OSSE

NEXT GENERATION SCIENCE STANDARDS

For States, By States

The Need to Improve Science Education: Why Now? An Overview

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Science Skills are in Demand

- Students will face unprecedented competition in the workforce not only within their home states, but also from foreign countries.
  - By 2015, nearly 60% of the new jobs being created will require skills currently being mastered by only 20% of the population, according to a recent report from the American Society for Training and Development.
  - According to the same report, job skills in STEM—science, technology, engineering and math—are among the skills experiencing the greatest increase in demand. In 1991, fewer than 50% of U.S. jobs required skilled workers. By 2015, 76% of all newly created U.S. jobs will require highly-skilled workers, with some proficiency in STEM.

Science Literacy in the 21st Century

- The definition of what it means to be “literate” in science continues to grow and includes the use of technology, critical thinking and analytical skills.
- As citizens, we are increasingly asked to make decisions on issues ranging from healthcare to the environment, where literacy in science is essential.
- Science literacy and the skills developed in the science classroom will help students improve performance and understanding in other subjects, including math and reading.

U.S. Students are Lagging Behind

- According to 2012 results from the Program for International Student Assessment (PISA), U.S. students ranked 20th in science compared to their peers in other countries.
- According to a 2011 ACT report, only 30% of U.S. high school graduates in 2011 were ready for college coursework in science.

State Science Standards are **Out of Date**

- It has been **more than 17 years** since the National Research Council and the American Association for Advancement of Science produced their reports from which most state science standards are based.
- Since then, major advances in science and our understanding of how students learn science have taken place and need to be reflected in state standards.

Since States Last Updated their Science Standards…

- GPS goes mainstream
- Text messaging introduced by AT&T
- Pluto is reclassified as a dwarf planet
- Apple releases the iPhone
- NASA Rovers discover evidence of water on Mars
- Robotic limbs with advanced movement by connecting electrodes and wires to human nerve endings
- Creation of the first synthetic genome for a bacterial cell
- Google was founded

Strong Science Education = College and Career Readiness

- A high-quality, robust science education means students learn more and will develop skills -- communication, collaboration, inquiry, problem-solving, flexibility -- that will serve them throughout their educational and professional lives.
- Teachers who apply the principles of high quality STEM instruction are able to teach students in the ways they learn best – in a hands-on, collaborative, and integrated environment rooted in inquiry and discovery.

The History of Standards

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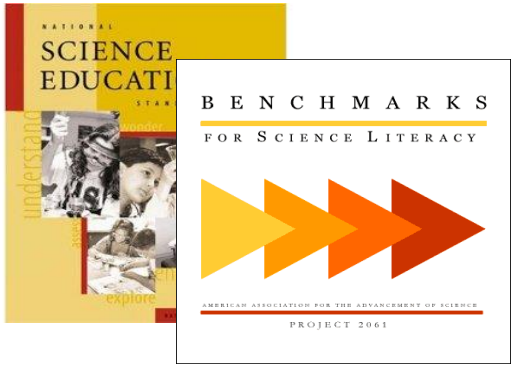
History of State Standards

State standards have been part of the education policy landscape for more than 20 years.

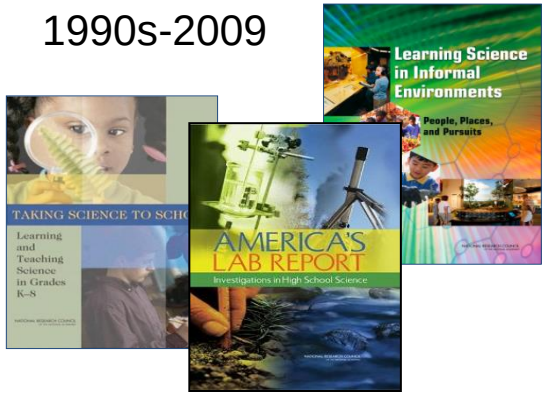
- **1983:** *A Nation at Risk* issues a call to arms for state leaders to raise the expectations for their education systems — the defining moment for the standards-based education reform movement.
- **1989:** Education Summit establishes education goals in core subject areas and calls on states to set academic standards as a first step in restructuring K–12 education systems.
- **By 2000:** Nearly every state has developed standards in core subject areas, and many have revised standards at least once.

