CREATE for STEM Institute

MICHIGAN STATE UNIVERSITY

A Framework for K-12 Science Education: Overview and Examples of Instruction Based on the Framework

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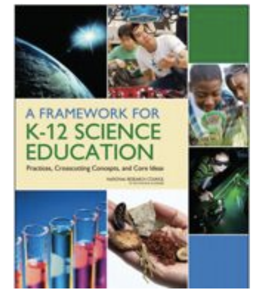
CREATE for STEM Institute

March 21, 2013

What we will do today



1. Describe the structure of the NGSS
2. Explain what is different about NGSS
    1. Review major highlights of Framework for K – 12 Science Education
    2. Examine how the Framework has influenced the Next Generation of Science Standards
3. Discuss implications for the NGSS

NEXT GENERATION SCIENCE STANDARDS

What Questions do you have regarding NGSS?

- Write down what you know about NGSS.
- What questions do you have regarding NGSS? Write them down.

Science for All Students

- Science, engineering and technology are cultural achievements and a shared good of humankind
- Science, engineering and technology permeate modern life and as such is essential at the individual level
- Understanding of science and engineering is critical to participation in public policy and good decision-making
- National need

The Shoebox – an illustrative example

Look into the round hole, what do you see?

Now open the side panel, what do you see now? Why is that?

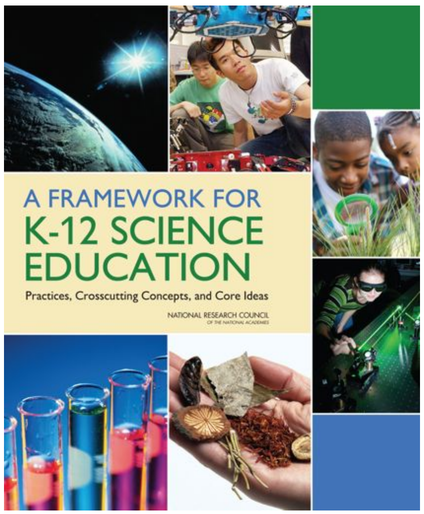
Working with a partner, draw a picture that shows why you can see the object in shoebox after opening the side panel.

Fortus, D., Grueber, D., Nordine, J. C., Rozelle, J., Schwarz, C. V., & Weizman, A. (2012). Seeing the light: Can we believe our eyes? In J. S. Krajcik, B. J. Reiser, L. M. Sutherland & D. Fortus (Eds.), *Investigating and Questioning our World through Science and Technology (IQWST)*. New York: Sangari Science.

Debrief the Shoebox Activity

- What did I have you do?
- I could have said: "Construct a model to explain why you can see the object in the shoebox."

The NRC Framework and NGSS



NEXT GENERATION SCIENCE STANDARDS

What is new?

1. Organized around core explanatory ideas
2. Coherence: building and applying ideas across time
3. Central role of scientific practices
4. Use of crosscutting concepts

Organized around core ideas

- Fewer, clearer, higher
  - "Many existing national, state, and local standards and assessments, as well as the typical curricula in use in the US, contain too many disconnected topics given equal priority." (NRC, 2009)
  - Standards and curriculum materials should be focused on a ***limited number*** of ***core ideas***.
  - Allows learners to develop understanding that can be used to solve problems and explain phenomena.

A core idea in K-12 science…

- Disciplinary significance
  - Has broad importance across multiple science or engineering disciplines, a key organizing concept of a single discipline
- Explanatory Power
  - Can be used to explain a host of phenomena
- *Generative*
  - Provides a key tool for understanding or investigating more complex ideas and solving problems
- *Relevant to peoples' lives:*
  - Relates to the interests and life experiences of students, connected to societal or personal concerns
- *Usable from K to 12*
  - Is teachable and learnable over multiple grades at increasing levels of depth and sophistication

