Using NGSS Implementation to Build Science Education Community

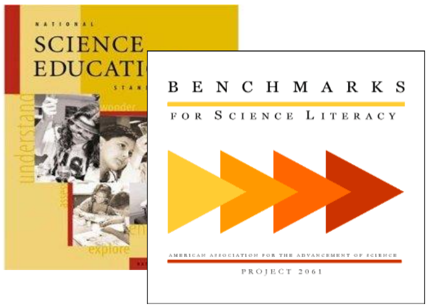
Discovery Research K-12
PI Meeting
June 2, 2016

Jennifer Childress, Ph.D., Director of Instructional Support for Science
Peter McLaren, Director of State and District Support for Science
Achieve

About Achieve

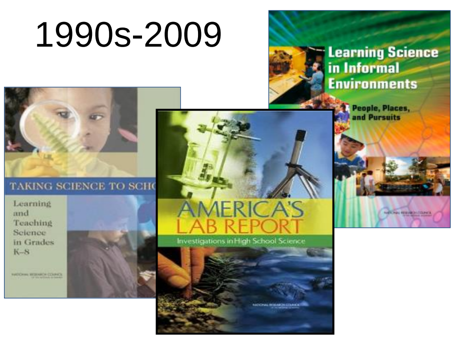
- An independent, nonpartisan, nonprofit education reform organization.
- Committed to ensuring all students graduate from high school "college and career ready" so students are academically prepared for next steps after high school.
- Work with states to raise academic standards and graduation requirements, improve assessments, and strengthen accountability systems.

Building on the Past; Preparing for the Future

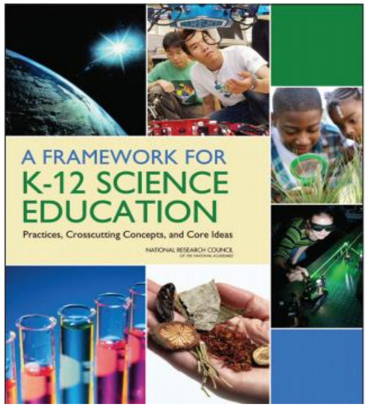


1990s

1990s-2009



Phase I



1/2010 - 7/2011

Phase II

NEXT GENERATION SCIENCE STANDARDS
For States, By States

7/2010 – Early 2013

Process for Developing the NGSS

States and other key stakeholders were engaged in the development and review of the NGSS

- State Led Process
  - 26 Lead State Partners
- Writing Team
  - 40 educators from across the country
- Critical Stakeholder Team
- Iterative Reviews
  - 2 public reviews
  - 3 additional private reviews for states and critical stakeholders
  - Fidelity review to the NRC Framework

Influence of Next Generation Science Standards on State Science Standards

NGSS Adopted States (Yr. Adopted)		States informed by the *Framework* and the NGSS (Three Dimensional)
• Arkansas (2015) • California (2013) • Connecticut (2015) • Delaware (2013) • District of Columbia (2013) • Hawaii (2016) • Illinois (2014) • Iowa (2015) • Kansas (2013)	• Kentucky (2013) • Maryland (2013) • Michigan (2015) • Nevada (2014) • New Jersey (2014) • Oregon (2014) • Rhode Island (2013) • Vermont (2013) • Washington (2013)	• Alabama • Georgia • Idaho • Indiana • Missouri • Oklahoma • South Carolina • South Dakota • Utah • West Virginia
• http://ngss.nsta.org/About.aspx		

Influence of Next Generation Science Standards on State Science Standards

NGSS Adopted States (Yr. Adopted)		States informed by the *Framework* and the NGSS (Three Dimensional)
• Arkansas (2015) • **California (2013)** • Connecticut (2015) • **Delaware (2013)** • **District of Columbia (2013)** • Hawaii (2016) • Illinois (2014) • Iowa (2015) • **Kansas (2013)**	• **Kentucky (2013)** • **Maryland (2013)** • Michigan (2015) • Nevada (2014) • New Jersey (2014) • Oregon (2014) • **Rhode Island (2013)** • **Vermont (2013)** • **Washington (2013)**	• Alabama • Georgia • Idaho • Indiana • Missouri • Oklahoma • South Carolina • South Dakota • Utah • West Virginia
• http://ngss.nsta.org/About.aspx		

Questions so far?

What's different about the NGSS?

