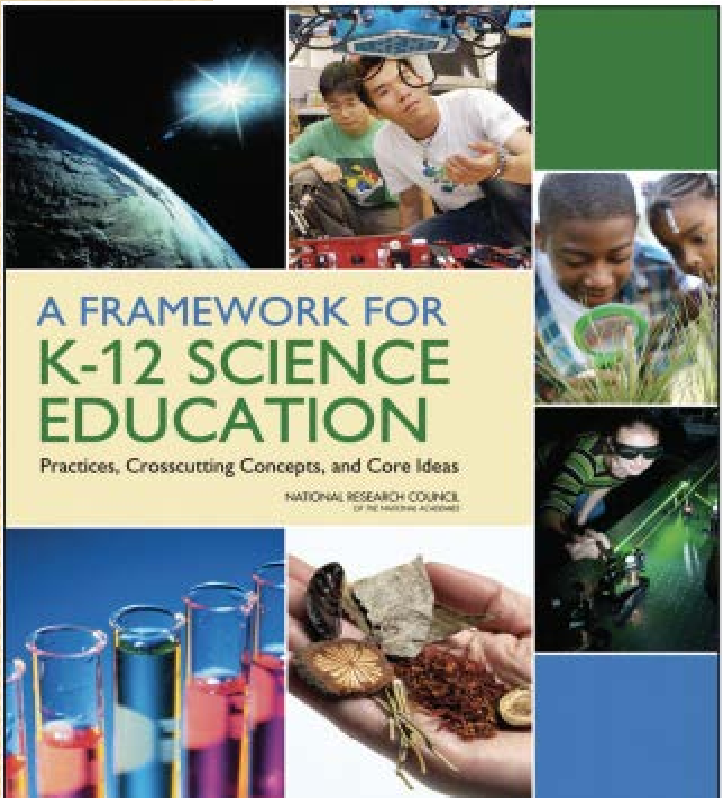


NEXT GENERATION
SCIENCE
STANDARDS

Next Generation Science Standards for Today's Students and Tomorrow's Workforce

Presented by:

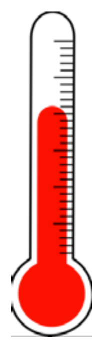
Phil Lafontaine, Director
Professional Learning Support Division
California Department of Education

Dean Gilbert, Science Coordinator
Orange County Department of Education

Why Are There Natural Occurrences Happening?

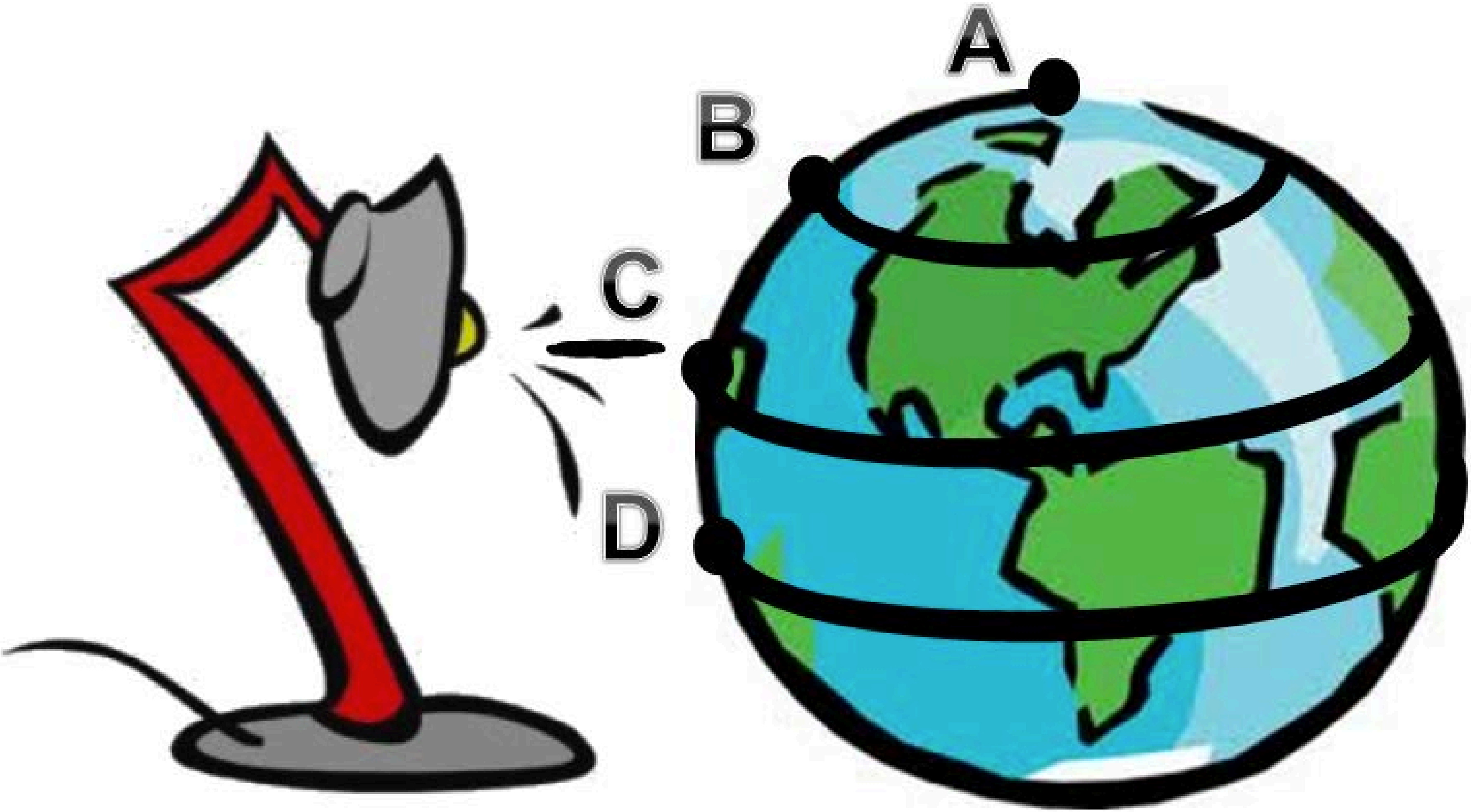
ACTIVITY: Season Simulation
Why do seasons occur on Earth?

Each group will receive a Earth globe, a lamp, a thermometer and masking tape. With these materials, move forward with your exploration.



Let's Get Started

1. Tape your group's thermometer on one of the four locations indicated in the diagram (A-B-C-D).
2. Place the lamp about 2 feet away from the globe. Aim the lamp's energy flow at what would be the equator of the globe.
3. Given the situation of the lamp and the thermometer, which thermometer will gain the most energy? Why do you think this will happen?


A
B
C
D

Next Steps

Your team will be monitoring the temperature of your location every 30 seconds.

1. Construct a data table to record the possible changes in the temperature.
   a. To begin, record in your data table what the starting temperature is of your thermometer.
   b. Turn the lamp on and monitor the temperature. Take reading **every 30 seconds** and record the temperature in your data table.

Analysis of Data

At the end of 10 minutes, construct a line graph of your data.

What patterns do you notice? Why do you think this pattern in the data occurred?

Collaborate with the other groups to compare your data with theirs. What are the differences and similarities? Again, why do you think this pattern occurred? ***Be sure to utilize the data to construct your argument.***

ACTIVITY: Season Simulation Further Investigation

Questions to Ponder

- What new information has your group gained from watching this video?
- What season do you think this model represents?
- What data provides you with the evidence to develop and support your argument?
- Construct a model that supports your explanation of what season this simulation represents.

NGSS Correlation to MS-ESS1-b

This activity supports the NGSS Earth's Place in the Universe Performance Expectation MS-ESS1-b:

"Use models of the Earth-Sun system to support the explanation that the seasons are a result of the Earth's tilt and are caused by the differential intensity and duration of sunlight on different regions of the Earth over the year."

The Three Dimensions

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.

- Apply scientific reasoning to show why the data are adequate for the explanation or conclusion. (MS-ESS1-g)
- Apply scientific knowledge and evidence to explain real-world phenomena, examples, or events. (MS-ESS1-d)

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.

