NEXT GENERATION SCIENCE STANDARDS

Public Draft Review

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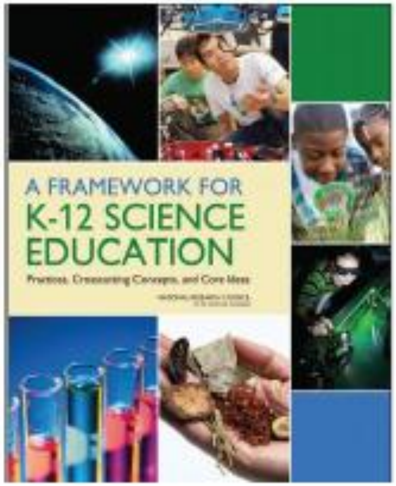
May 2012

Minnesota Department of Education

"Leading for educational excellence and equity. Every day for every one."

A Two – Step Process



NEXT GENERATION SCIENCE STANDARDS

- Assessment
- Curricula
- Instruction
- Teacher development

Agenda

- Minnesota's Science Standards situation
- Framework for K-12 Science Education
- Introduction to Next Generation Standards
- Review of selected standards (by interest groups)
- Discussion of significant issues.

MN Standards Periodic Review Cycle

Review	Implementation	Review
‘06-07	Math ‘10-11	‘15-16
‘07-08	Arts ‘10-11	‘16-17
‘08-09	Science ‘11-12	‘17-18
‘09-10	Language Arts ‘12-13	‘18-19
‘10-11	Social Studies ‘13-14	‘19-20

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2009 Minnesota Science Standards

Nature of Science & Engineering

Physical Science

- Matter
- Motion
- Energy
- Human Interactions

Earth & Space Science

- Earth Structure & Processes
- Interdependence in Earth System
- The Universe
- Human Interactions

Life Science

- Structure & Function
- Interdependence in Living Systems
- Evolution
- Human Interactions

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Minnesota STEM Teacher Center

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Frameworks for the Minnesota Mathematics & Science Standards

CREATED BY SCIMATHMN AND THE MINNESOTA DEPARTMENT OF EDUCATION

BETA Site

WHAT ARE FRAMEWORKS?
Frameworks are resources developed to help teachers translate Minnesota state standards into classroom practice and assist in student achievement of those standards.
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About the Creators

SciMathMN is a non-profit business, education partnership promoting quality science, technology, engineering and mathematics (STEM) in Minnesota's K-16 educational systems. SciMathMN partnered with the Minnesota Department of Education to develop Frameworks for the delivery of Minnesota's mathematics and science standards, as well as the MN STEM Resource Teacher Center. Please note we are continuing to finalize the work on this website..

Getting the Most out of this Site

First, download and review the

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6.2.1.1 Particles

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STANDARD 6.2.1.1

Pure substances can be identified by properties which are independent of the sample of the substance and the properties can be explained by a model of matter that is composed of small particles.

Grade: 6
Subject: Science
Strand: Physical Science
Substrand: Matter

BENCHMARK: 6.2.1.1.1 Particle Model
Explain density, dissolving, compression, diffusion and thermal expansion using the particle model of matter.

Overview Misconceptions Vignette Resources Assessment Differentiation Parents/Admin

Student Misconceptions

Students of all ages show a wide range of beliefs about the nature and behavior of particles. They lack an appreciation of the very small size of particles; attribute macroscopic properties to particles; believe there must be something in the space between particles; have difficulty in appreciating the intrinsic motion of particles in solids, liquids and gases; and have problems in conceptualizing forces between particles (Children's Learning in Science, 1987).

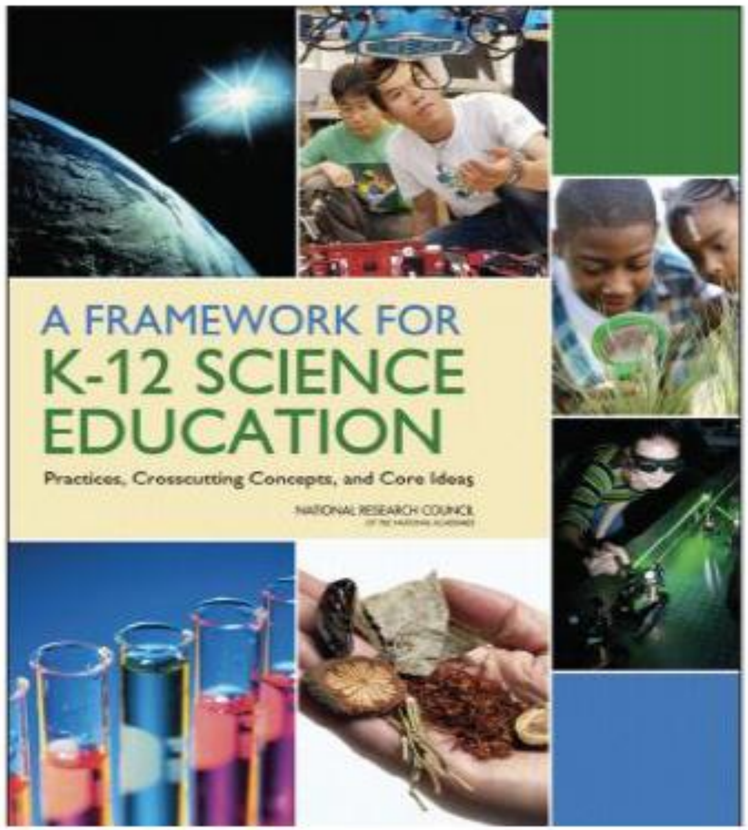
(Atlas, Vol. 1, p. 54)

Why New Science Standards?