The Innovations of the NGSS

1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

The Innovations of the NGSS

1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

Three-Dimensional Learning

Traditional	NGSS-Designed
Using of science practices and crosscutting concepts only to serve the purpose of acquiring more science information	• Careful design to build student proficiency in all three dimensions of the standards • Student performances where the three dimensions intentionally work together to explain phenomena or design solutions to problems
Students learning the three dimensions in isolation from each other, i.e.: • a separate lesson or unit on science process/methods followed by a later units focused on delivering science knowledge;	Blending of SEPs, CCCs, and DCIs in ways that instructionally make sense, but also inform teachers about student progress toward the performance expectations • students actively engaged in scientific practices to develop an understanding of each of the three dimensions.
• Rote memorization of facts and terminology; providing discrete facts and concepts in science disciplines, with limited application of practice or the interconnected nature of the disciplines	• Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning
• including crosscutting concepts only implicitly, or in sidebars with no attempt to build student proficiency in utilizing them)	• CCCs are included explicitly, and students learn to use them as tools to make sense of phenomena and make connections across disciplines.
Assessments that focus on one dimension at a time and are mostly concerned with measuring students' ability to remember information.	Assessments within the instructional materials reflect each of the three distinct dimensions of science and their interconnectedness.

The Innovations of the NGSS

1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

Explaining Phenomena and Designing Solutions

Traditional	NGSS-Designed
Focusing on delivering disciplinary core ideas to students, neatly organized by related content topics; explaining phenomena or designing solutions are used occasionally as engagement strategies, but are not a central part of student learning	Engaging all students with phenomena or problems that are meaningful, relevant, and age-appropriate and that can be explained or solved through the application of SEPs, CCCs, and DCIs as the central component of learning
The phenomenon explanation or solution design is separate from learning (i.e., used only as an engagement tool to introduce the learning; only loosely connected to a disciplinary core idea)	Students focus on explaining phenomena and/or designing solutions to give a purpose for the three-dimensions to be learned.
Designing solutions is a step-by-step directions-following exercise, or is trial-and-error.	Students are learning aspects of how to design solutions while engaged in the design process
Only talking or reading about phenomena	Students experiencing the phenomena directly or through rich multimedia
The focus is only on getting the “right” answer to explaining the phenomenon	Student sense-making is used as a window into student understanding of all three dimensions of the standards

The Innovations of the NGSS

1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

Engineering and the Nature of Science are Integrated into Science

Traditional	NGSS-Designed
Engineering design is supplemental or only for selected schools and students, and is disconnected from science learning (e.g., design projects do not require science knowledge to complete successfully)	Engineering design is incorporated through K–12 science education, integrated with all science disciplines (e.g., engineering concepts and practices contribute to building science knowledge)
Engineering is not included in assessments	Engineering concepts and practices are integrated into science assessments
Nature of Science concepts are rarely taught and are disconnected from the three-dimensions of science education, often in a stand-alone lesson or side-bar	Nature of Science concepts are integrated frequently and throughout science instruction

The Innovations of the NGSS

1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

All Three Dimensions Build Coherent Learning Progressions

Traditional	NGSS-Designed
Concepts and practices are disconnected from prior learning; Concepts are repeated between grade bands or pre-requisite concepts are missing	Concepts are purposefully connected between and across grade levels and courses.

The Innovations of the NGSS

1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

Science is connected to Math and Literacy

Traditional	NGSS-Designed
Few, if any connections between science and other disciplines	Connections are explicitly made throughout the science curriculum to relevant math and ELA concepts in meaningful, grade-appropriate and substantive ways that build broad and deep conceptual understanding in all three subject areas.