- Communicate scientific information and/or technical information (e.g. about a proposed object, tool, process, system) in different formats (e.g., verbally, graphically, textually, and mathematically). (MS-ESS1-e)

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

ESS1.B: Earth and the Solar System

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-c),(MS-ESS1-d)
- This model of the solar system can explain tides, eclipses of the sun and the moon, and the motion of the planets in the sky relative to the stars. (MS-ESS1-a),(MS-ESS1-c)
- Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-b)

ESS1.C: The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Major historical events include the formation of mountain chains and ocean basins, evolution and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and the development of watersheds and rivers through glaciation and water erosion. (MS-ESS1-f),(secondary to MS-ESS2-o)
- Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-g),(secondary to MS-ESS2-o)

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (MS-ESS1-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

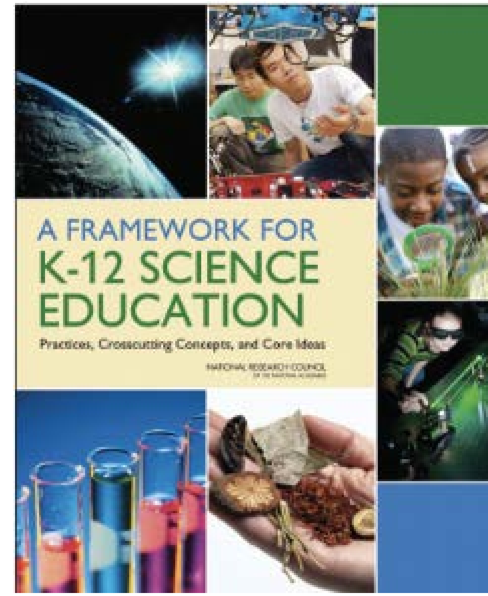
- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. Science and technology drive each other forward. (MS-ESS1-d),(MS-ESS1-e)

Connections to Nature of Science

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice, Disciplinary Core Idea, or Crosscutting Concept.

A Framework for Science Education

Practices, Crosscutting Concepts, and Core Ideas



Vision

- Science for ALL Students
- Coherent Learning

Realizing the Vision

- Integrating the Three Dimensions
- Implementation
- Equity and Diversity
- Guidance for Standards Development
- Looking Toward the Future: Research to Inform K-12 Science Education Standards

Three Dimensions

- Scientific and Engineering Practices
- Crosscutting Concepts
- Core Ideas

Focus of the Framework

Three Dimensions

- **Scientific and Engineering Practices**
- **Crosscutting Concepts**
- **Disciplinary Core Ideas**

Science and Engineering Practices

These statements were derived from the Framework to further explain the science and engineering practices important to emphasize in each grade band. The practices are grouped by the eight categories detailed in the Framework. Most standards emphasize only a few of the practice categories. However, all practices are emphasized within a grade band.

Disciplinary Core Ideas

These statements are taken verbatim from the Framework, and detail the sub-ideas necessary for student mastery of the core idea.

Crosscutting Concept Statements

These statements were derived from the Framework to further explain the crosscutting concepts important to emphasize in each grade band. The crosscutting concepts are grouped by the seven categories detailed in the Framework. Most standards emphasize only a few of the crosscutting concept categories. However, all crosscutting concepts are emphasized within a grade band.

Dimension 1
Scientific and Engineering Practices

Inquiry = Practices

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

For each, the Framework includes a description of the practice, the culminating 12th grade learning goals, and what we know about progression over time.

Dimension 2
Crosscutting Concepts

Crosscutting Concepts = Disciplinary Connective Tissue

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

NEXT GENERATION SCIENCE STANDARDS

Dimension 3- Disciplinary Core Ideas

Disciplinary Core Ideas = Defines Content Knowledge

- *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

Background Information: The National Standards Movement

- SB 300, chaptered in October 2011, required the Superintendent of Public Instruction, Tom Torlakson, to submit a set of revised standards to the State Board of Education by March 2013.
- The revised standards must be based upon NGSS
- The SBE must take action on the revised standards by July 2013.

Legislative Update

- SB 1200 chaptered in October 2012, modifies the timeline that the Superintendent of Public Instruction (SSPI), Tom Torlakson, is required to submit revised California Standards in Science
- The revised standards must be still based upon NGSS
- The SSPI must submit revised standards to the SBE by July 2013, after which Board action must be taken by November 2013.