- Science documents used by states to develop standards are about 15 years old
- Call for new, internationally-benchmarked standards
- Science, engineering and technology are cultural achievements and a shared good of humankind
- Science, engineering and technology permeate modern life
- Understanding of science and engineering is critical to participation in public policy and good decision-making

NEXT GENERATION SCIENCE STANDARDS

The Framework provides a New Vision of Science Teaching and Learning

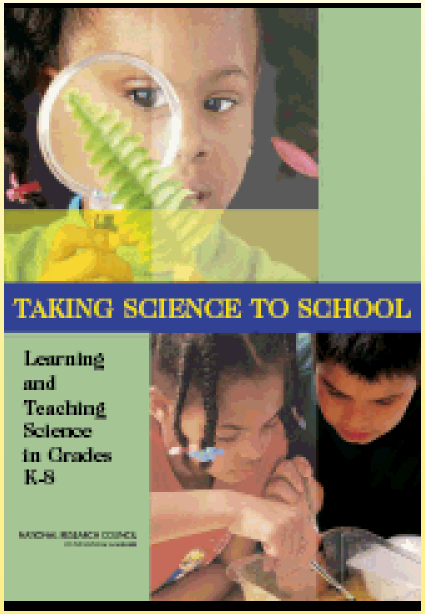


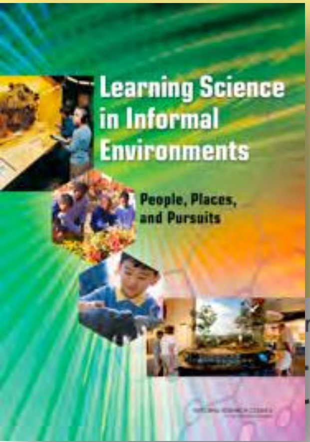
A Vision for K-12 Education in the Natural Sciences and Engineering

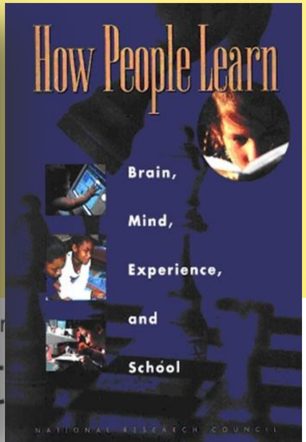
Students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of each fields' disciplinary core ideas.

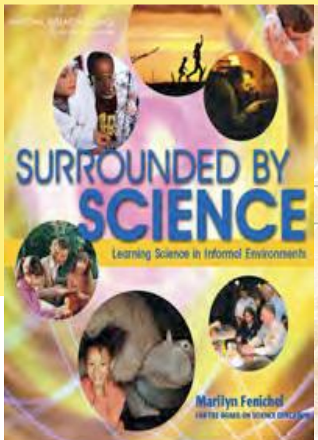
The Guiding Principles of the Framework are Research-Based and Include. . .

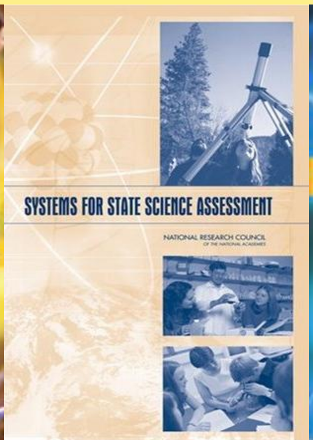
- **Children are born investigators**
- **Understanding builds over time**
- **Science and Engineering require both knowledge and practice**
- **Connecting to students' interests and experiences is essential**
- **Focusing on core ideas and practices**
- **Promoting equity**

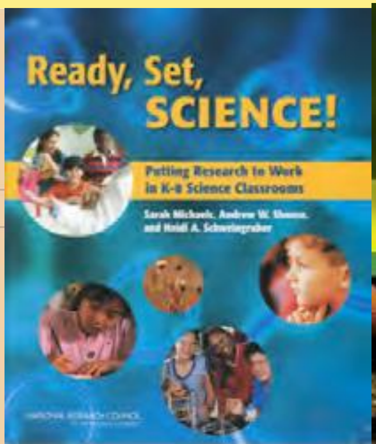












Children are Born Investigators

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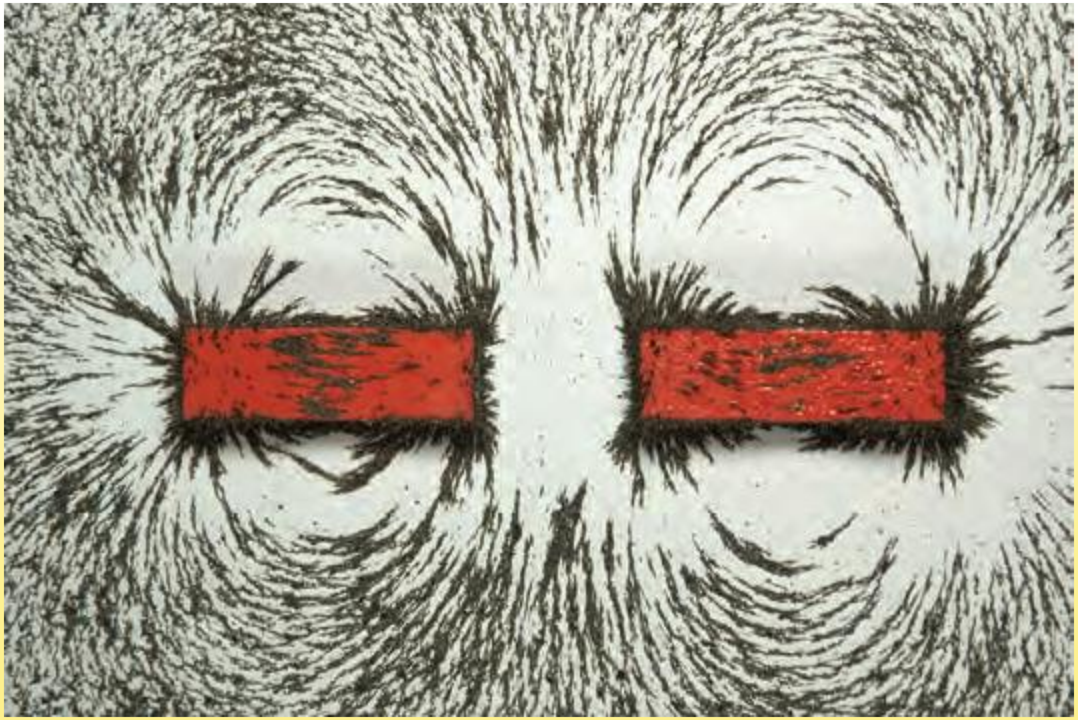
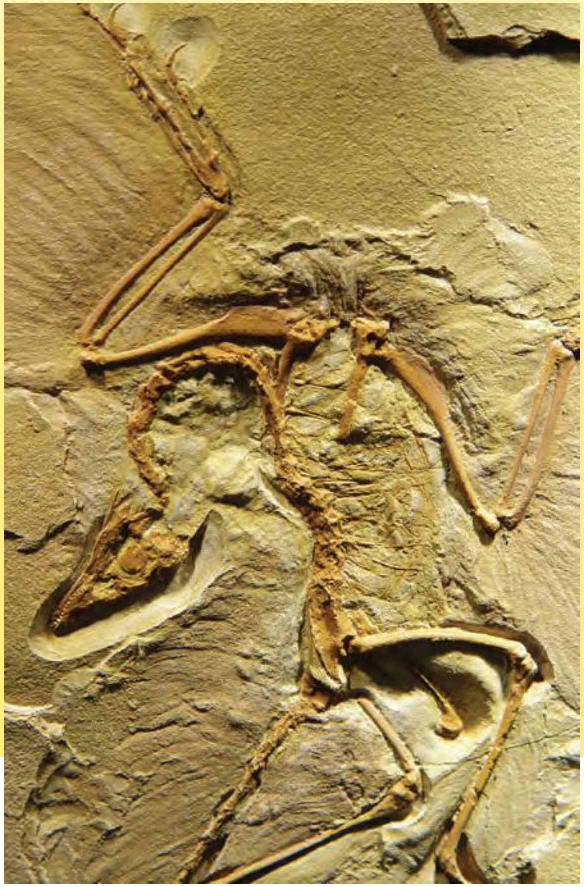


