Materials

Materials

a) Agenda
b) Blank Forms for writing Standards
c) Framework OR Following Handouts
   a) CCC, Practices and DCI one page summary
   b) Handout Pages 50, 51, 52 Framework
   c) Handout Brief one page Practice sheet and Crosscutting Concepts

Activity 1 Siphon – Table groups of 3-4
   • Tubs
   • Cups
   • Tubes
   • Volume Measuring devices

Activity 2 Water Bottles – Pairs
   • Full 500 ml water bottles one per group of 2
   • 2 sheet of paper per group of 2

Activity 3 Seeds - Table groups of 3-4
   • Seed Collections

Activity 4 – Group of 5-7
   • Printing - RSS copies or online PDF or print chapter 5
   • Printing - PLC 1.0 from RSS

Activity 5

Activity 6 – Pairs
   • Printing - Standards format hard copy and electronic as well
Vision for Science Education
A Framework for K-12 Science Education:
Practices, Crosscutting Concepts, and Core Ideas

Professional Development
Understanding the Framework
2 Day Workshop
Understanding the Vision of the Framework for Science Education

Science Education for a New Generation
Produced by the Council of State Science Supervisors. www.ccsss-science.org
Overview

• The Framework
  – Vision as Described
  – Three Dimensions

• Science and Engineering Practices
  – Activity 1) Explanations from Evidence (Siphon)
  – Activity 2) Engineering (Engineering a Paper Tower)

• Crosscutting Concepts
  – What are CCC?
  – Activity 3) Structure and Function, Patterns (Seed Dispersal)

• Making Thinking Visible
  – Activity 4) PLC Making Thinking Visible

• Disciplinary Core Ideas
  – What are the Core Ideas?
  – Activity 4) Mapping the Concepts (Chart Paper and Framework or Laptops)

• Where is the Inquiry?
  – Understanding this Change in Focus
  – Methods of Science

• Science Standards
  – Framework Expectations
  – Activity 7) Writing a Standard

• What is the Vision?
  – Putting it All Together
  – Discussion of Your Vision for the Classroom

• Closure and Final Questions
The Framework

– Vision as Described
– Three Dimensions
Goals for Science Education

Activity

Turn to the educator next to you and answer the following questions:

One minute for each question -

• Identify from your current Science Education Standards a few student expectations that are specific to Science Practices?

• How are these expectations related to how science and scientists work?

Framework Page 43 - 44
Handout on How Scientists Work
Dimensions of the Framework

• Science and Engineering Practices
• Disciplinary Core Ideas
• Crosscutting Concepts
Framework → Standards
Why Practices?

• Emphasizes outcomes from instruction.
• References both scientific inquiry and engineering design.
Science and Engineering 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, Information and Computer Technology, and Computational Thinking
6. Constructing Explanations (Science) and Designing Solutions (Engineering)
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information
Why Practices?

The idea of science as a set of practices has emerged from the work of historians, philosophers, psychologists, and sociologists over the past 60 years. This perspective is an improvement over previous approaches in several ways.

First – It minimizes the tendency to reduce scientific practices to a single set of procedures, such as identifying and controlling variables, classifying entities, and identifying sources of error. This tendency overemphasizes experimental investigation at the expense of other practices, such as, posing questions, arguing from evidence, modeling, critique, and communication.

Second – A focus on practices (in the plural) avoids the mistaken impression that there is one distinctive approach common to all science—a single “scientific method”—or that uncertainty is a universal attribute of science.

Third – Attempts to develop the idea that science should be taught through a process of inquiry have been hampered by the lack of a commonly accepted definition of its constituent elements.
Science and Engineering Practices

• Science Practices are the process and habits of mind specific to doing science.

• Science Practices distinguish science from other ways of knowing.

• When students actively engage in Science Practices they deepen their understanding of core science ideas.

• This vision of the Core Ideas and Practices in science provides the utility students need to engage in making sense of the natural and design worlds.
Understanding How Scientists Work

The idea of science as a set of practices has emerged from the work of historians, philosophers, psychologists, and sociologists over the past 60 years. This perspective is an improvement over previous approaches, in several ways.

