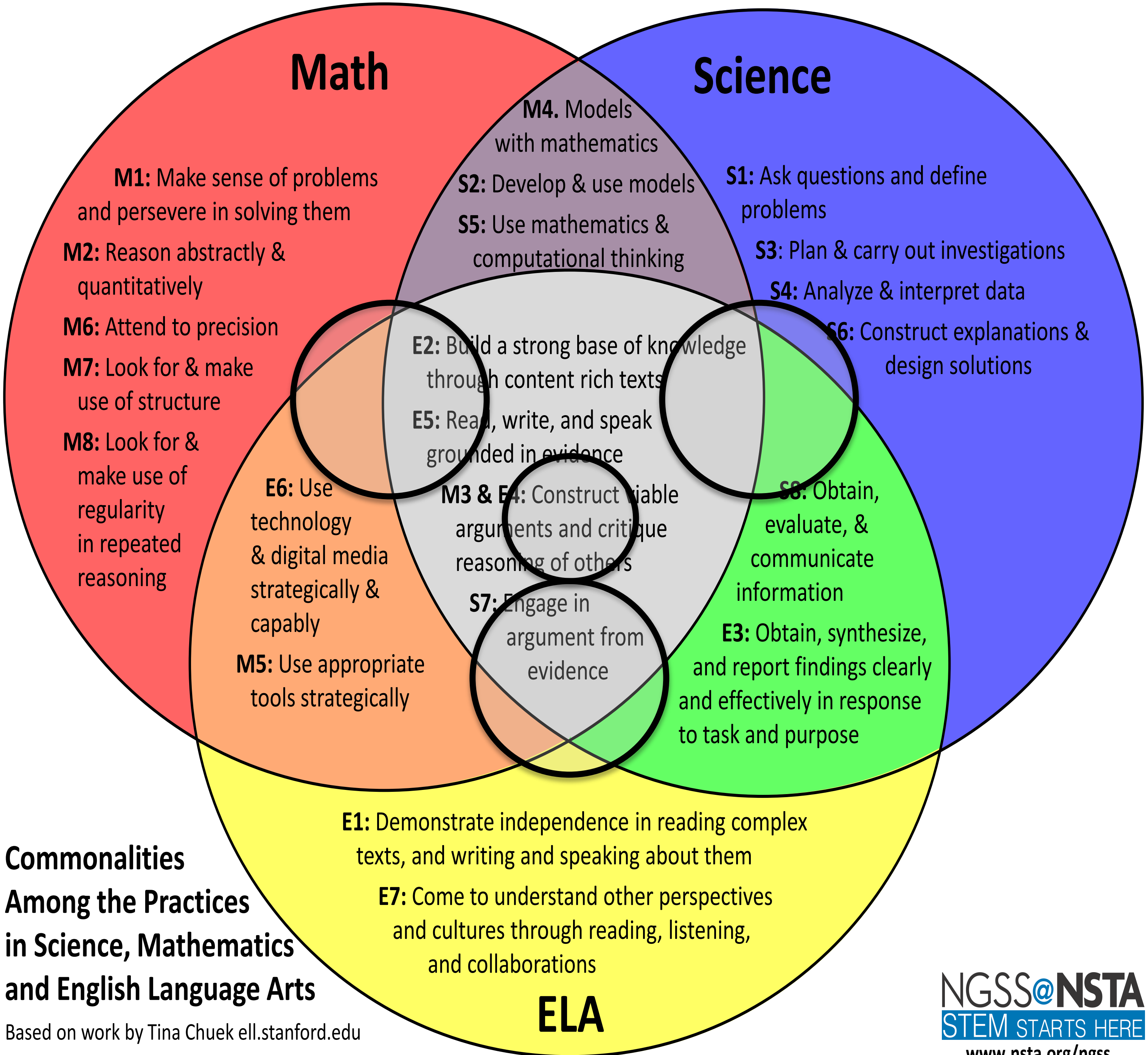
Issues of Local Relevance in Iowa

- 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

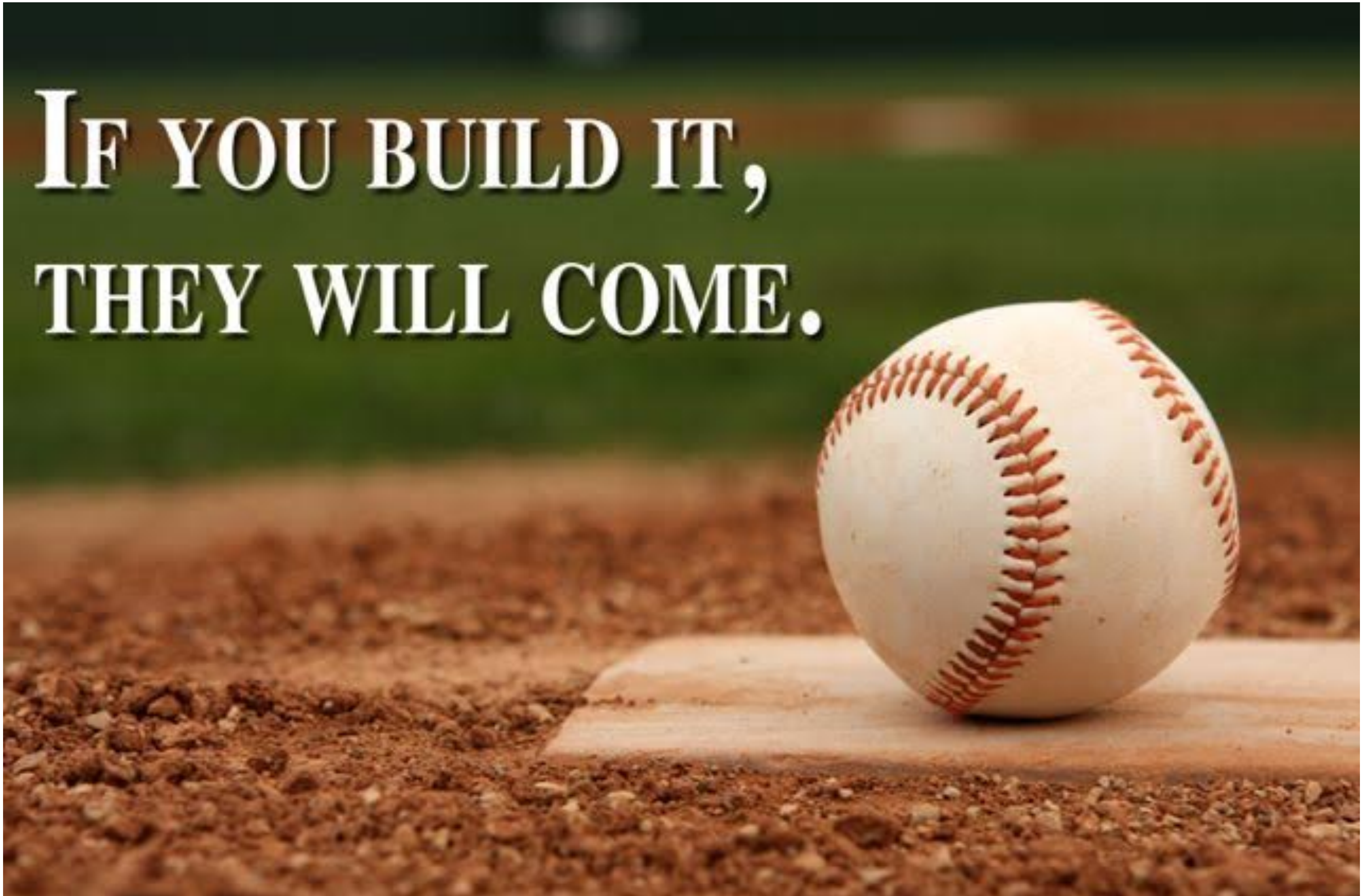


Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek ell.stanford.edu

Question

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.

NEXT GENERATION SCIENCE STANDARDS For States, By States

The Next Generation Science Standards

Printer-friendly version

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.

NGSS Front Matter

NGSS Structure

NGSS Appendices:

A. Conceptual Shifts

B. Responses to Public Drafts

C. College and Career Readiness

D. All Standards, All Students / Case Studies

E. Disciplinary Core Idea Progressions

F. Science and Engineering Practices

G. Crosscutting Concepts

H. Nature of Science

I. Engineering Design in the NGSS

J. Science, Technology,

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.

NGSS FOR ALL STUDENTS

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Questions and Comments

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Thank You!