Focusing on Core Ideas and Practices



Understanding Develops Over Time

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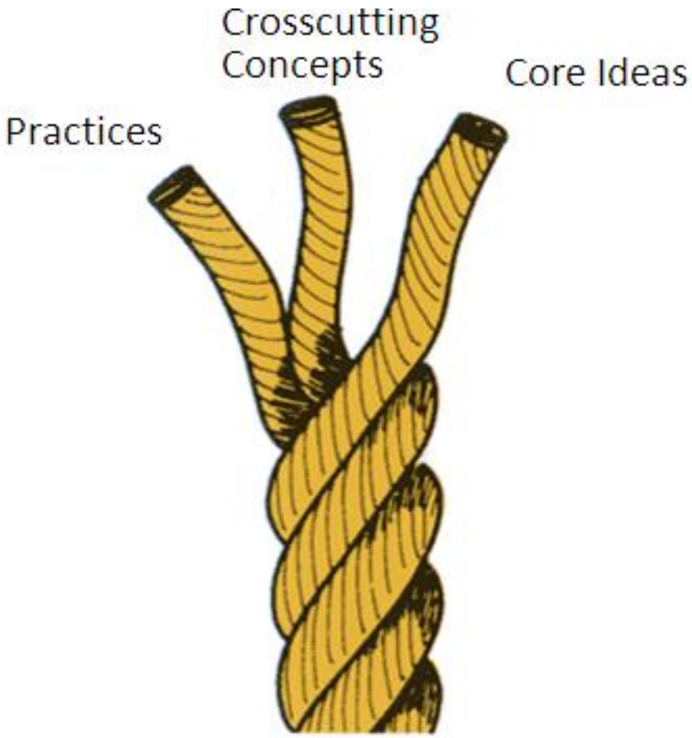
Science & Engineering Require Both Knowledge & Content

Connecting Learning to Students' Interests and Experiences

Promoting Equity

Three Dimensions

- Dimension I – Scientific and Engineering Practices
- Dimension II – Crosscutting Concepts
- Dimension III – Core Ideas



I. Science and Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Developing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Asking Questioning. . .

Why are there seasons?
Why did the structure collapse?
How is electric power generated?
What do plants need to survive?

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. . . Defining Problems

Developing and Using Models

Planning and Carrying Out Investigations

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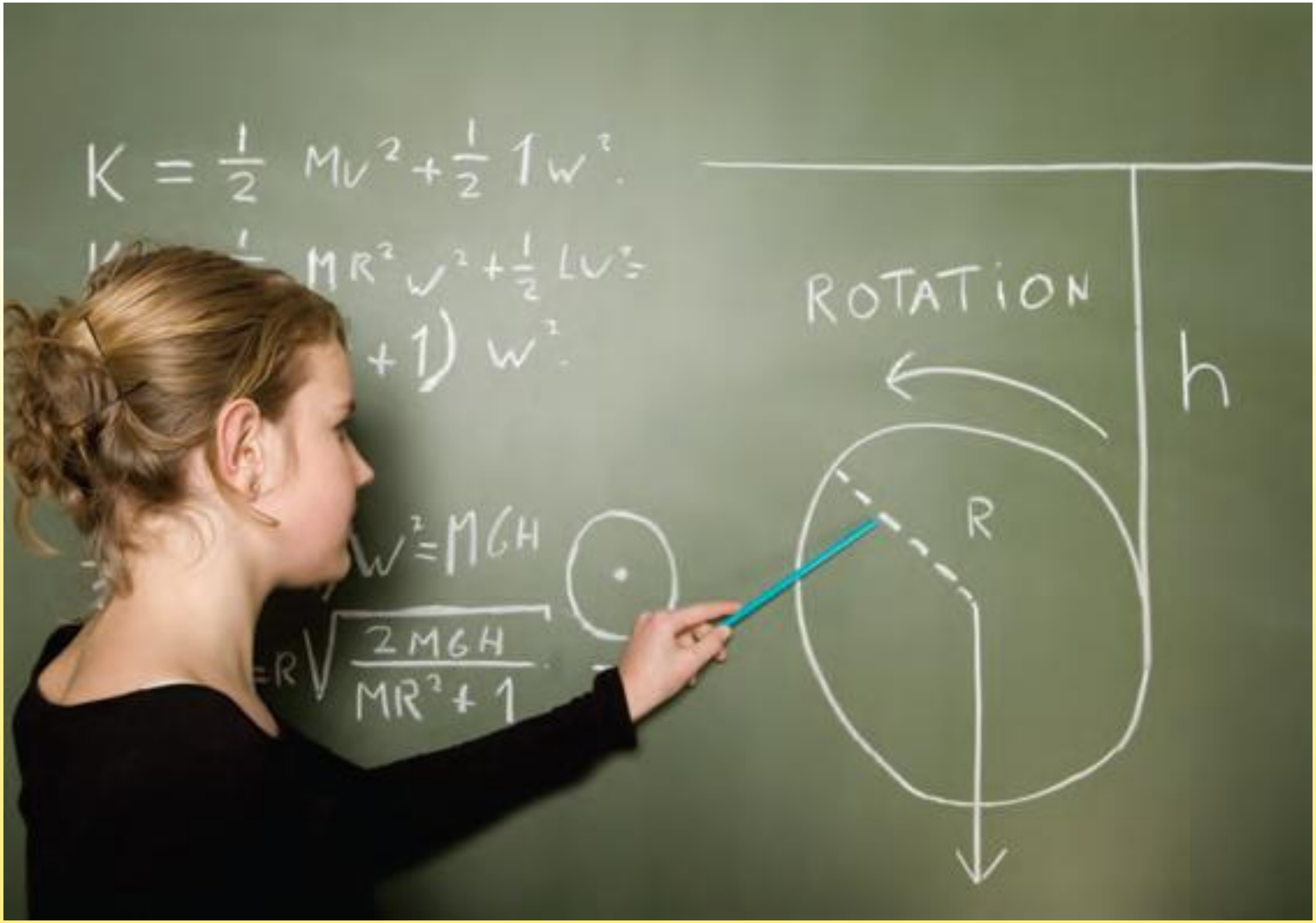
Analyzing and Interpreting Data