Lead Partners

NEXT GENERATION SCIENCE STANDARDS

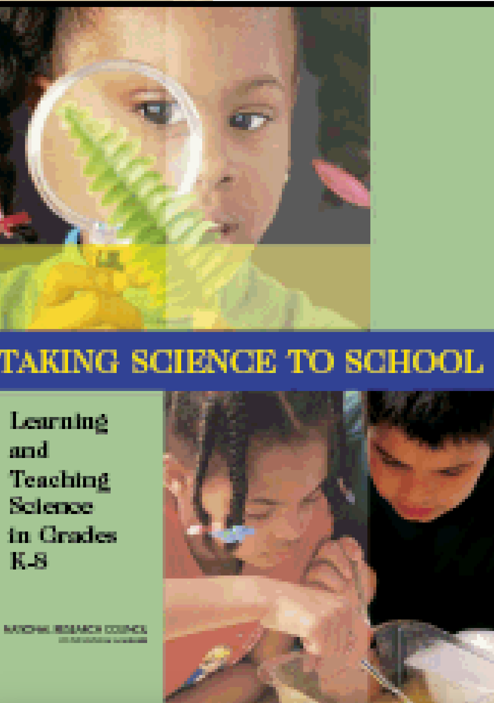
NRC

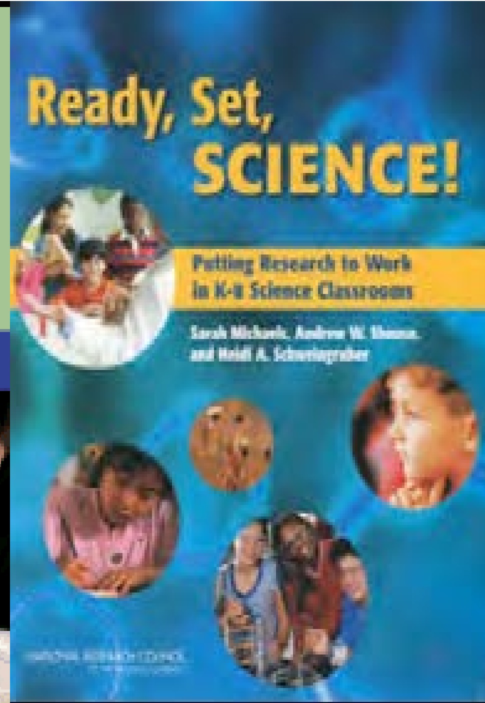
AAAS
ADVANCING SCIENCE, SERVING SOCIETY

NSTA
National Science Teachers Association

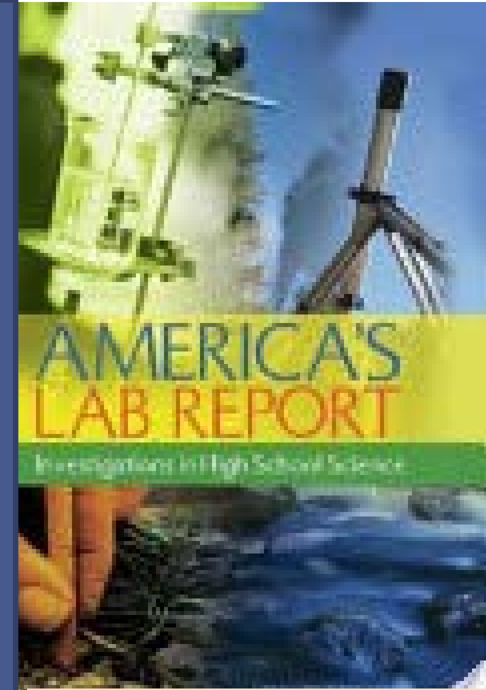
Council of State Science Supervisors

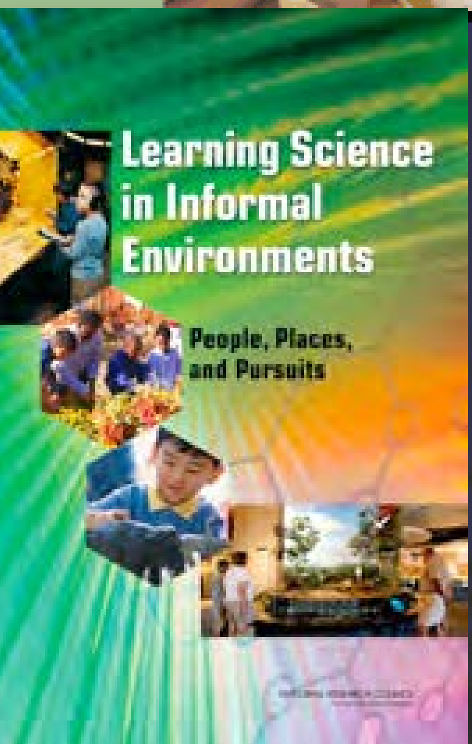
Achieve

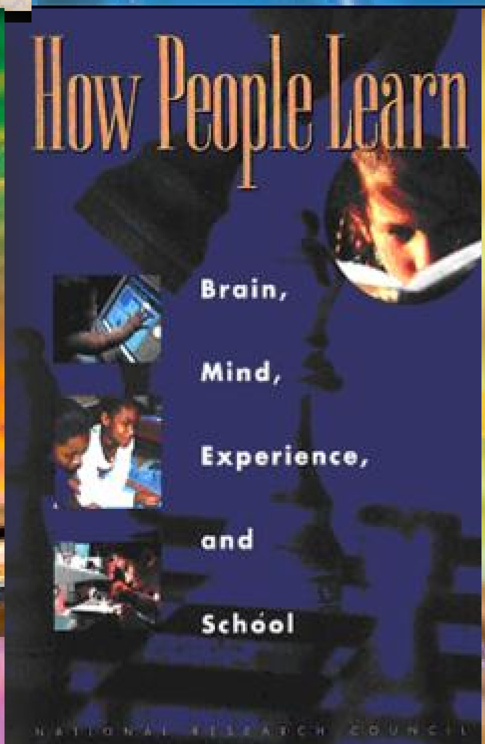


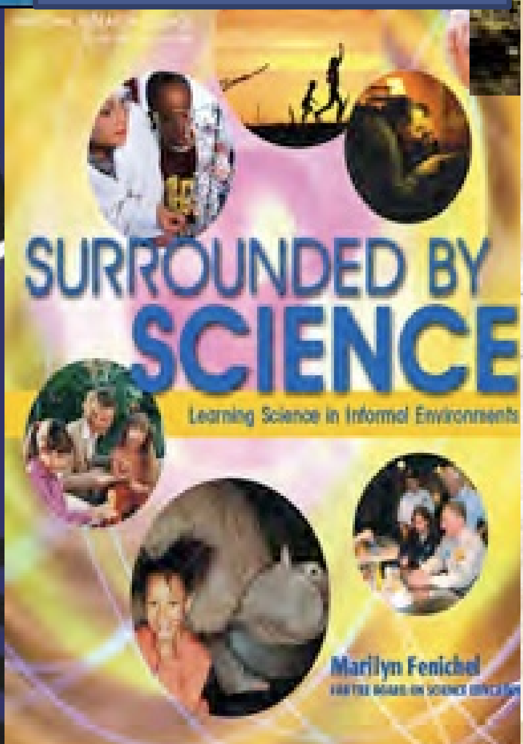


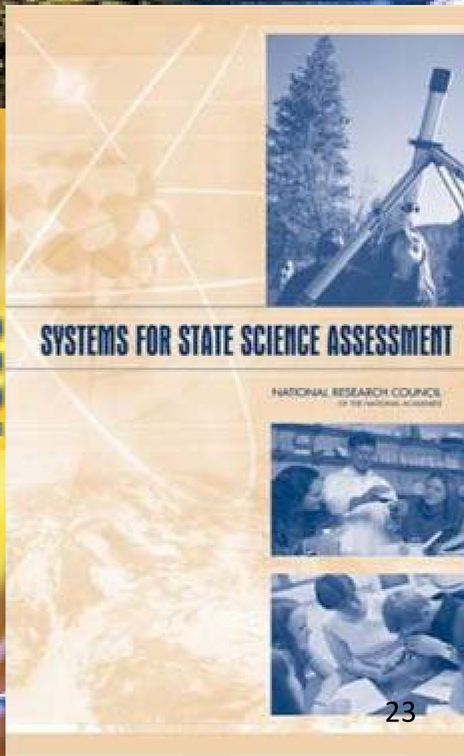
The Guiding Principles of the Framework are Research-Based and Include. . .