The Innovations of the NGSS

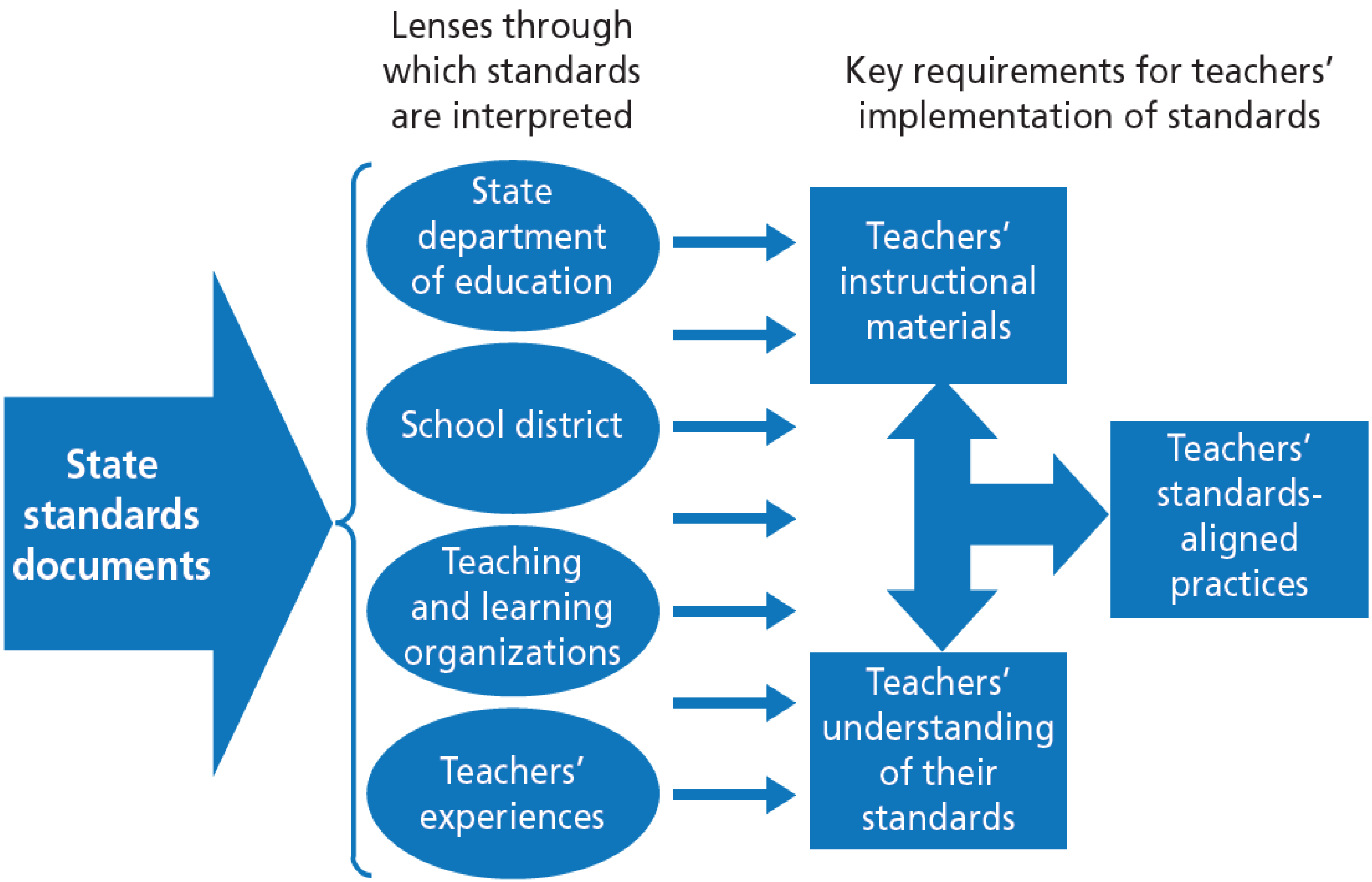
1. Three-dimensional learning
2. Students engaged in phenomena and designed solutions
3. Engineering and Nature of Science are integrated into science
4. All three dimensions build coherent learning progressions
5. Science is connected to math and literacy
6. Science is for all students

Science is for all students

Traditional	NGSS-Designed
Only a small percentage of high school students take any kind of chemistry, physics, or earth sciences course in high school	All K-12 students take courses that build proficiency in chemistry, physics, biology, and earth sciences

Challenges of NGSS Implementation

Factors Influencing Teachers' Implementation of State Standards



Opfer, V. Darleen, Julia H. Kaufman and Lindsey E. Thompson. Implementation of K–12 State Standards for Mathematics and English Language Arts and Literacy: Findings from the American Teacher Panel. Santa Monica, CA: RAND Corporation, 2016. http://www.rand.org/pubs/research_reports/RR1529.html.

Challenges

School Structures

- The NGSS PEs need to be organized into cohesive courses that build on students' understanding within and between courses.
- The school day is structured such that all students have opportunities to learn science, especially in K-6.
- Teachers need time to plan and coordinate with other teachers.