Disciplinary Core Ideas: Physical Sciences

- PS1 Matter and its interactions
  - PS1.A: Structure and Properties of Matter
  - PS1.B: Chemical Reactions
  - PS1.C: Nuclear Processes
- PS2 Motion and stability: Forces and interactions
  - PS2.A: Forces and Motion
  - PS2.B: Types of Interactions
  - PS2.C: Stability and Instability in Physical Systems
- PS3 Energy
  - PS3.A: Definitions of Energy
  - PS3.B: Conservation of Energy and Energy Transfer
  - PS3.C: Relationship Between Energy and Forces
  - PS3.D: Energy in Chemical Processes and Everyday Life
- PS4 Waves & their applications in technologies for information transfer
  - PS4.A: Wave Properties
  - PS4.B: Electromagnetic Radiation
  - PS4.C: Information Technologies and Instrumentation

A Core Idea: Grade Band Endpoints

PS1 Matter and Its Interactions

PS1.A: STRUCTURE AND PROPERTIES OF MATTER

By the end of grade 12. Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy, by an amount known as the binding energy, than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

Disciplinary Core Ideas: Life Sciences

- LS1 From molecules to organisms: Structures and processes
  - LS1.A: Structure and Function
  - LS1.B: Growth and Development of Organisms
  - LS1.C: Organization for Matter and Energy Flow in Organisms
  - LS1.D: Information Processing
- LS2 Ecosystems: Interactions, energy, and dynamics
  - LS2.A: Interdependent Relationships in Ecosystems
  - LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
  - LS2.C: Ecosystem Dynamics, Functioning, and Resilience
  - LS2.D: Social Interactions and Group Behavior
- LS3 Heredity: Inheritance and variation of traits
  - LS3.A: Inheritance of Traits
  - LS3.B: Variation of Traits
- LS4 Biological evolution: Unity and diversity
  - LS4.A: Evidence of Common Ancestry and Diversity
  - LS4.B: Natural Selection
  - LS4.C: Adaptation
  - LS4.D: Biodiversity and Humans

Disciplinary Core Ideas: Earth and Space Sciences

- ESS1 Earth's place in the universe
  - ESS1.A: The Universe and Its Stars
  - ESS1.B: Earth and the Solar System
  - ESS1.C: The History of Planet Earth
- ESS2 Earth's systems
  - ESS2.A: Earth Materials and Systems
  - ESS2.B: Plate Tectonics and Large-Scale System Interactions
  - ESS2.C: The Roles of Water in Earth's Surface Processes
  - ESS2.D: Weather and Climate
  - ESS2.E: Biogeology
- ESS3 Earth and human activity
  - ESS3.A: Natural Resources
  - ESS3.B: Natural Hazards
  - ESS3.C: Human Impacts on Earth Systems
  - ESS3.D: Global Climate Change

Disciplinary Core Ideas: Earth and Space Sciences

- ESS1 Earth's place in the universe
- ESS2 Earth's systems
- ESS3 Earth and human activity

Disciplinary Core Ideas: Engineering

- ETS1 Engineering design
    - ETS1.A: Defining and Delimiting an Engineering Problem
    - ETS1.B: Developing Possible Solutions
    - ETS1.C: Optimizing the Design Solution
- ETS2 Links among engineering, technology, science and society
    - ETS2.A: Interdependence of Science, Engineering, and Technology
    - ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

Value of Using Core Ideas

Allows time for:

- Deep exploration of important concepts and principles,
- Develop integrated understanding,
- Practice of science and engineering,
- Reflect on the nature of science and scientific knowledge.

Provides a more coherent way for science to develop across grades K-12.

Crosscutting Concepts

Ideas the cut across and important to all the science disciplines

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

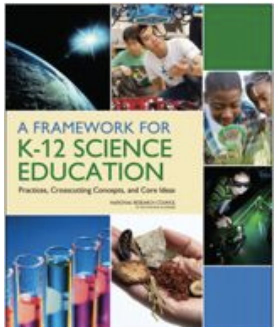
Content (scientific ideas) is not enough!

- Understanding content is inextricably linked to engaging in practices. Simply “consuming” information leads to declarative, isolated ideas.
- Science is both a body of knowledge and the process that develops and refines that body of knowledge. Understanding both the ideas and process is essential for progress in science.
- The learning of science is similar: students cannot learn one without the other.