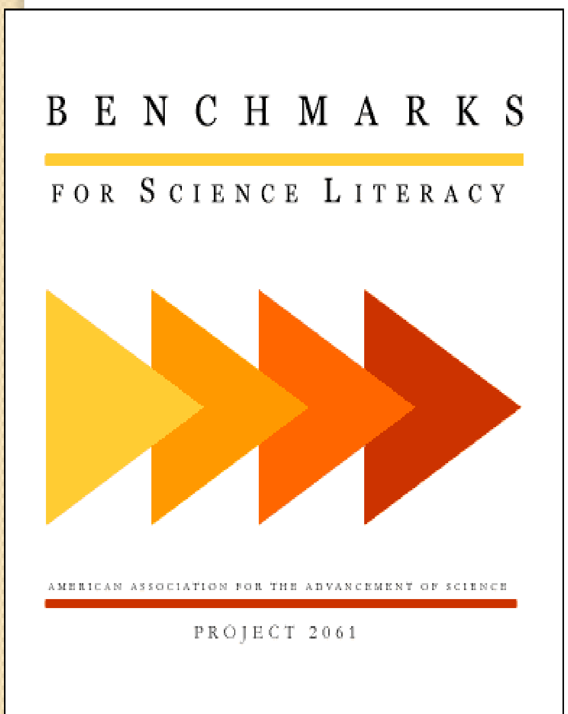


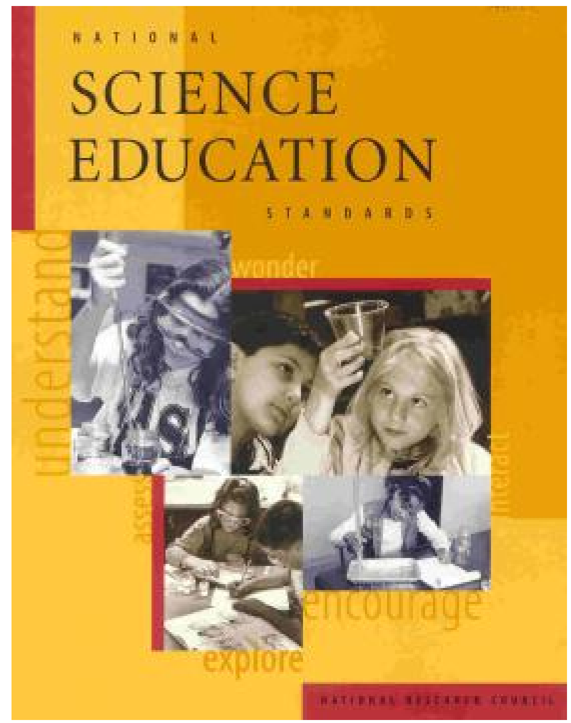




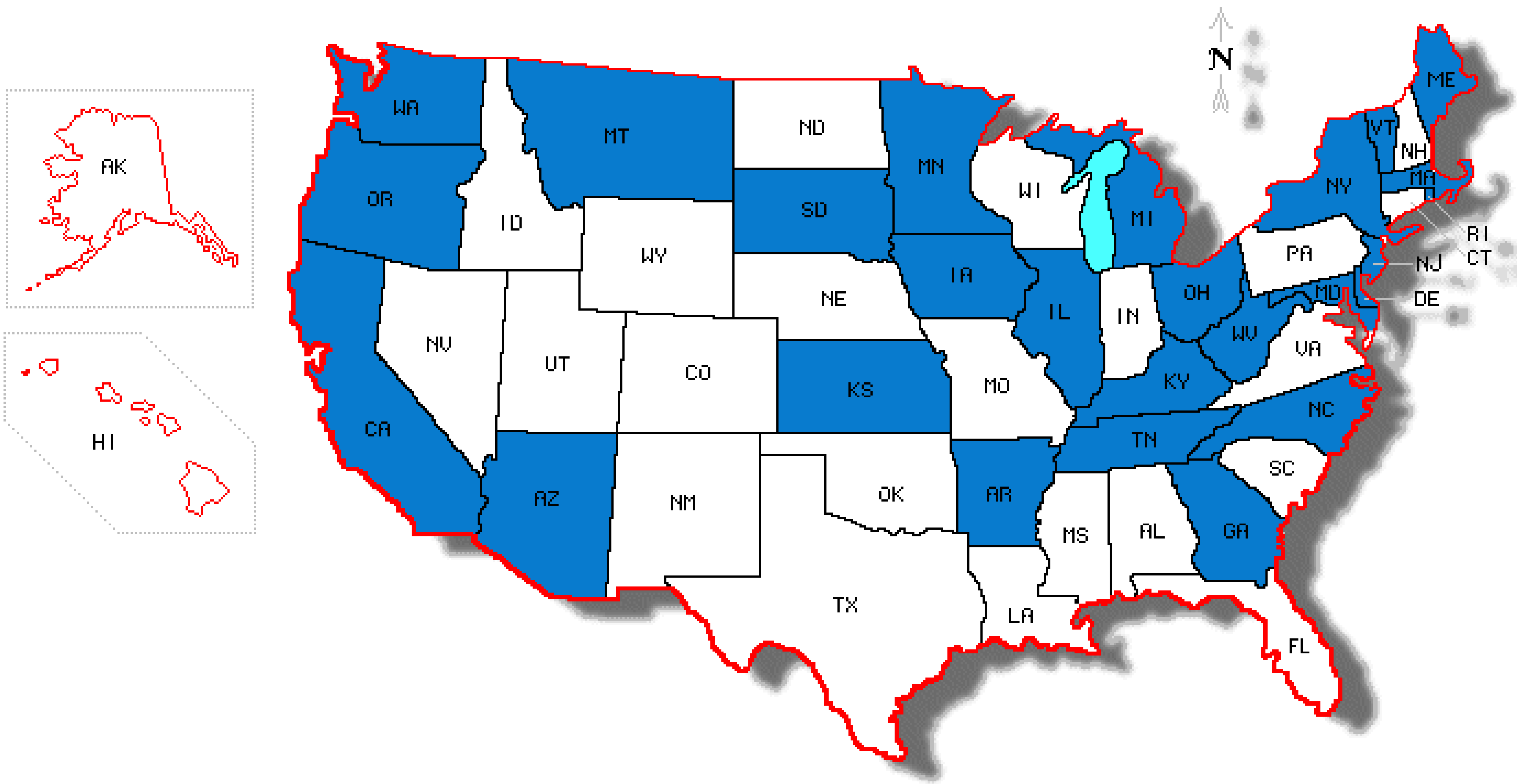
Vision for Science Education

Builds on Existing National Science Education Efforts





NGSS Lead States

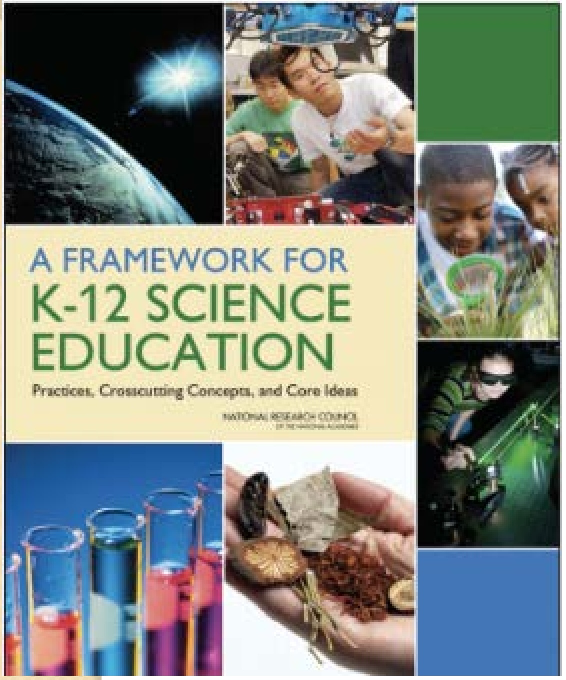


California is actively participating in NGSS development.

California Internal Review Team

K-12 Teachers
County Offices of Education
College and University Faculty
Practicing Scientists
Leaders in Business and Industry
Formal and Informal Science programs
California Science Teachers Association
California Mathematics and Science Projects
California Department of Education