Communication

- It is important to engage stakeholders at all levels (students, teachers, parents, IHE, business, etc) in the innovations of the NGSS in a cohesive manner.

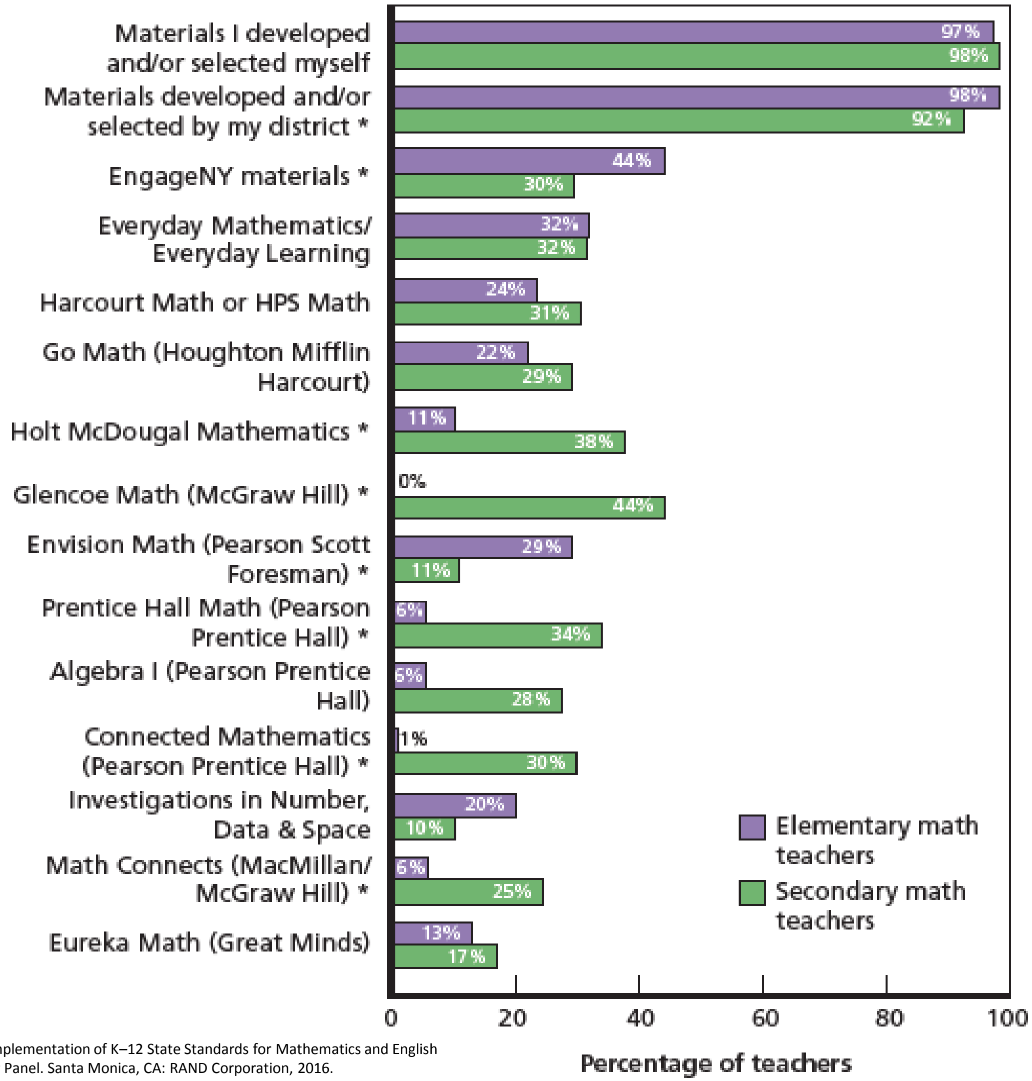
Challenges *(continued)*

- Professional Learning
  - Educators and school leadership need professional learning opportunities so they have the knowledge and abilities to implement the innovations of the NGSS.
- Assessment
  - There is a lack of exemplars of three-dimensional assessment at all levels
  - Teachers need training to fully incorporate three-dimensional formative assessment into instruction.
  - Instructional materials developers need to incorporate three-dimensional assessment into their materials.