Scientific and Engineering Practices

The multiple ways of knowing and doing that scientists and engineers use to study the natural world and design world.

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations and design solutions
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



Scientific and Engineering Practices

The practices work together – they are not separated!

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

Implications for curriculum materials and instruction

- Not separate treatment of “content” and “inquiry”
- Curriculum materials and classroom instruction need to more than present and assess scientific ideas – they need to involve learners in using scientific practices to develop and apply the scientific ideas.

Standards integrate core ideas, crosscutting ideas, & practices

- "Standards should emphasize all three dimensions articulated in the framework—not only crosscutting concepts and disciplinary core ideas but also scientific and engineering practices." (NRC 2011, Rec 4)

- "Standards should include performance expectations that integrate the scientific and engineering practices with the crosscutting concepts and disciplinary core ideas. These expectations should require that students demonstrate knowledge-in-use and include criteria for identifying successful performance." (NRC 2011, Rec 5).

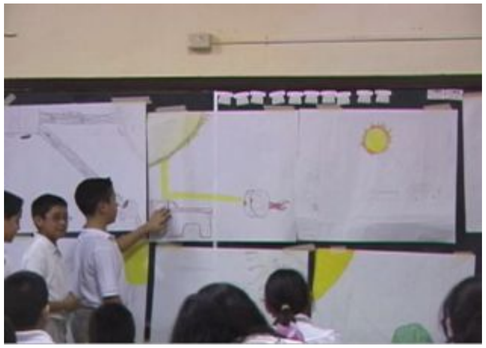
Creating performance expectations from core idea + practice + crosscutting Concept

Practice: Developing and using models

Core idea PS4.B: Electromagnetic Radiation -- An object can be seen when light reflected from its surface enters the eyes.

Crosscutting Concept: Cause and Effect

Performance expectation* MS-PS3*: Develop models to represent that you can see an object when light reflects off the surface of an objects and enters your eye.



Light Unit in a real classroom

Learning develops over time

- More expert knowledge is structured around conceptual frameworks
  - Guide how they solve problems, make observations, and organized and structure new information
- Learning continuously builds overtime
- Learning difficult ideas takes time and often come together as students work on a task that forces them to synthesize ideas
- Learning is facilitated when new and existing knowledge is structured around the core ideas
- Developing understanding is dependent on instruction

Organized according to learning progressions

- “Standards should be organized as progressions that support students’ learning over multiple grades. They should take into account how students’ command of the concepts, core ideas, and practices becomes more sophisticated over time with appropriate instructional experiences.” (NRC 2011, Rec 7)

Progression for Core Idea: Structure of Matter

Highest level

By the end of 5th/5th grade—a particle model: Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means (e.g., by weighing or by its effects on other objects). For example, a model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations including: the impacts of gas

By the end of 12th grade – an atomic structure model: Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy, by an amount known as the binding energy, than the same set of atoms separated; one must provide at least this energy to take the molecule apart.

with variations in temperature or pressure can be described and predicted using these models of matter.

Lowest level

NGSS is Different

- Standards expressed as performance expectations
- Combine practices, core ideas, and crosscutting concepts into a single statement of ***what is to be assessed***.
- They are not instructional strategies or objectives for a lesson.

NGSS: Performance Expectation

MS-PS1 Matter and Its Interactions

MS-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

MS-PS1-a. **Develop molecular-level models to communicate the composition of, and differences between, simple molecules and extended structures.** [Clarification Statement: Emphasis is on developing models that vary in complexity. Examples of molecular-level models could include drawings, 3D ball and stick structures or computer representations. Examples of simple molecules could include hydrogen peroxide or water. Examples of extended structures could include sodium chloride or diamond.] [Assessment Boundary: Valence electrons and bonding energy are not assessed. When complex structures are made of subunits of ionic natures, discussing the ionic nature of the subunits is not assessed. A complete depiction of all individual atoms in a complex molecule or extended structure is not assessed.]

MS-PS1-b. **Develop a molecular-level model that depicts and predicts that either temperature change and/or change of state can occur when adding or removing thermal energy from a pure substance.** [Clarification Statement: Emphasis is on molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of pure substances could include water, menthol, or metals.] [Assessment Boundary: The use of mathematical formulas is not assessed. Showing that electrostatic interactions break when changing state is not assessed.]