Using Mathematics and Computational Thinking

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Constructing Explanations (Science) and . . .

. . . Designing Solutions (Engineering)

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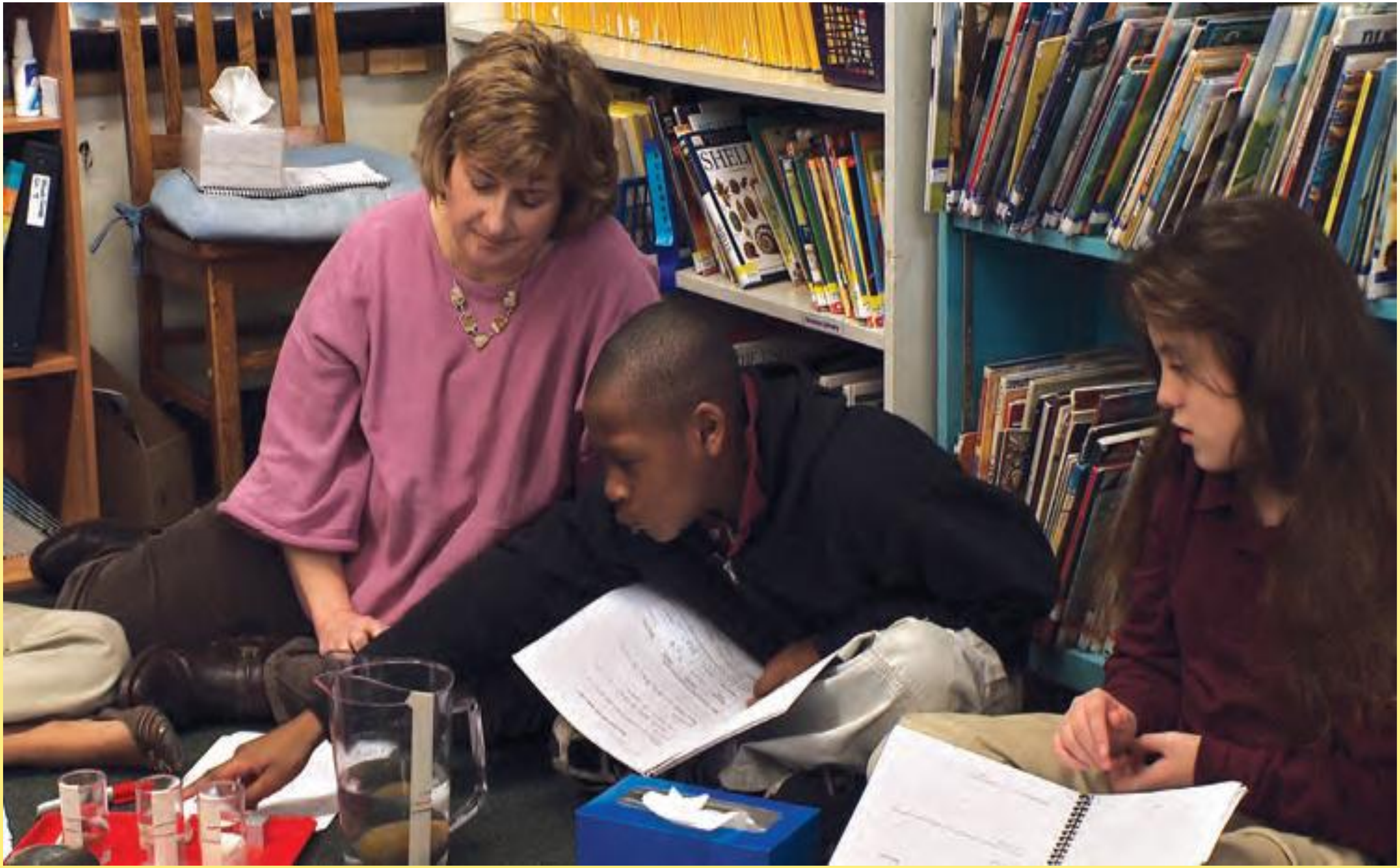
Engaging in Argument from Evidence



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Obtaining, Evaluating, and Communicating Information