Evolution of State Science Standards

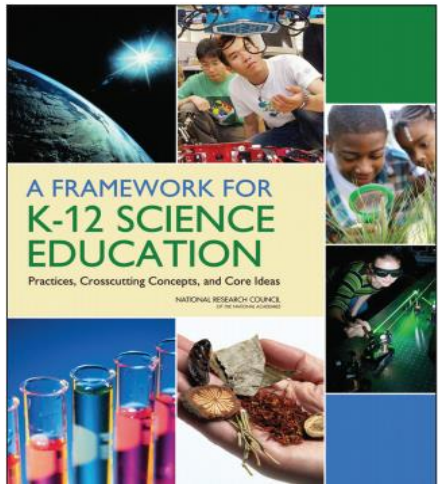


1990s

1990s-2009



Phase I



1/2010 - 7/2011

Phase II

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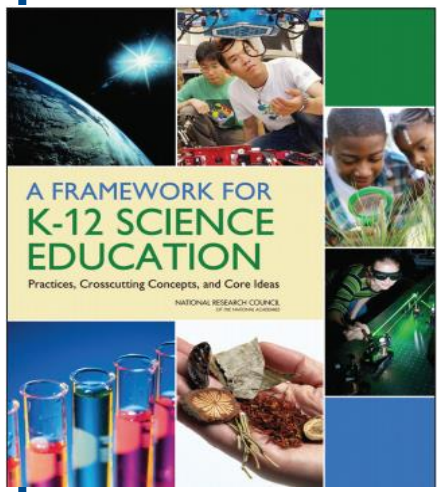
7/2010 – April 2013

Purpose of State Standards



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- Assessment
- Curricula
- Instruction
- Teacher development

Developing the NGSS

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Partners in the Development of the Framework and NGSS

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Achieve

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NSTA National Science Teachers Association

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

By States, For States

- The NGSS are a new set of K-12 science education standards developed by states, for states.
- The NGSS identify science and engineering practices and content that all K-12 students should master in order to be prepared for success in college and 21st-century careers.
- The NGSS are based on *A Framework for K-12 Science Education* developed by the National Research Council.