Challenges *(continued)*

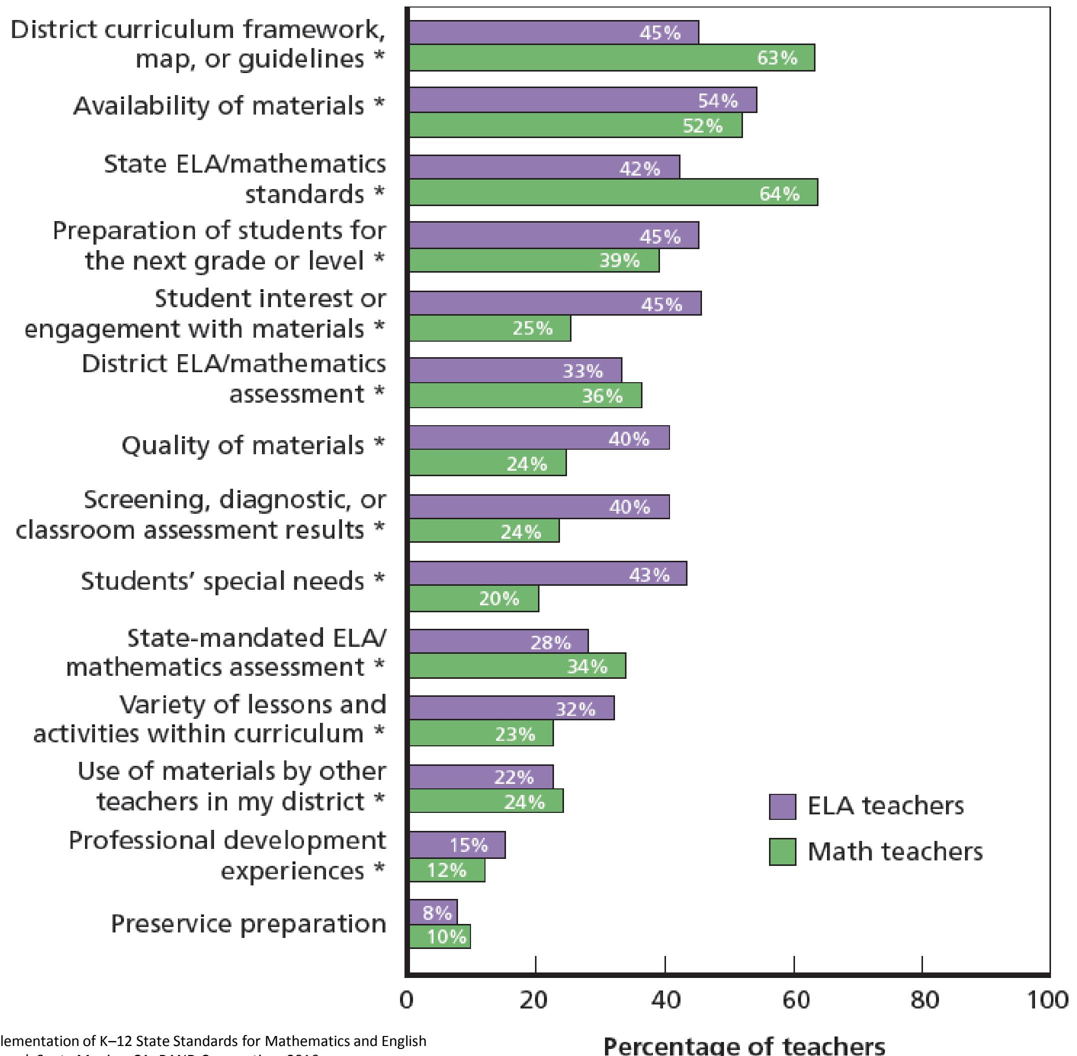
- Instructional materials
  - The NGSS are so different that there is a dearth of well-aligned instructional materials.
  - The urgency of need might lead to educators “settling” on materials that are not aligned.

Figure 2.1
Top Instructional Materials Used for Mathematics Classroom Lessons Among Teachers in SACC States



Opfer, V. Darleen, Julia H. Kaufman and Lindsey E. Thompson. Implementation of K–12 State Standards for Mathematics and English Language Arts and Literacy: Findings from the American Teacher Panel. Santa Monica, CA: RAND Corporation, 2016. http://www.rand.org/pubs/research_reports/RR1529.html.