Two-Step Process



NRC

NEXT GENERATION SCIENCE STANDARDS

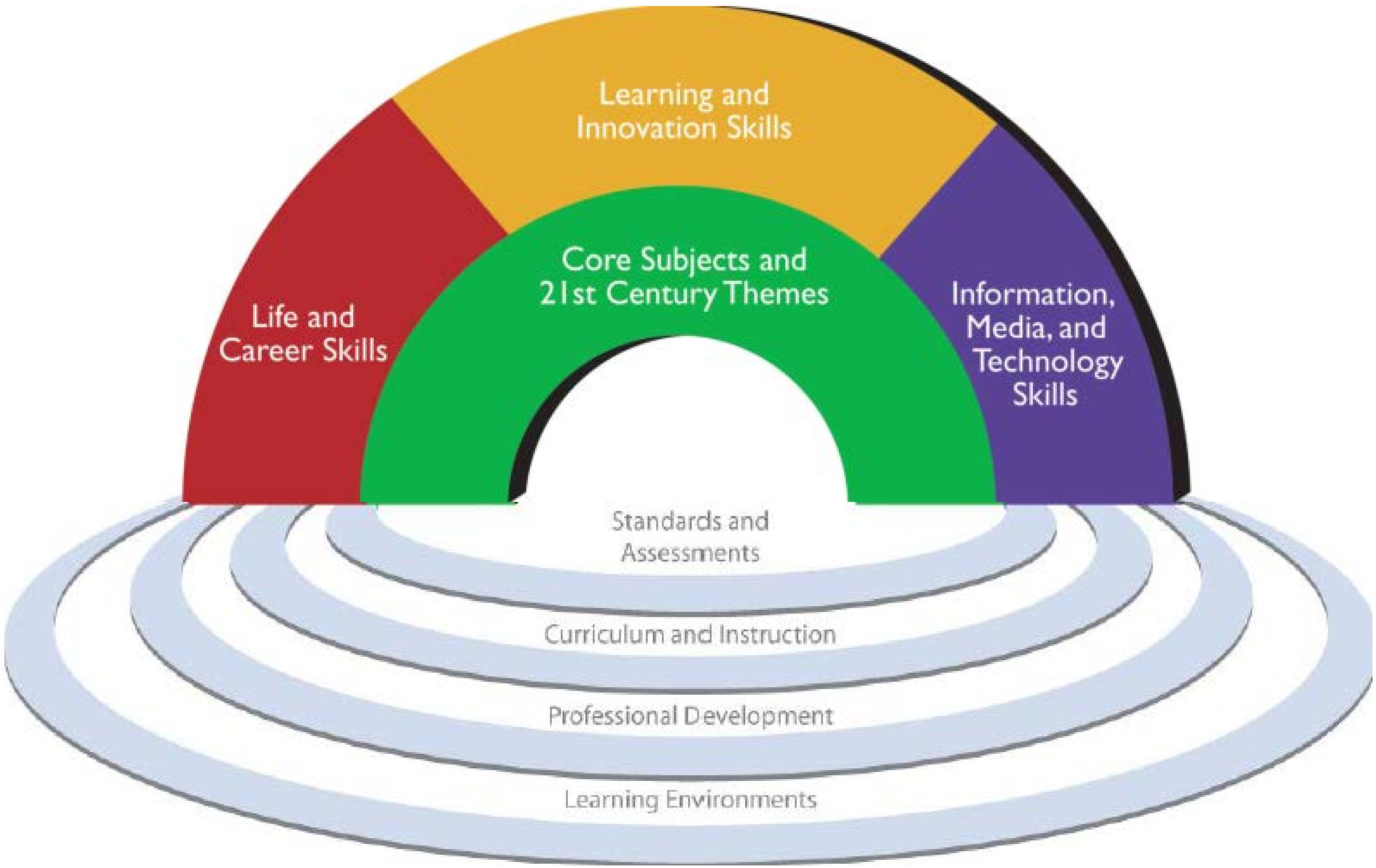
http://www.nextgenscience.org/

NEXT GENERATION SCIENCE STANDARDS

Organized Around Core Ideas

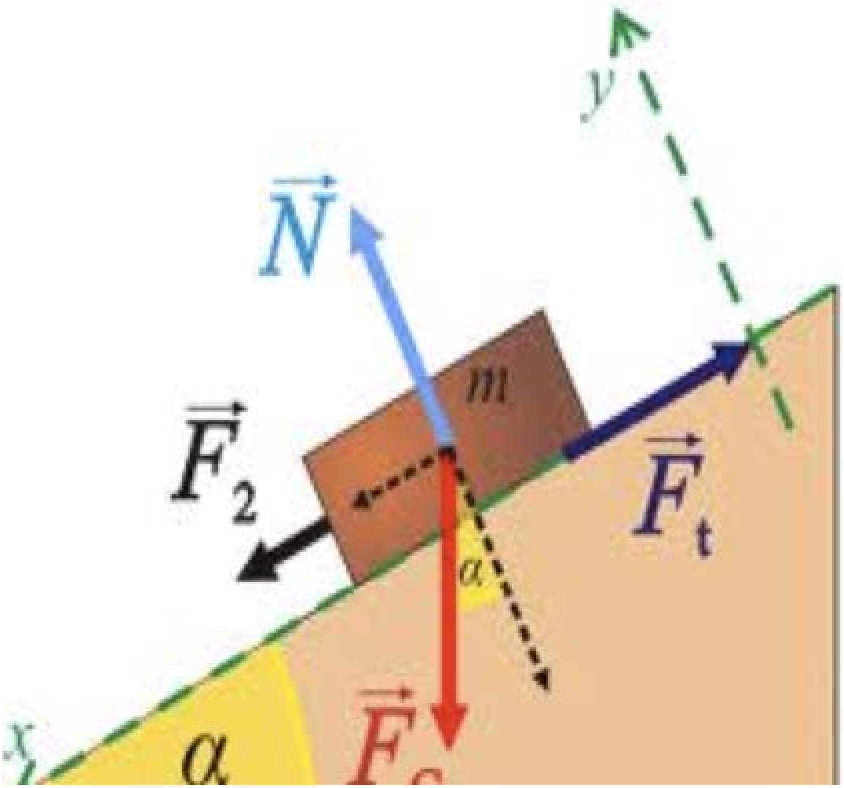
- Fewer, clearer, higher
  - "Many existing national, state, and local standards and assessments, as well as the typical curricula in use in the US, contain too many disconnected topics given equal priority." (NRC, 2009)
  - Standards and curriculum materials should be focused on a ***limited number***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

The Partnership for 21st Century Skills



Physical Sciences

- Matter and Its Interactions
- Motion and Stability
- Energy
- Waves and Their Applications

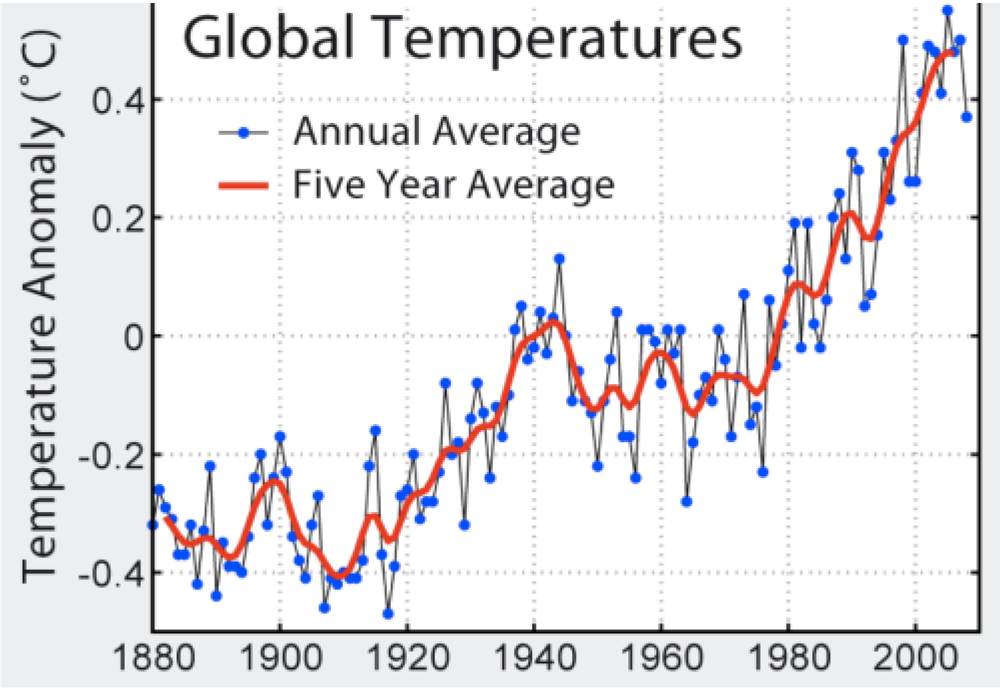


Life Sciences

- From Molecules to Organisms: Structures and Processes
- Ecosystems: Interactions, Energy, and Dynamics
- Heredity: Inheritance and Variation of Traits
- Biological Evolution: Unity and Diversity