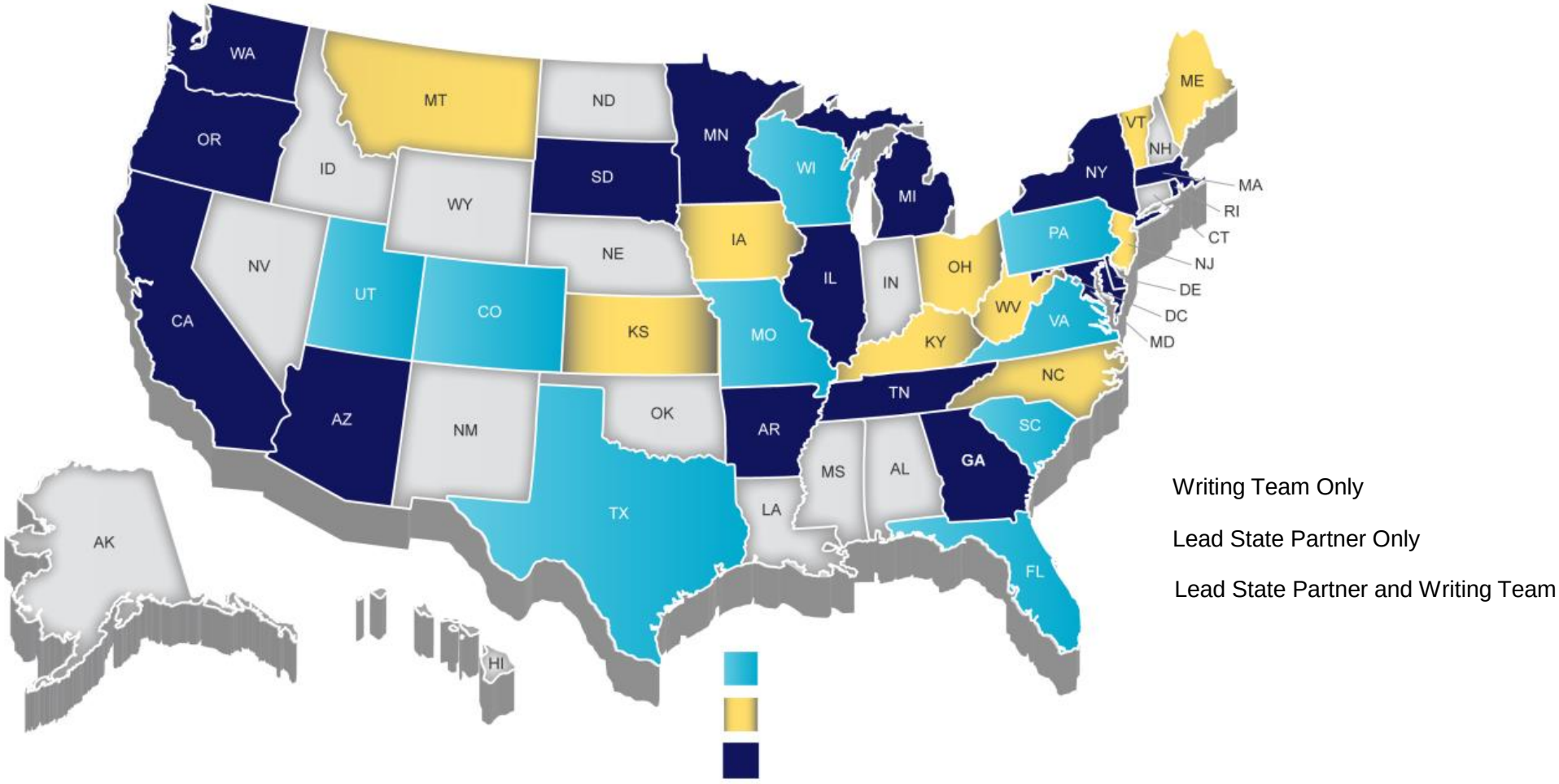
By States, For States

- The NGSS were built upon a vision for quality science education for ALL students, not just a select few.
- The NGSS are not curricula. The standards articulate what students need to know and be able to do by the end of each grade level.
- The NGSS were benchmarked against countries whose students perform well in science and engineering.

Process for Development of Next Generation Science Standards

- **States and other key stakeholders were engaged in the development and review of the NGSS**
  - State-Led Process
    - 26 Volunteer Lead State Partners
  - Writing Team
    - 41 educators, scientists, and engineers from across the country
  - Critical Stakeholder Team
    - Education, science, business and industry, as well as the general public -- including, in some cases, parents and students.

Lead State Partners and NGSS Writing Team



Incorporating Feedback

- 3 State and Critical Stakeholder Review Periods
  - Winter 2012, Fall 2012, Winter 2013
- 2 Public Review Periods
  - Spring 2012, Winter 2013

The draft standards received comments from more than 10,000 individuals

Release and Adoption

- The NGSS were released April 2013 after passing a fidelity review by the National Research Council which ensured the NGSS were consistent with the vision outlined in *A Framework for K-12 Science Education*.

- As of January 2015, 12 states and the District of Columbia have adopted: California, Delaware, Illinois, Kansas, Kentucky, Maryland, New Jersey, Nevada, Oregon, Rhode Island, Vermont and Washington.

A Framework for K-12 Science Education

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Framework Vision (Summary)

- New learning builds on previous knowledge, skills and instruction
- Focuses on a limited number of core ideas, but each in greater depth
- Emphasizes integration of content knowledge and the practices

Principles of the Framework

- Children are born investigators
- Understanding builds over time
- Science and engineering require both knowledge and practice
- Connecting to students' interests and experiences is essential
- Focusing on core ideas and practices
- Promoting equity

Scientific and Engineering Practices

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Scientific and Engineering Practices

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics, information and computer technology, and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Framework pp.41-82