Figure 2.11
Factors Influencing Mathematics and ELA Teachers' Use of Instructional Materials "A Great Deal" in SACC States



Opfer, V. Darleen, Julia H. Kaufman and Lindsey E. Thompson. Implementation of K–12 State Standards for Mathematics and English Language Arts and Literacy: Findings from the American Teacher Panel. Santa Monica, CA: RAND Corporation, 2016. http://www.rand.org/pubs/research_reports/RR1529.html.

Achieve's Work To Address A Few of the Grand Challenges

- Support of the NGSS Network (States and Districts)
- Support for increasing the understanding of how NGSS assessment is aligned and designed
- Support for increasing the alignment of instructional materials

Achieve's Work To Address A Few of the Grand Challenges

- Support of the NGSS Network (States and Districts)
- Support for increasing the understanding of how NGSS assessment is aligned and designed
- Support for increasing the alignment of instructional materials

Achieve's Work To Address A Few of the Grand Challenges

- Support of the NGSS Network (States and Districts)
- Support for increasing the understanding of how NGSS assessment is aligned and designed
- Support for increasing the alignment of instructional materials

Achieve's Work To Address A Few of the Grand Challenges

- Support of the NGSS Network (States and Districts)
- Support for increasing the understanding of how NGSS assessment is aligned and designed
- Support for increasing the alignment of instructional materials

Observing a Chemical Reaction

Purpose: In this lab experiment you will observe that when a chemical reaction occurs the materials that are formed have new properties from those of the starting materials.

Background knowledge: When a chemical reaction occurs, the products that form have different properties than the initial materials.

Materials for each group:

- 1 baggie with zip seal
- 1 plastic spoon
- 1 25-ml graduated cylinder
- 1 film canister or small container
- 1 plastic spoonful of sodium bicarbonate (baking soda)
- 2 plastic spoonfuls of calcium chloride (road salt)

Safety:

Wear goggles at all times

Wash your hands after you finish the investigation.

Procedure

1. Recall the solubility data about baking soda and road salt from Lesson 2. Both baking soda and road salt are soluble.
2. Observed what the baking soda looks like and record the information in your table.
3. Place 1tsp of the baking soda in the plastic bag.
4. Observed what the rock salt looks like and record the information in your table.
5. Place 2tsp of road salt into a plastic bag.
6. Observe if anything happens.
7. Use a graduated cylinder to measure 10mL of water.
8. Pour the water into a small container that was provided.
9. Carefully set the container inside the bag without spilling any of the water.
10. Zip the bag closed. Do not spill the container as you zip the bag closed.
11. Tip over the container inside the sealed bag.
12. Make careful observations.
13. Record your observations in your data table.

Data Collection:

Record you data in the following table.

	Observations before mixing substances		
Substance	Color	Solubility in water	State of Matter
Baking Soda		*Soluble*	
Road Salt		*Soluble*	
Observations after mixing substances but before adding water			
Observations after mixing substances and adding water			

Data Analysis:

When you mixed the baking soda, calcium chloride and water together what changes did you see that would indicate a chemical reaction occurred? Remember, when a chemical reaction occurs new properties are formed in the materials.

Conclusions:

Write a statement if a chemical reaction occurred or not.

What happens to properties when I combine substances?

Purpose:

In this investigation, you will make observations of baking soda, road salt, powdered sugar, and water. Then you will combine the four substances, observe what happens and write a scientific explanation.

Safety:

- Wear safety goggles.
- Wash hands after completing this investigation.

Procedure:

1. Put 1 teaspoon of baking soda, 1 teaspoon of powdered sugar, and 2 teaspoons of road salt in separate small containers. Label each container.
2. Measure 10 mL of water with a graduated cylinder. Pour it into a small container.
3. Write your observations of baking soda, powdered sugar, road salt, and water in the table below.
4. Pour the baking soda, powdered sugar, and road salt into a corner of a zip seal bag.
5. Stand the container of water upright in the bag. Be careful not to tip it over.
6. Remove as much air as possible.
7. Zip the bag closed. Be sure the bag is completely sealed. Tip over the container to combine the substances.
8. Write your observations of the four substances combined in the table below.
9. Save your bag with substances until your teacher asks you to throw it away.

Data Collection:

Substances	Observations
Baking Soda	
Powdered Sugar	
Road Salt	
Water	

Scientific Explanation: Look for patterns in your data to write a **scientific explanation** that states whether new substances were formed after combining the baking soda, powdered sugar, road salt, and water.

Claim: (Write a statement that responds to the original question.)