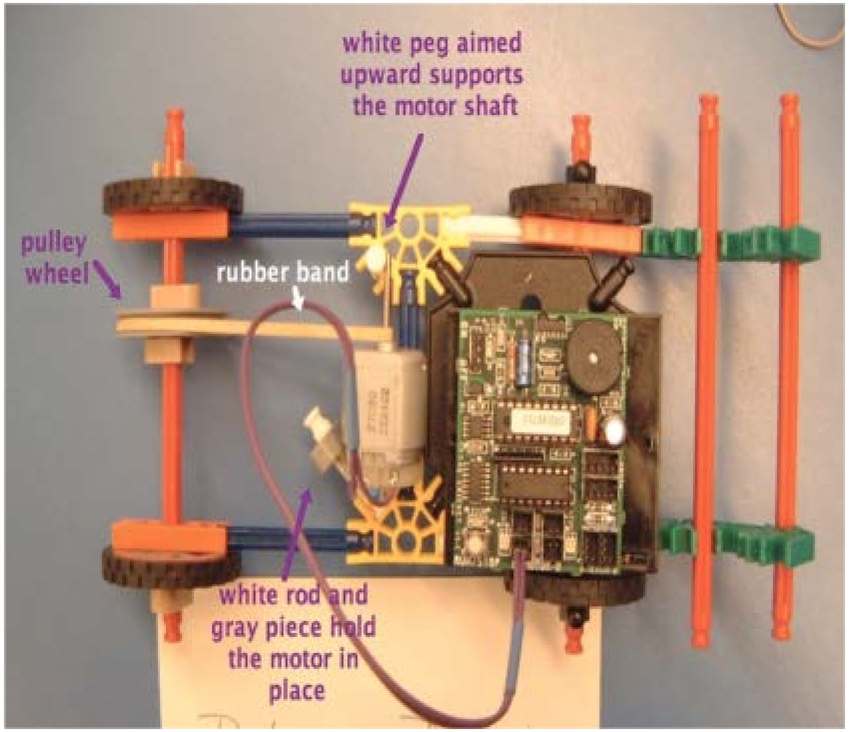
Earth and Space Sciences

- Earth's Place in the Universe
- Earth Systems
- Earth and Human Activity



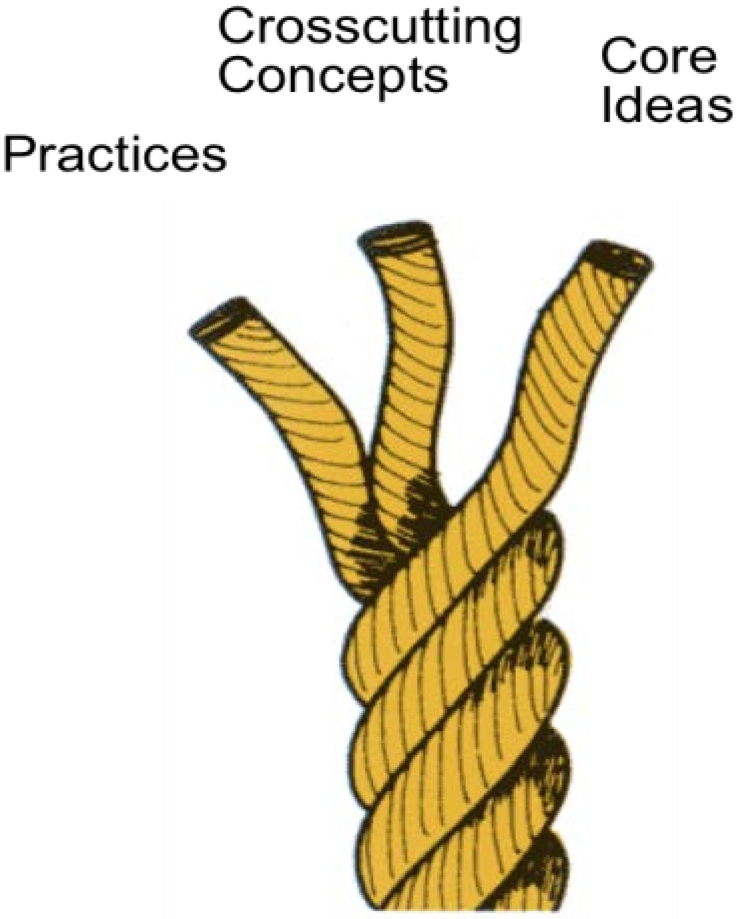
Engineering, Technology and Applications of Sciences

- Engineering Design
- Links Among Engineering, Technology, Science and Society



Next Generation Science Standards Architecture

Integration of 3 Dimensions:



Practices

Crosscutting Concepts

Core Ideas

Alignment to Common Core

- Each science standard is correlated to the cognitive demands of both English Language Arts standards and mathematics standards.
- Specific correlation of the Common Core standards are noted in the architecture of each individual science standard.

Habits of Mind

SCIENCE

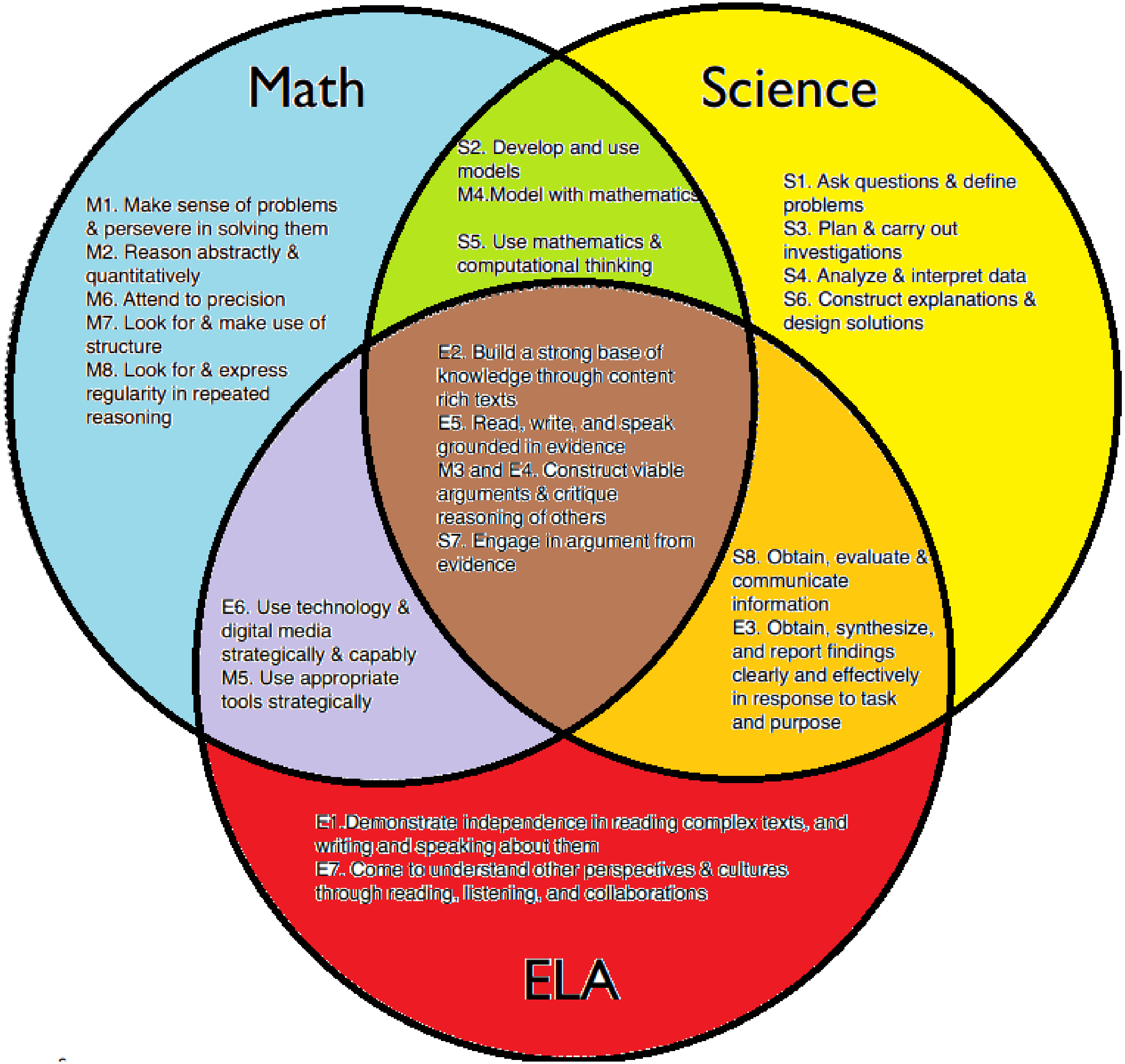
Science and Engineering Practices

ELA

College and Career Readiness Anchor Standards

MATH

Standards for Mathematical Practice



Cheuk, T. (2012). Relationships and Convergences Found in the Common Core State Standards in Mathematics (practices), Common Core State Standards in ELA/Literacy*(capacities), and A Framework for K-12 Science Education (science & engineering practices).

Performance Expectations Guide Summative Assessment

Shayna had a small bottle of Bromine gas. The bottle was closed with a cork. She tied a string to the cork, and then placed the bottle inside a larger bottle. She sealed the large bottle shut (Figure 1). Next, Shayna opened the small bottle by pulling the string connected to the cork. Figure 2 shows what happened after the cork of the small bottle was opened.

1. Draw a model that shows what is happening in this experiment.
2. Explain in writing what is happening in your model.

Figure 1

Figure 2

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:
  - Careful construction of a storyline – helping learners build sophisticated ideas from simpler explanations, using evidence.
  - Connections between scientific disciplines, using powerful ideas (nature of matter, energy) across life, physical, and environmental sciences.

Shifts in the Teaching and Learning of Science (cont.)

- Performance expectations should bring together scientific ideas (core ideas, cross cutting ideas) with scientific and engineering 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.

Product Not The Process

Performance expectations represent "the product" which defines what **each** student should know and be able to do.

It **does NOT** define "the process" Curriculum/instructional strategies that the teacher utilizes to achieve the outcome.