MS-PS1-c. **Develop a molecular-level model of reactants and products to support the explanation that atoms, and therefore mass, are conserved in a chemical reaction or phase change.** [Clarification Statement: Emphasis is on law of conservation of matter (an example of a regularity in nature), and on physical models and drawings that represent atoms rather than symbols.] [Assessment Boundary: The use of atomic masses is not assessed. Balancing symbolic equations (e.g. $N_2 + H_2 \rightarrow NH_3$) is not assessed. Intermolecular forces are not assessed.]

MS-PS1-d. **Analyze and interpret the properties of substances before and after they interact to determine if a chemical reaction has occurred.** [Clarification Statement: Emphasis is on the idea that a chemical reaction will result in the formation of new substances that have different properties (an example of the connection between evidence and explanation). Examples of reactions could include burning sugar, mixing vinegar and baking soda, and mixing copper with a weak acid.] [Assessment Boundary: Properties to analyze are limited to density, melting point, boiling point, states, colors, solubility, flammability, and odor.]

MS-PS1-e. **Gather and communicate information that people's needs and desires for new materials drive chemistry forward, and that synthetic materials come from natural resources and impact society.*** [Clarification Statement: Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Information obtained should be qualitative.]

MS-PS1-f. **Design, construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*** [Clarification Statement: Emphasis is on both the design and modification of a device using factors such as amount and type of substance, concentration. Examples of designs could involve chemical reactions such as dissolving ammonium chloride, or burning a food item and measuring the temperature of water heated from the reaction.] [Assessment Boundary: Only the criteria of amount, time, and temperature of substance in testing the device are assessed.]

MS-PS1 Matter and Its Interactions

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

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems.
- Use and/or develop models to predict, describe, support explanation, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. (MS-PS1-a),(MS-PS1-c),(MS-PS1-d)

Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Analyze and interpret data in order to determine similarities and differences in findings. (MS-PS1-e)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.
- Undertake design projects, engaging in the design cycle, to construct and implement a solution that meets specific design criteria and constraints. (MS-PS1-b)
- Apply scientific knowledge to design, construct, and test a design of an object, tool, process or system. (MS-PS1-g)

Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.
- Gather, read, and communicate information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used. (MS-PS1-f)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence
- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-e)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-d)

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter
- All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-a)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-e)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-c)
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-c)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-a)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-c)

PS1.B: Chemical Reactions
- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-d),(MS-PS1-e),(MS-PS1-f)
- The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-d)
- Some chemical reactions release energy, others store energy. (MS-PS1-g)

PS3.A: Definitions of Energy
- The term "heat" as used in everyday language refers both to thermal motion (the motion of atoms or molecules within a substance) and radiation (particularly infrared and light). In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures. (*secondary to MS-PS1-c*)
- Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (*secondary to MS-PS1-c*)

ETS1.A: Defining and Delimiting an Engineering Problem
- Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (*secondary to MS-PS1-b*)

ETS1.B: Developing Possible Solutions
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (*secondary to MS-PS1-g*)
- There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (*secondary to MS-PS1-b*)

ETS1.C: Optimizing the Design Solution
- Comparing different designs could involve running them through the same kinds of tests and systematically recording the results to determine which design performs best. (*secondary to MS-PS1-g*)
- This iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (*secondary to MS-PS1-g*)

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-c)
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-PS1-c)

Scale, Proportion, and Quantity
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-a)

Energy and Matter
- Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-d)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-g)

Structure and Function
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function. (MS-PS1-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-f)
- In order to design better technologies, new science may need to be explored. (MS-PS1-f)

Influence of Science, Engineering and Technology on Society and the Natural World
- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-PS1-b), (MS-PS1-f)
- The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-b), (MS-PS1-f)
- Technologies that are beneficial for a certain purpose may later be seen to have impacts that were not foreseen. In such cases, new regulations on used or new technologies may be required. (MS-PS1-f)