Evidence: (Provide scientific data to support your claim. You should only use appropriate data and include enough data. Appropriate data is relevant for the problem and allows you to figure out your claim. Remember that not all data is appropriate. Enough data refers to providing the pieces of evidence necessary to convince someone of your claim.)

Reasoning: (In your reasoning statement, connect your claim and evidence to show how your data links to your claim. Also, tell why your data counts as evidence to support your claim by using scientific principles. Remember, reasoning is the process where you apply your science knowledge to answer the question.)

What New Questions do you have?

What combination caused the changes?

Purpose:

In this activity, your group will design and carry out an experiment to determine what combination of 3 substances from the last investigation caused new substances to be formed.

What evidence will you look for to determine what caused the changes?

Safety:

- Wear goggles during this investigation.
- Wash hands after completing this investigation.

Procedure:

With your group, discuss what your procedure should be. Record your procedure below. Use numbers or bullet points.

Data Collection:

Create a data table below where you will record your results.

Explanation of what caused the changes?

Write a scientific explanation of what substances caused the changes.

What happens to properties when I combine substances?

Purpose:

In this investigation, you will make observations of baking soda, road salt, powdered sugar, and water. Then you will combine the four substances, observe what happens and write a scientific explanation.

Safety:

- Wear safety goggles.
- Wash hands after completing this investigation.

Procedure:

1. Put 1 teaspoon of baking soda, 1 teaspoon of powdered sugar, and 2 teaspoons of road salt in separate small containers. Label each container.
2. Measure 10 mL of water with a graduated cylinder. Pour it into a small container.
3. Write your observations of baking soda, powdered sugar, road salt, and water in the table below.
4. Pour the baking soda, powdered sugar, and road salt into a corner of a zip seal bag.
5. Stand the container of water upright in the bag. Be careful not to tip it over.
6. Remove as much air as possible.
7. Zip the bag closed. Be sure the bag is completely sealed. Tip over the container to combine the substances.
8. Write your observations of the four substances combined in the table below.
9. Save your bag with substances until your teacher asks you to throw it away.

Data Collection:

Substances	Observations
Baking Soda	
Powdered Sugar	
Road Salt	
Water	

Scientific Explanation: Look for patterns in your data to write a scientific explanation that states whether new substances were formed after combining the baking soda, powdered sugar, road salt, and water.

Claim: (Write a statement that responds to the original question.)

Evidence: (Provide scientific data to support your claim. You should only use appropriate data and include enough data. Appropriate data is relevant for the problem and allows you to figure out your claim. Remember that not all data is appropriate. Enough data refers to providing the pieces of evidence necessary to convince someone of your claim.)

Reasoning: (In your reasoning statement, connect your claim and evidence to show how your data links to your claim. Also, tell why your data counts as evidence to support your claim by using scientific principles. Remember, reasoning is the process where you apply your science knowledge to answer the question.)

What New Questions do you have?

What combination caused the changes?

Purpose:

In this activity, your group will design and carry out an experiment to determine what combination of 3 substances from the last investigation caused new substances to be formed.

What evidence will you look for to determine what caused the changes?

Safety:

- Wear goggles during this investigation.
- Wash hands after completing this investigation.

Procedure:

With your group, discuss what your procedure should be. Record your procedure below. Use numbers or bullet points.