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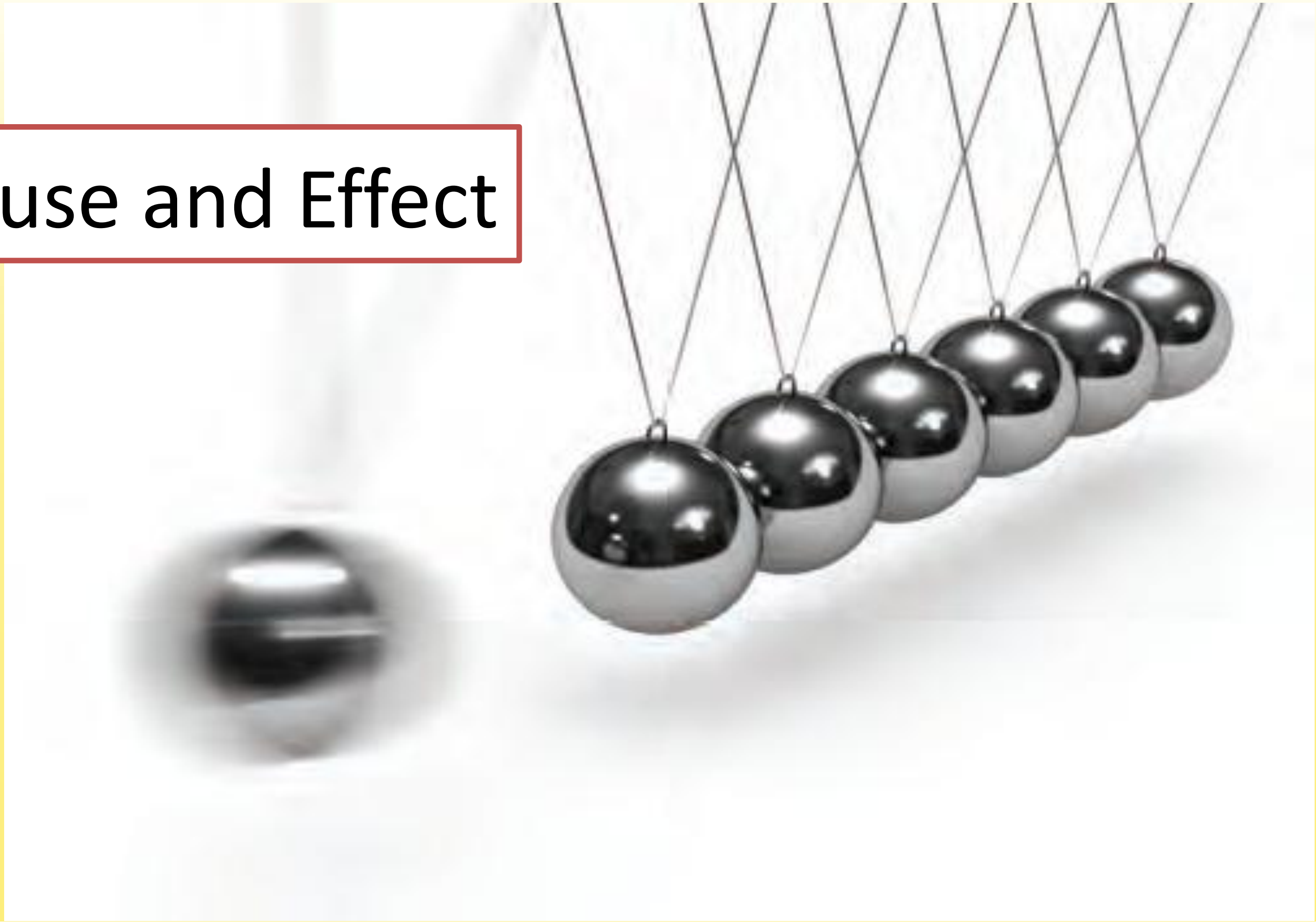
II. Cross Cutting Concepts

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

Patterns

Cause and Effect



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Systems and System Models

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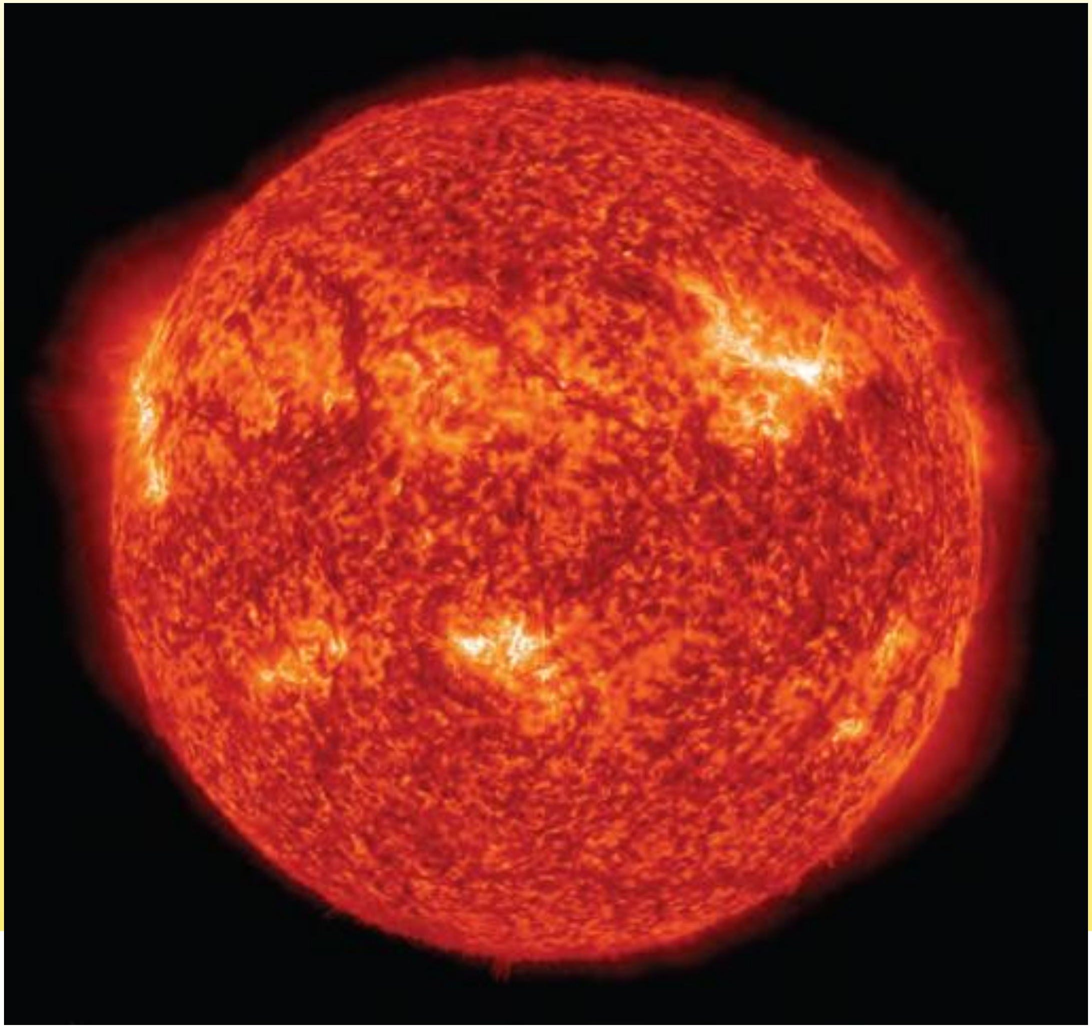
Scale, Proportion, and Quantity