NEXT GENERATION SCIENCE STANDARDS

NGSS Development Timeline

Next Generation Science Standards Development Process

2011

- July 2011: *Framework for K-12 Science Education* Released by National Research Council
- 2011: Promotion of the NGSS and Conceptual Framework at Conferences and Workshops
- September 2011: California Chosen as Lead State in Development of New Science Standards, Based on Framework
- November 2011: First Meeting of State Review Team of Science Experts

2012

- February 2012: Second Meeting of State Review Team of Science Experts
- May 2012: First Public Draft of NGSS Released
- October 2012: Third Meeting of State Review Team of Science Experts

2013

- January 2013: Second Public Draft of NGSS Released
- March 2013: Final Draft of NGSS Released
- Spring 2013: Two Public Meetings of Final NGSS
- July 31, 2013: SSPI Presents to California SBE Recommended Science Standards Based on the NGSS
- November 30, 2013: California SBE Adopts, Rejects, or Modifies Recommended Science Standards

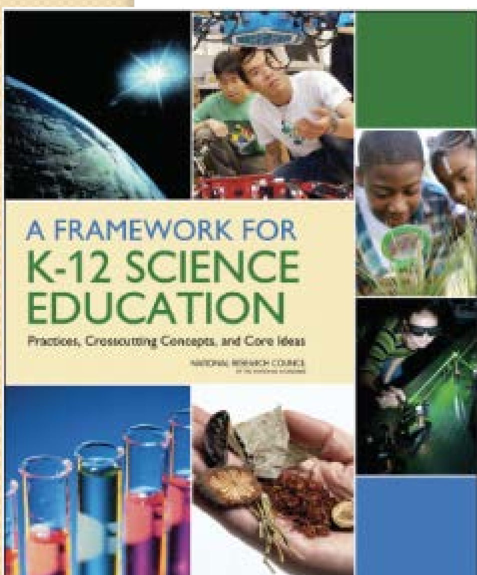
2014

- 2014*: Implementation of New Science Standards

* pending SBE action

Lots of work completed, underway, and left to do

California's Next Steps



NEXT GENERATION SCIENCE STANDARDS

- SBE Adoption of NGSS
- State Framework Development
- Instruction and Assessment
- Professional Development

NEXT GENERATION SCIENCE STANDARDS

How to Read the Standards Map

Code for the standard name

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. [Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen NOT the chemical equation for photosynthesis]

b. Developing and using models of the cycling of matter among living and nonliving parts of ecosystems.

c. Using models to explore the transfer of energy into, out of, and within the ecosystems. [Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change]

d. Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

e. Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.

f. Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.

Science and Engineering Practices

Developing and Using Models

- Use models to explore relationships between variables, especially those representing input and output. (b),(c),(d)
- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b),(c),(d)

Constructing Explanations and Designing Solutions

- Generate and revise causal explanations from data (e.g. observations and sources of reliable information) and relate these explanations to current knowledge. (a)
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(e)

Engaging in Argument from Evidence

- Use arguments and empirical evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

Disciplinary Core Ideas

LS1.C: Structure and Function

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (d),(e)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce waste carbon-dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact—primarily, for food—within an ecosystem. (d)
- Transfers of matter into and out of the physical environment occur at every level. For example when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal matter. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b),(c),(d)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (b),(c),(d)
- Models are limited in that they only represent certain aspects of the system under study. (b),(c)

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter in nature. (b),(e)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (c),(d)
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a)

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (f)

Connections to other topics in this grade-level: MS.ESS-HE, MS.ESS-ESP, MS.PS-SPM, MS.PS-ECT, MS.PS-CR

Articulation across grade-levels: 3.SFS, 5.MEE, HS.LS-MEOE, HS.LS-IRE

Common Core State Standards Connections:

ELA –

W.6.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

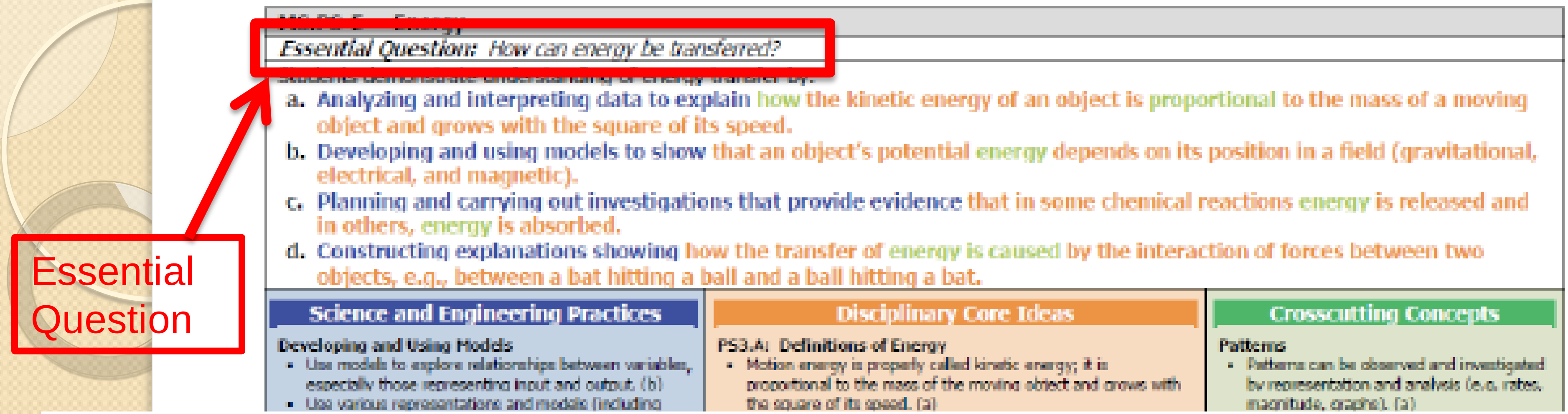
W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

8.F Use functions to model relationships between quantities



Essential Question: How can energy be transferred?

a. Analyzing and interpreting data to explain how the kinetic energy of an object is proportional to the mass of a moving object and grows with the square of its speed.
b. Developing and using models to show that an object's potential energy depends on its position in a field (gravitational, electrical, and magnetic).
c. Planning and carrying out investigations that provide evidence that in some chemical reactions energy is released and in others, energy is absorbed.
d. Constructing explanations showing how the transfer of energy is caused by the interaction of forces between two objects, e.g., between a bat hitting a ball and a ball hitting a bat.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Use models to explore relationships between variables, especially those representing input and output. (b) • Use various representations and models (including	**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. (a)	**Patterns** • Patterns can be observed and investigated by representation and analysis (e.g. rates, magnitude, graphs). (a)

The Essential Questions are designed to show an aspect of the world that will be explained as a student gains understanding of the disciplinary core ideas as defined by the Framework. In most cases, these questions were taken directly from the NRC Framework.

Performance Expectations = Standard

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems		
Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by: a. Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. [Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen NOT the chemical equation for photosynthesis] b. Developing and using models of the cycling of matter among living and nonliving parts of ecosystems. c. Using models to explore the transfer of energy into, out of, and within the ecosystems. [Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change] d. Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem. e. Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web. f. Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

a) Stem: Each standard is written in the form of one sentence, with a stem statement describing the overall core idea that is important for student understanding of science, followed by several performance expectations that describe how students will demonstrate that understanding.

b) Component statements/Student Performance Expectations: Component statements are lettered with lowercase letters, and each combines Practices, Disciplinary Core Ideas, and Crosscutting Concepts into a performance expectation.

Blue font designates a science and engineering practice concept

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. [Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen NOT the chemical equation for photosynthesis]

b. Developing and using models of the cycling of matter among living and nonliving parts of ecosystems.

c. Using models to explore the transfer of energy into, out of, and within the ecosystems. [Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change]

Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

e. Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.

f. Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.