First - It minimizes the tendency to reduce scientific practices to a single set of procedures, such as identifying and controlling variables, classifying entities, and identifying sources of error. This tendency overemphasizes experimental investigation at the expense of other practices, such as modeling, critique, and communication.

Second - A focus on practices (in the plural) avoids the mistaken impression that there is one distinctive approach common to all science—a single “scientific method”—or that uncertainty is a universal attribute of science.

Third - Attempts to develop the idea that science should be taught through a process of inquiry have been hampered by the lack of a commonly accepted definition of its constituent elements. The focus in the Framework is on important practices, such as modeling, developing explanations, and engaging in critique and evaluation (argumentation), that have too often been underemphasized in the context of science education. Students engage in argumentation from evidence to understand the science reasoning and empirical evidence to support explanations.
Break

• Education is not filling a pail, but lighting a fire.
  
  William Butler Yeats
How do Instructional Activities Connect to Practices?

1. In pairs review the instructional activity provided.
2. Now use the “Practices by Strand” to identify and select the science and engineering practices that best match the activity.
3. Discuss the nature of how these practices play out in an instructional activity.
4. Now consider the activity in terms of multiple practices and how these practices work together.
Evidence to Support Explanations

• What distinguishes science from other ways of knowing is the reliance on evidence.

• Value and use science as a process of obtaining knowledge based on empirical evidence.
Science and Engineering Practices

– Activity 1) Explanations from Evidence (Siphon)
Siphoning Water Science Practices - Activity 1

Group Activity
1. Explore how a siphon works.
2. Formulate questions and investigate explanations of the observed phenomena.
3. Develop and use evidence to support your explanations.

Individual Activity
4. Write in your journal (or on a sheet of paper) your explanation that can be used to communicate to others your explanation for this phenomena and describe the evidence to support your explanation.

Following Discussion
• Write a three sentence reflection on the nature of instruction that leads students to develop explanations based upon evidence.

• Handout page 91 RSS
What is the Role of Investigations in the Classroom?

**Student – Planning and Carrying out Investigations**
- Providing empirical evidence to support assertions
- Listening to others’ arguments and analyze the evidence
- Evaluating arguments based on evidence and reasoning
- Developing own explanations based on evidence
- Communicating findings

**Teacher – Engaging students in practices**
- Making student thinking visible using argumentation, writing and models.
- Assessing student understanding to support student reasoning and sense making.
- Evaluating student explanations of Core Ideas used in the explanations.
Science and Engineering 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, Information and Computer Technology, and Computational Thinking
6. Constructing Explanations (Science) and Designing Solutions (Engineering)
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information
Lunch

Always remember that man does not live by bread alone....we need peanut butter too!

Enjoy your conversations over lunch
Science and Engineering Practices

– Activity 3) Engineering (Engineering a Paper Tower)
Engineering Practices

• These practices are a natural extension of science practices.

• Science instruction often includes opportunities for students to engage engineering practices.
Building Interest in Science

• The line between applied science and engineering is fuzzy.

• The Framework seeks ways for science and engineering to be used to investigate real-world problems and explore opportunities to apply scientific knowledge to engineering design problems.

• The Framework is designed to build a strong base of core competencies to be applied by students to develop a better grounding in scientific knowledge and practices—and create greater interest in furthering science learning.

• Applying the science ideas in the context of engineering is one way to build interest in science.
Engineering Practices

• Engineering practices are a natural extension of science practices.

• Science instruction often includes opportunities for engineering practices.

• Engineering is not a new component of science standards. Some states currently have elements of engineering in their science standards.

• The Framework provides meaningful connections of science and engineering in the Practices.
Let’s Explore Engineering with Paper – **Activity 2**

- Using only the two sheets of paper provided, construct a platform that supports the mass of the full water bottle in a stable position as far above the table top as possible.
- While constructing the tower, consider the **engineering practices** that are useful in constructing the tower.
- Consider the science knowledge needed or relevant to construct the tower.
Core Idea ETS1: Engineering Design

How do engineers solve problems?