Structure and Function

Energy and Matter: Flows, Cycles, & Conservation



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Stability and Change

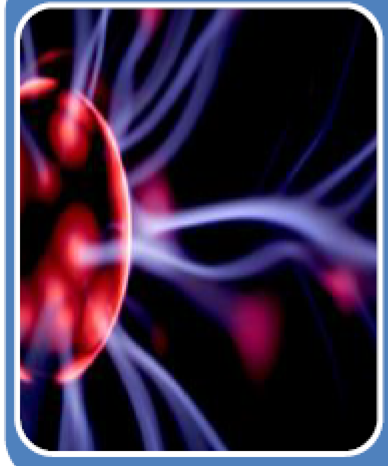
III. Disciplinary Core Ideas

A core idea for K-12 science instruction is a scientific idea that:

- **Has <u>broad importance</u> across multiple science or engineering disciplines or is a <u>key organizing concept</u> of a single discipline**
- **Provides a <u>key tool</u> for understanding or investigating more complex ideas and solving problems**
- **Relates to the <u>interests and life experiences of students</u> or can be connected to <u>societal or personal concerns</u> that require scientific or technical knowledge**
- **Is <u>teachable</u> and <u>learnable</u> over multiple grades at increasing levels of depth and sophistication**

Structured in four strands: Earth Space, Physical Science, Life Science and Engineering

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

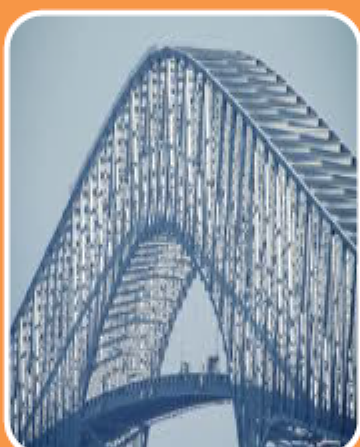
Life Science

- 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

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

Conceptual Framework Summary

Less

- Focus on eradicating misconceptions
- Inquiry as activity
- Science as just a body of knowledge
- Only older children able to learn science
- Focus on ambitious learning goals for select students

More

- Build on prior knowledge
- Practices which embody inquiry as how one does and learns science
- Science is content learned through practices
- Young children are quite capable and interested
- Focus on ambitious learning goals for all students

NEXT GENERATION SCIENCE STANDARDS

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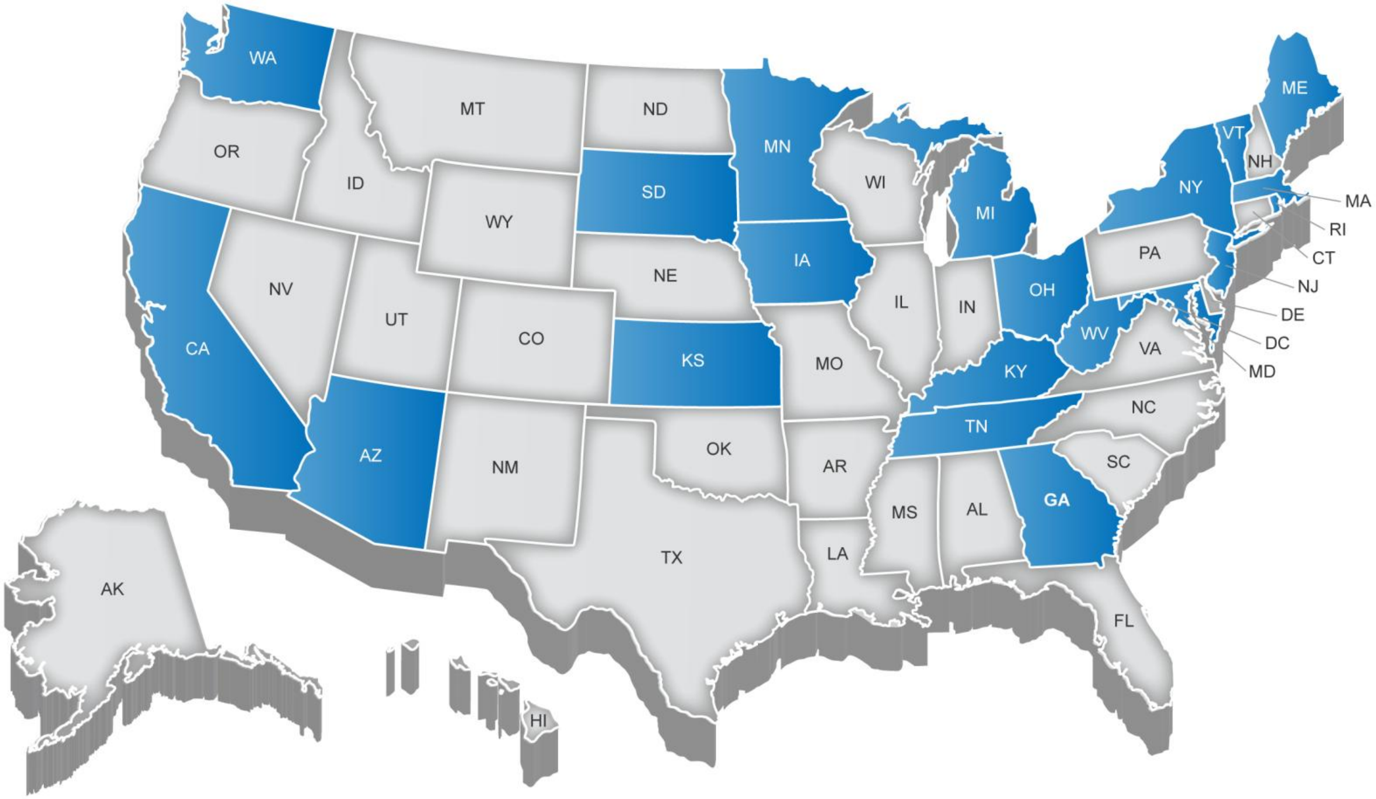
CURRENT PHASE