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Dimension Boxes

Connections to Common Core Standards in Literacy and Mathematics

MS-PS1 Matter and Its Interactions

Connections to other topics in this grade-level: will be added in future version.	
Articulation across grade-levels: will be added in future version.	
Common Core State Standards Connections:	
ELA/Literacy –	
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. *(MS-PS1-b)*
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). *(MS-PS1-c), (MS-PS1-d),(MS-PS1-g)*
RI.8.3	Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories). *(MS-PS1-g)*
WHST.6-8.7	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. *(MS-PS1-b)*
SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. *(MS-PS1-c)*
SL.7.5	Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. *(MS-PS1-a)*
Mathematics –	
MP.2	Reason abstractly and quantitatively. (MS-PS1-e),(MS-PS1-g)
MP.5	Use appropriate tools strategically. *(MS-PS1-g)*
MP.9	Look for and express regularity in repeated reasoning. (MS-PS1-d)
6.EE	Represent and analyze quantitative relationships between dependent and independent variables. *(MS-PS1-b), (MS-PS1-e)*
6.SP	Develop understanding of statistical variability (MS-PS1-b), (MS-PS1-e)

MS-PS1 Matter and Its Interactions

Students who demonstrate understanding can:

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. • Use and/or develop models to predict, describe, support explanation, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. (MS-PS1-a),(MS-PS1-c),(MS-PS1-d) *Connections to Nature of Science*	**PS1.A: Structure and Properties of Matter** • All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-a) • Solids may be formed from molecules, or they may be extended structures with repeating subunits (MS-PS1-a)	**Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-a) *Connections to Engineering, Technology, and Applications of Science*

Articulation across grade-levels: will be added in future version.

Common Core State Standards Connections:

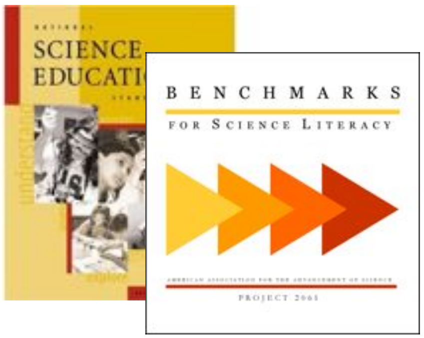
ELA/Literacy –

SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. *(MS-PS1-a)*

Mathematics –

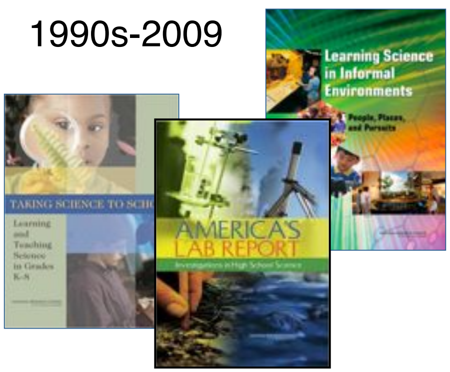
MP.2

Building on the Past; Preparing for the Future

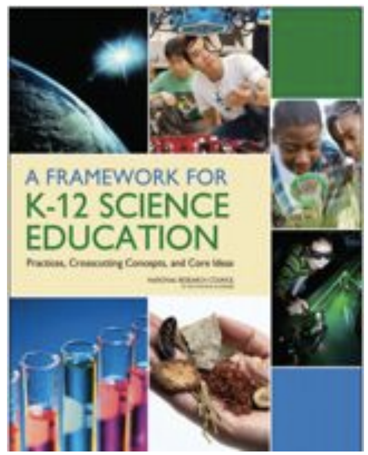


1990s

1990s-2009



Phase I



1/2010 - 7/2011

Phase II

NEXT GENERATION SCIENCE STANDARDS
For States, By States

7/2010 – Early 2013

My dream: engaging students in constructing models throughout the K – 12 curriculum

Students of all ages and backgrounds can take part in modeling!

Greater sophistication

Grades K - 2	Grades 3 - 5	Middle School	High School
Develop a simple model that represents a proposed object or tool.	Develop and revise models collaboratively to measure and explain frequent and regular events.	Develop models to describe unobservable mechanisms.	Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system.