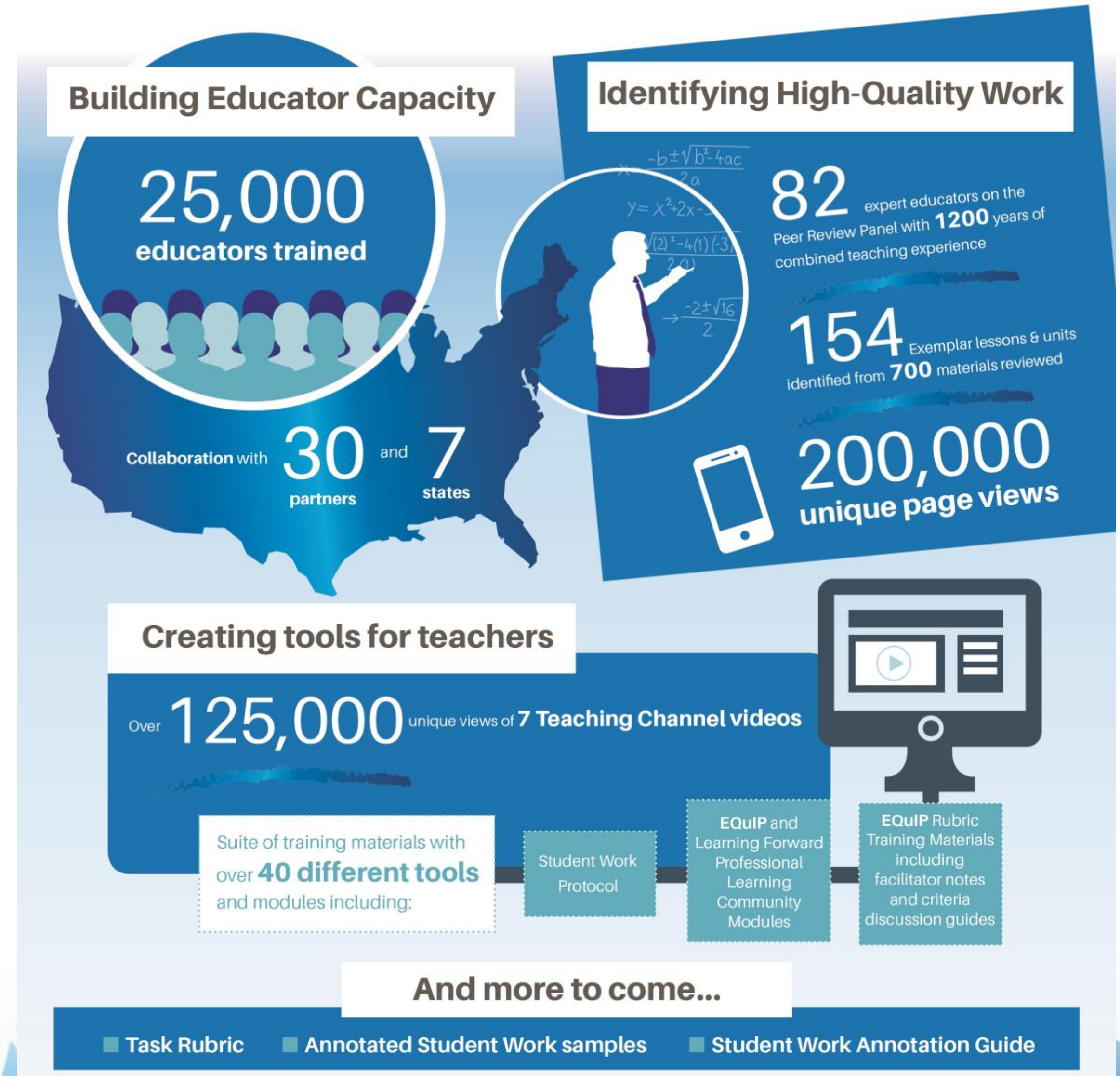
Data Collection:

Create a data table below where you will record your results.

Explanation of what caused the changes?

Write a scientific explanation of what substances caused the changes.

Educators Evaluating
Quality Instructional Products



Educators Evaluating
Quality Instructional Products

Planned Work Supporting NGSS-Designed Instructional Materials

- Supply- and demand-side trainings on EQuIP and PEEC
- NGSS EQuIP Peer Review Panel
- Collaborative work to review and revise current promising materials

For more information, see:

nextgenscience.org/equip

nextgenscience.org/peec

Questions so far?

Small Group Discussion

Take a minute to respond to the prompts below:

Does your work relate to NGSS implementation?

If so, please enter a summary of the related work in this Padlet page: http://tinyurl.com/gnqks3f

In small groups of 2-3, discuss:

What are you experiencing as the biggest challenge(s) to implementing the vision of science teaching and learning in *A Framework for K-12 Science Education /* NGSS with <u>all students</u>?

What supports would you need to address the challenge(s)?

Whole Group Discussion

What are some of the *commonalities* among the challenges you identified?

What are some of the differences among the challenges you identified?

What are barriers to getting high-quality instructional materials out to educators?

What are some barriers to getting materials out quickly?

What are some opportunities to work together to address some of the challenges?

Next Steps

"Runners to your mark. Get set. Go! … OK, come get your T-shirts."

Contact Information

Peter J. McLaren

Director of State and District Support - Science
pmclaren@achieve.org
202-419-1594

Jennifer Childress, PhD

Director of Instructional Support - Science

jchildress@achieve.org
202-419-1578