Crosscutting Concepts

Crosscutting Concepts

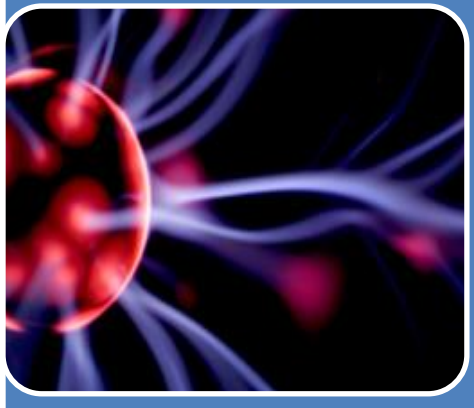
- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change

Framework pp.83-102

Disciplinary Core Ideas

Disciplinary Core Ideas

Physical Science



- PS1: Matter and Its Interactions
- PS2: Motion and Stability: Forces and Interactions
- PS3: Energy
- PS4: Waves and Their Applications in Technologies for Information Transfer

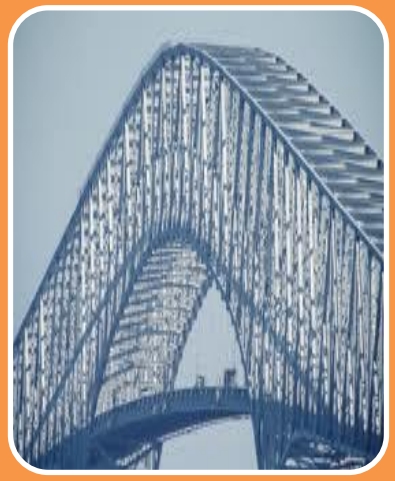
Life Science

- LS1: From Molecules to Organisms: Structure and Processes
- LS2: Ecosystems: Interactions, Energy, and Dynamics
- LS3: Heredity: Inheritance and Variation of Traits
- LS4: Biological Evolution: Unity and Diversity

Disciplinary Core Ideas (cont.)

Earth and Space Science

- 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

What's Different about the Next Generation Science Standards?

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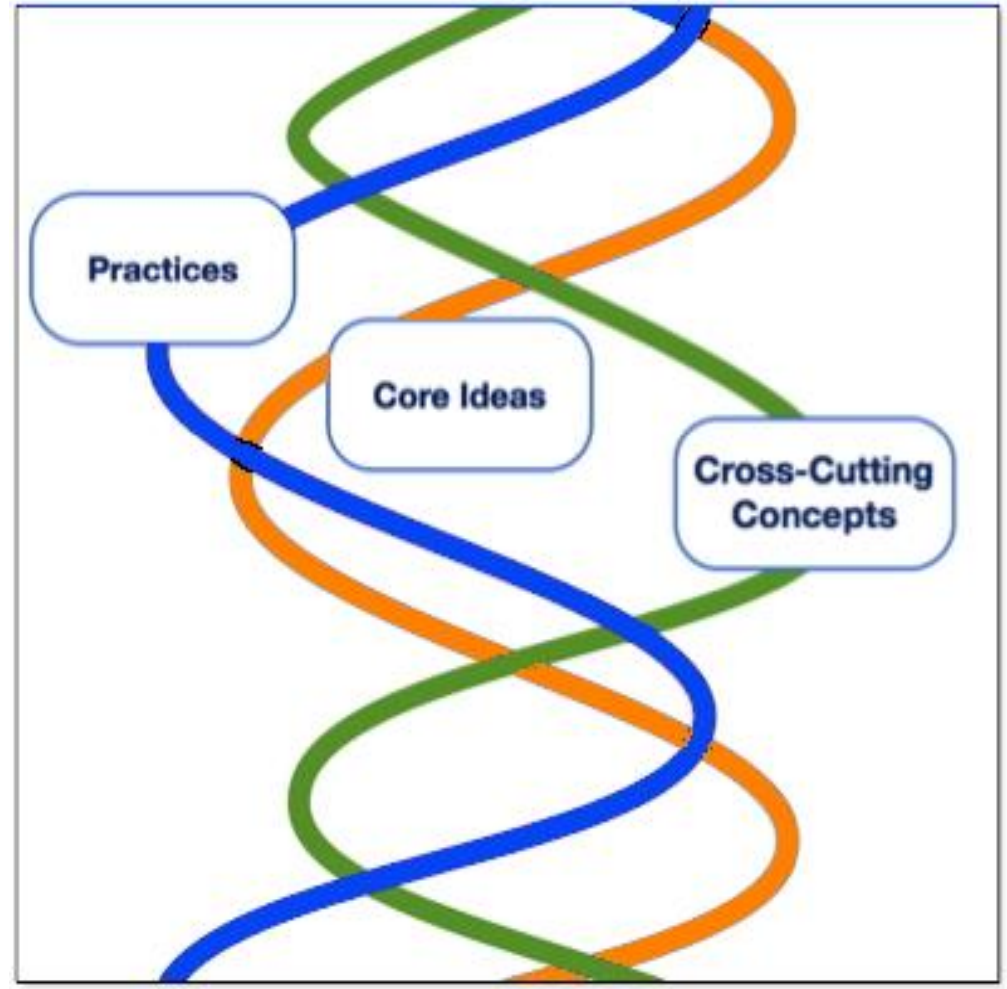
Three Dimensions Intertwined