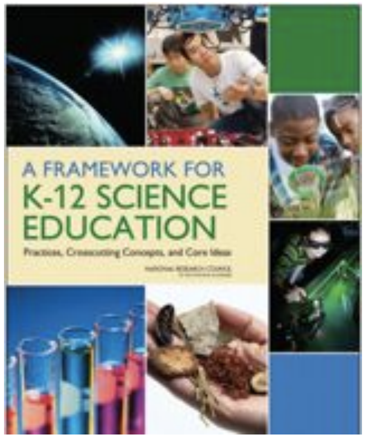
Dreaming continued: engage students in constructing arguments throughout the K – 12 curriculum

Students of all ages and backgrounds can take part in argumentation!

Greater sophistication →

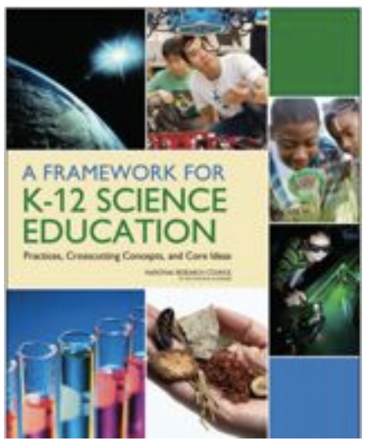
Grades K - 2	Grades 3 - 5	Middle School	High School
Make a claim and use evidence	Construct and support arguments drawing on evidence, data, or a model. Consider other ideas.	Construct and present oral and written arguments supported by empirical evidence and reasoning to support or refute an explanation for a phenomenon.	Construct a counter-argument that is based in data and evidence that challenges another proposed argument.

- Business is not the same!
- Framework is different!
- NGSS is different!
- Revolution and not evolution



NEXT GENERATION SCIENCE STANDARDS

Lots of work completed, underway, and left to do

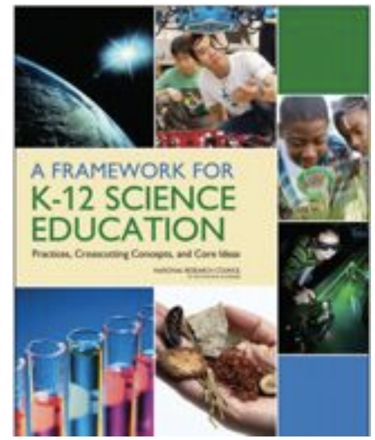


NEXT GENERATION SCIENCE STANDARDS

- Assessments
- Curricula
- Instruction
- Teacher development

Framework: Shifts in the Teaching and Learning of Science

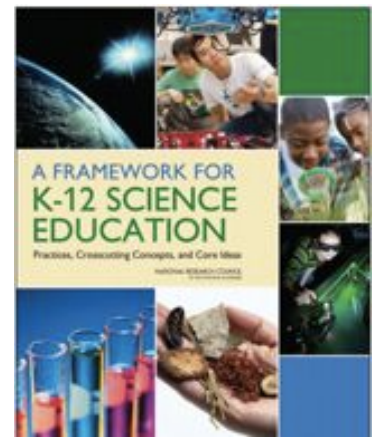
- Organize around limited number of core ideas. Favor depth and coherence over breadth of coverage.
- Core ideas need to be revisited in increasing depth, and sophistication across years. Focus needs to be on connections among scientific practices, core ideas and crosscutting concepts:
  - Careful construction of a storyline – helping learners build sophisticated ideas from simpler explanations, using evidence.



NEXT GENERATION SCIENCE STANDARDS

Summary (cont.)

- Performance expectations bring together scientific ideas (core ideas, cross cutting ideas) with scientific practices.
  - Curriculum materials need to do more than present and assess content.
  - Curriculum materials need to involve learners in practices that develop, use, and refine the scientific ideas.



NEXT GENERATION SCIENCE STANDARDS

Questions Framework and NGSS???

- Questions about core ideas?
- Questions about scientific practices?
- Questions about crosscutting concepts?
- Questions about performance expectations?
- Other questions?

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