The draft standards are under state review

Roll over the arrows to the right to see upcoming development phases

1 2 3 4 5 6 7 8 9

Lead State Partners



Minnesota Roles

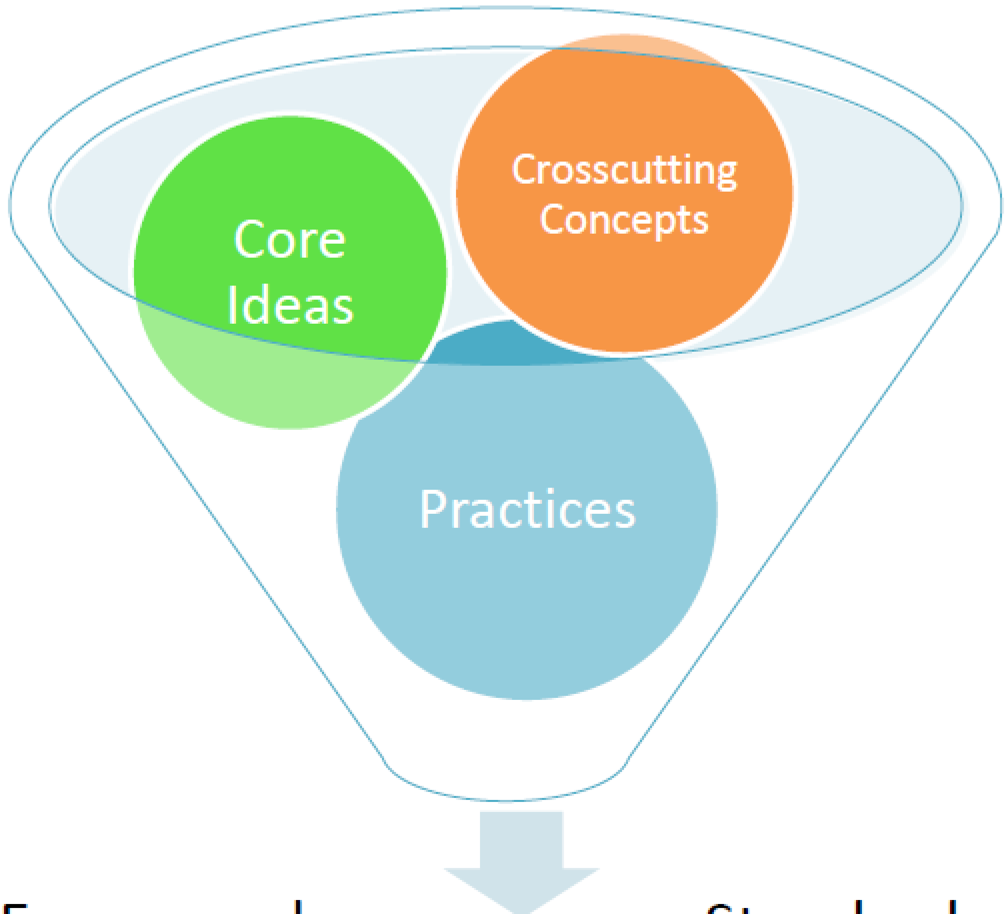
A. Review and comment on four drafts of the standards as they are being written.

B. Provide advice and support for the potential adoption and implementation for the standards.

C. Communicate the vision and messages of the Conceptual Framework.

Timeline

- **July 2011 - Framework Document Published**
- **Sep 2011   - NGSS Writing Begins**
- **Nov 2011, Jan 2012 - Lead State Drafts**
- **May 11 – June 1, 2012 - 1st Public Draft**
- **Summer 2012 - Lead State Drafts, Implementation Planning**
- **Late Fall 2012 - 2nd Public Draft**
- **Early 2013 - Next Gen. Science Standards Published**



Framework → Standards

Student Performance Expectations

MS.PS-E Energy

Performance Expectations

MS.PS-E.1 Energy

Analyzing and interpreting data to explain that the kinetic energy of an object is proportional to the mass of a moving object and grows with the square of its speed. [Assessment Boundary: Qualitative, not quantitative]

Foundation Boxes

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data ▪ Use standard techniques for displaying, analyzing, and interpreting data including appropriate statistical techniques.	**PS3.A: Definitions of Energy** ▪ Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	**Scale, Proportion, and Quantity** ▪ Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Connection Boxes

Connections to other DCIs in this grade-level: **MS.ESS-SS, MS.LS-MEOE**

Articulation to DCIs across grade-levels: **4.E, HS.PS-E, HS.PS-FE, HS.PS-ECT**

Common Core State Standards Connections:

ELA–

W.6.1 Write arguments to support claims with clear reasons and relevant evidence

W.7.1 Write arguments to support claims with clear reasons and relevant evidence

W.8.1 Write arguments to support claims with clear reasons and relevant evidence

WHST.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Mathematics–

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

6.RP Understand ratio concepts and use ratio reasoning to solve problems.

6.EE Represent and analyze quantitative relationships between dependent and independent variables.

7.RP Analyze proportional relationship and use them to solve real-world and mathematical problems.

7.EE Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

8.EE Understand the connections between proportional relationships, lines, and linear equations.

8.F Use functions to model relationships between quantities.

HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

HS-ETS-ETSS Links Among Engineering, Technology, Science, and Society

Students who demonstrate understanding can:

a. **Plan and carry out an investigation to improve a technology and suggest ideas for further related scientific study.** [Clarifying Statement: For example, a group of students investigate the environmental conditions needed to maintain a healthy aquatic population, apply findings to improving an aquarium, and recommend research that can be done with the improved technology to study aquatic ecosystems.]

b. **Gather evidence to evaluate different explanations for the widespread adoption of a modern technology, including the role of societal demands, market forces, evaluations by scientists and engineers, and possible government regulation.** [Clarifying Statement: For example, students evaluate explanations for the rapid spread of cell phones, LED lighting, or genetically engineered crops for farming.)

c. **Analyze data to compare different technologies designed to accomplish the same function regarding their relative environmental impacts, costs, risks, and benefits, and what may need to be done to reduce unanticipated negative effects.** [Clarifying Statement: Comparisons include paper vs. electronic books, nuclear vs. coal-fired power plants.] [Assessment Boundary: Analysis limited to data available online or provided to students.]

d. **Construct or critique arguments based on evidence concerning the costs, risks, and benefits of changes in major technological systems related to agriculture, health, water, energy, transportation, manufacturing, or construction, needed to support a growing world population.** [Clarifying Statement: For example, students construct arguments concerning the costs and benefits of shifting from centralized to distributed energy generation systems or natural to genetically engineered crops.] [Assessment Boundary: Limited to relative comparison of costs and benefits of different technological changes.]

The performance expectations above were developed using the following elements from the NRC *A Framework for K – 12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that build, test, and revise conceptual, mathematical, physical and empirical models.

- Plan and carry out investigations Individually and collaboratively and test designs as part of building and revising models, explaining phenomena, or testing solutions to problems. Consider possible confounding variables or effects, and ensure the investigation's design has controlled for them. (a)

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. (c)

Disciplinary Core Ideas

ETS2.A: Interdependence of Science, Engineering, and Technology

- Science and engineering complement each other in the cycle known as research and development (R&D). (a)
- Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (a)

ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems, including those related to agriculture, health, water, energy, transportation, manufacturing, construction, and communications. (d)
- Engineers continuously modify these technological systems by applying scientific and engineering knowledge and practices to increase benefits while decreasing costs and risks. (d)
- Widespread adoption of technological innovations often depends on market forces or other societal demands, but it may also be subject to evaluation by scientists and engineers and to eventual government regulation. (b)
- New technologies can have deep impacts on society and

Crosscutting Concepts

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects. (a),(b)

Stability and Change

Much of science deals with constructing explanations of how things change and how they remain stable. Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability. (b),(c),(d)

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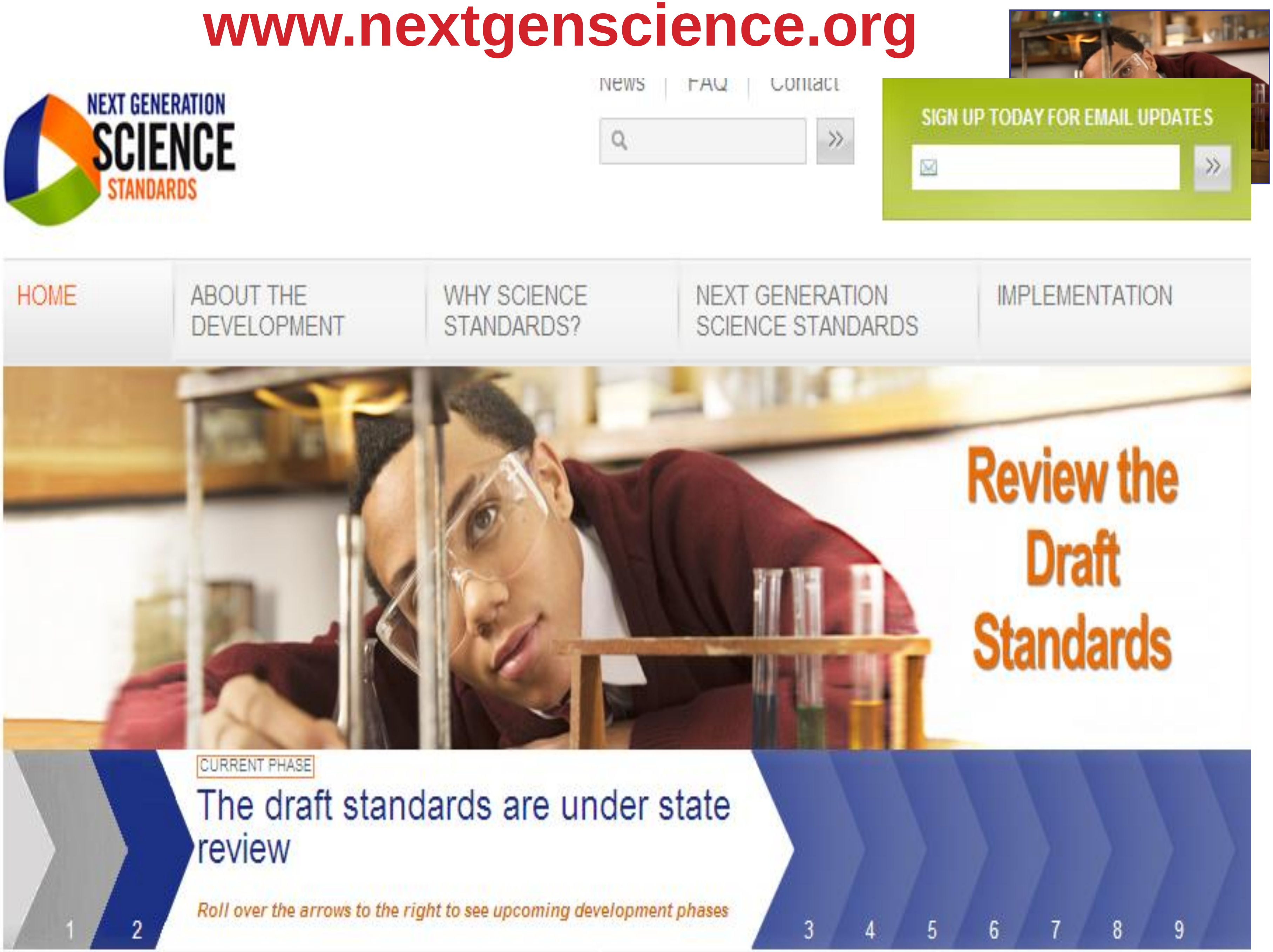

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