- Performance Expectations
- The Framework requires contextual application of the three dimensions by students.
- Focus is on how and why as well as what



Current State Science Standard Sample

Inquiry Standards

- Students will explore the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.
- Students will use standard safety practices for all classroom laboratory and field investigations.
- Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.
- Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities utilizing safe laboratory procedures.
- Students will use the ideas of system, model, change, and scale in exploring scientific and technological matters.
- Students will communicate scientific ideas and activities clearly.
- Students will question scientific claims and arguments effectively.

Content Standards

- Distinguish between atoms and molecules.
- Describe the difference between pure substances (elements and compounds) and mixtures.
- Describe the movement of particles in solids, liquids, gases, and plasmas states.
- Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
- Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
- Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
- Identify and demonstrate the Law of Conservation of Matter.

Standards Comparison:
Structure and Properties of Matter

Current State Middle School Science Standard

- **Distinguish** between atoms and molecules.
- **Describe** the difference between pure substances (elements and compounds) and mixtures.
- **Describe** the movement of particles in solids, liquids, gases, and plasmas states.
- **Distinguish** between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
- **Distinguish** between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
- **Recognize** that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
- **Identify and demonstrate** the Law of Conservation of Matter.

Standards Comparison:
Structure and Properties of Matter

NGSS Middle School Sample

- Students who demonstrate understanding can:
  - **Develop models to describe** the atomic composition of simple molecules and extended structures.
  - **Analyze and interpret data** on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
  - **Gather and make sense of information to describe** that synthetic materials come from natural resources and impact society.
  - **Develop a model that predicts and describes** changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
  - **Develop and use a model to describe** how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
  - **Undertake a design project to construct, test, and modify a device** that either releases or absorbs thermal energy by chemical processes.*

Conceptual Shifts in the NGSS

- K-12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real World.
- The Next Generation Science Standards are student performance expectations – NOT curriculum.
- The science concepts build coherently from K-12.
- The NGSS focus on deeper understanding of content as well as application of content.
- Science and engineering are integrated in the NGSS from K–12.
- NGSS content is focused on preparing students for the next generation workforce.
- The NGSS and Common Core State Standards (English Language Arts and Mathematics) are aligned.

Moving from Standards to Instruction

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Performance Expectation

Instruction Builds Toward PEs

Instructional Shifts in the NGSS

- Focus on big picture, not lessons
- New learning builds on previous knowledge, skills and instruction
- Evidence of learning

Current and Upcoming NGSS Projects

- Science EQuIP – Spring 2014
- Standards Comparison Tool – July 1, 2014
- High School Evidence Statements – *Coming Summer 2014*
- SciMath Tasks– *Coming Summer 2014*
- Accelerated Model Course Maps – *Coming Summer 2014*
- State of Science Education Research – *Coming Fall 2014*
- Publishers Criteria – *Coming Fall 2014*
- Model Content Frameworks – *Coming Fall 2014*

What's Next in Our State?

- Curriculum will be developed locally; classroom materials will be selected locally.
- State and districts supporting schools and teachers in the upcoming transition to new standards
- Professional development opportunities for teachers around higher expectations in K-12 science
- Parents engaged early on about changes coming to science classrooms and how they can support students