Science and Engineering Practices

Developing and Using Models

- Use models to explore relationships between variables, especially those representing input and output. (b),(c),(d)
- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b),(c),(d)

Constructing Explanations and Designing Solutions

- Generate and revise causal explanations from data (e.g. observations and sources of reliable information) and relate these explanations to current knowledge. (a)
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(e)

Engaging in Argument from Evidence

- Use arguments and empirical evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

Disciplinary Core Ideas

LS1.C: Structure and Function

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (d),(e)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce waste carbon-dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact—primarily, for food—within an ecosystem. (d)
- Transfers of matter into and out of the physical environment occur at every level. For example when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal matter. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b),(c),(d)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (b),(c),(d)
- Models are limited in that they only represent certain aspects of the system under study. (b),(c)

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter in nature. (b),(e)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (c),(d)
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a)

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (f)

Connections to other topics in this grade-level: **MS.ESS-HE, MS.ESS-ESP, MS.PS-SPM, MS.PS-ECT, MS.PS-CR**

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Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

8.F Use functions to model relationships between quantities

Orange font designates a disciplinary core idea

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

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b. **Developing and using models of the cycling of matter among living and nonliving parts of ecosystems.**
c. **Using models to explore the transfer of energy into, out of, and within the ecosystems.** [Assessment Boundary: Only light, chemical, and the [illegible] energy need to be addressed with an emphasis that the total amount of energy does not change]
d. **Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.**
e. **Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.**
f. **Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.**

Science and Engineering Practices

Developing and Using Models
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Disciplinary Core Ideas

LS1.C: Structure and Function
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LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
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LS2.C: Ecosystem Dynamics, Functioning, and Resilience
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Crosscutting Concepts

Systems and System Models
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (b),(c),(d)
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Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

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Green font designates a crosscutting concept

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

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Science and Engineering Practices

Developing and Using Models

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Constructing Explanations and Designing Solutions

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Disciplinary Core Ideas

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LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

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LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (b),(c),(d)
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Mathematics –

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Red font designates an Assessment Boundary statement

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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models	LS1.C: Structure and Function	Systems and System Models

Assessment Boundary Statements provide further guidance or to restrict the scope of the standard at a particular grade level.

An asterisk (*) indicates an engineering connection in a practice, core idea or crosscuting concept.

Foundation Boxes

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

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Science and Engineering Practices

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LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

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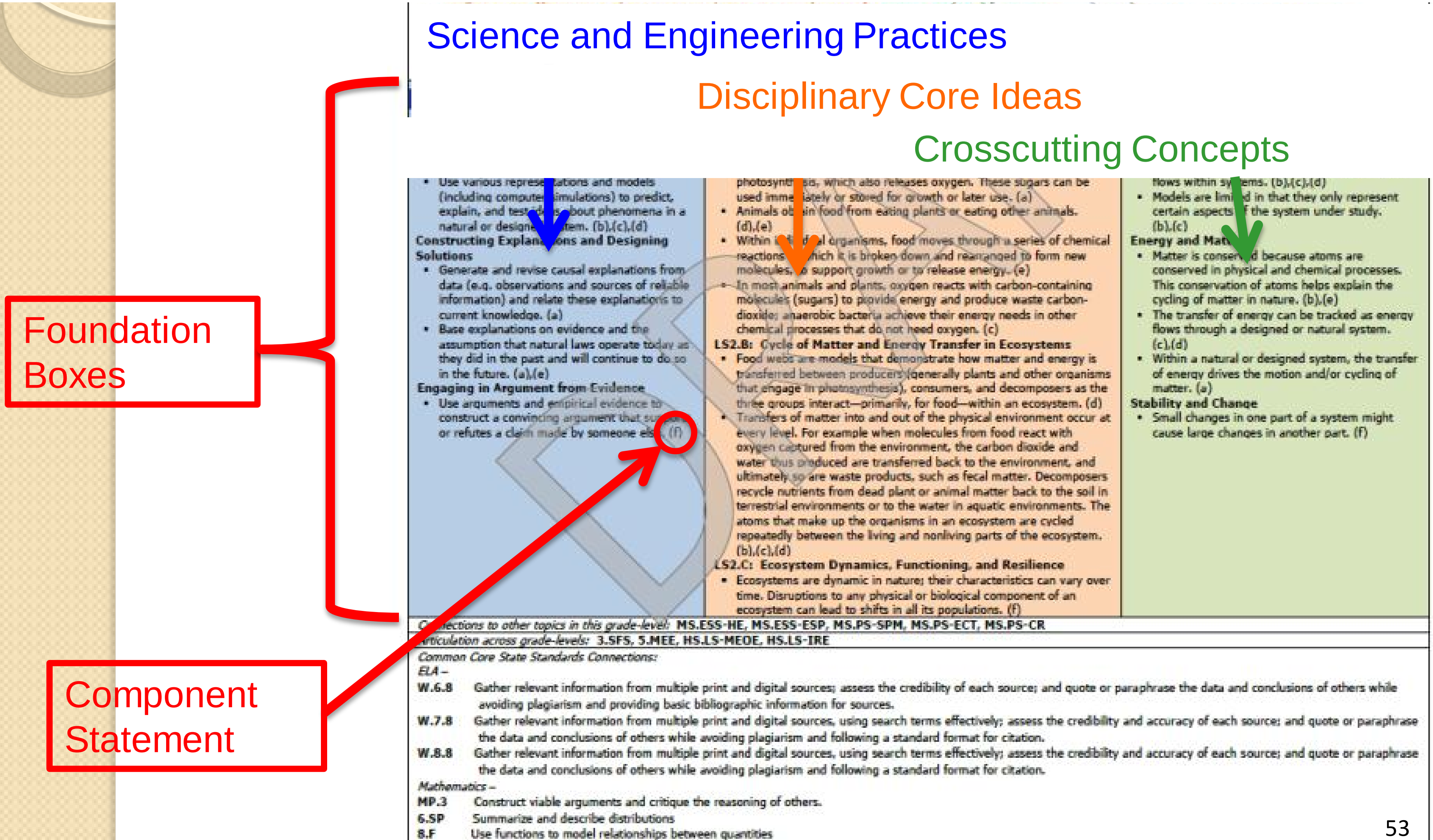
Foundation boxes provide additional information that expands and explains the standards statements in relation to the three dimensions:



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Lowercase letters designate which of the standard statements uses this practice, disciplinary core idea or crosscutting concepts

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[illegible]onstructing Explanations and Designing So[illegible]ions

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LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (b),(c),(d)
- Models are limited in that they only represent certain aspects of the system under study. (b),(c)

Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter in nature. (b),(e)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (c),(d)
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a)

Stability and Change

- Small changes in one part of [illegible] system might cause large changes in [illegible] (f)

Connections to other topics in this grade-level: **MS.ESS-HE, MS.ESS-ESP, MS.PS-SPM, MS.PS-ECT, MS.PS-CR**

Articulation across grade-levels: **3.SFS, 5.MEE, HS.LS-MEOE, HS.LS-IRE**

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Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

8.F Use functions to model relationships between quantities

Connections to the Nature of Science can be highlighted in either the practices or crosscutting concepts foundation box.

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. **Developing an explanation** for the role of photosynthesis in the cycling of matter and flow of energy on Earth. [Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen NOT the chemical equation for photosynthesis]

b. **Developing and using models** of the cycling of matter among living and nonliving parts of ecosystems.

c. **Using models** to explore the transfer of energy into, out of, and within the ecosystems. [Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change]

d. **Constructing and communicating models** of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

e. **Using evidence to explain that** matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.

f. **Using evidence from credible sources to support arguments** that changing a component of an ecosystem affects the species in the ecosystem.

Science and Engineering Practices

Developing and Using Models

- Use models [illegible] between variables, especially those representing input and output. (b),(c),(d)
- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b),(c),(d)

Constructing Explanations and Designing Solutions

- Generate and revise causal explanations from data (e.g. observations and sources of reliable information) and relate these explanations to current knowledge. (a)
- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(e)

Engaging in Argument from Evidence

- Use arguments and empirical evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

Disciplinary Core Ideas

LS1.C: Structure and Function

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (d),(e)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce waste carbon-dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact—primarily, for food—within an ecosystem. (d)
- Transfers of matter into and out of the physical environment occur at every level. For example when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal matter. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b),(c),(d)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

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Stability and Change

- Small changes in one part of a system might cause large changes in another part. (f)

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Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

8.F Use functions to model relationships between quantities

Connection Boxes provide:

a) connections to other topics in a particular grade level.

b) articulation across grade levels.

c) connections to Common Core State Standards.

- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(e)

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chemical processes that do not need oxygen. (c)

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Connection boxes

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Italics indicates a potential connection, rather than required prerequisite knowledge.

Connection boxes

Articulation across grade-levels: 3.SFS, 3.MEE, HS.LS-MEE[illegible], HS.LS-IRE

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Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others. *(MS-LSI-c)*

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