• The design process—engineers’ basic approach to problem solving—involves many different practices.

• They include problem definition, model development and use, investigation, analysis and interpretation of data, application of mathematics and computational thinking, and determination of solutions.

• These engineering practices incorporate specialized knowledge about criteria and constraints, modeling and analysis, and optimization and trade-offs.

Framework Page 204

• Core Idea ETS1: Engineering Design
  – ETS1.A: Defining and Delimiting an Engineering Problem
  – ETS1.B: Developing Possible Solutions
  – ETS1.C: Optimizing the Design Solution
Reflect on the Paper Tower Activity in Light of ETS1.A: Defining and Delimiting an Engineering Problem

What is a design for? What are the criteria and constraints of a successful solution?

The engineering design process begins with:

• Identification of a problem to solve.
• Specification of clear goals, or criteria, for final product or system.
  – Criteria, which typically reflect the needs of the expected end-user.

Engineering must contend with a variety of limitations or constraints

  – Constraints, which frame the salient conditions under which the problem must be solved, may be physical, economic, legal, political, social, ethical, aesthetic, or related to time and place.
  – In terms of quantitative measurements, constraints may include limits on cost, size, weight, or performance.
  – Constraints place restrictions on a design, not all of them are permanent or absolute.
Reflect on the Paper Tower Activity in Light of ETS1.B: Developing Possible Solutions

What is the process for developing potential design solutions?

The creative process of developing a new design to solve a problem is a central element of engineering.

- Open-ended generation of ideas.
- Specification of solutions that meet criteria and constraints.
- Communicated through various representations, including models.
- Data from models and experiments can be analyzed to make decisions about a design.
Reflect on the Paper Tower Activity in Light of ETS1.C: Optimizing the Design Solution

How can the various proposed design solutions be compared and improved?

Multiple solutions to an engineering design problem are always possible; determining what constitutes “best” requires judgments.  
• Optimization requires making trade-offs among competing criteria.  
• Judgments are based on the situation and the perceived needs of the end-user of the product or system.  
• Different designs, each optimized for different conditions, are often needed.
Reflect on the Paper Tower Activity in Light of ETS1: Engineering Design

Core Idea ETS1: Engineering Design

- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution
Similarities and Differences

• Engineering and science are similar in that both involve creative processes, and neither use just one method.
  – Just as scientific investigation has been defined in different ways, engineering design has been described in various ways.
  – However, there is widespread agreement on the broad outlines of the engineering design process.

• Like scientific investigations, engineering design is both iterative and systematic.
  – It is iterative in that each new version of the design is tested and then modified, based on what has been learned up to that point.
  – It is systematic in that a number of characteristic steps must be undertaken.

• Differences mainly in *purpose* and *product*
## Similarities and Differences

<table>
<thead>
<tr>
<th>Scientific Inquiry</th>
<th>Engineering Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask a question</td>
<td>Define a problem</td>
</tr>
<tr>
<td>Obtain, evaluate and communicate technical information</td>
<td>Obtain, evaluate and communicate technical information</td>
</tr>
<tr>
<td>Plan investigations</td>
<td>Plan designs and tests</td>
</tr>
<tr>
<td>Develop and use models</td>
<td>Develop and use models</td>
</tr>
<tr>
<td>Design and conduct tests of experiments or models</td>
<td>Design and conduct tests of prototypes or models</td>
</tr>
<tr>
<td>Analyze and interpret data</td>
<td>Analyze and interpret data</td>
</tr>
<tr>
<td>Use mathematics and computational thinking</td>
<td>Use mathematics and computational thinking</td>
</tr>
<tr>
<td>Construct explanations using evidence</td>
<td>Design solutions using evidence</td>
</tr>
<tr>
<td>Engage in argument using evidence</td>
<td>Engage in argument using evidence</td>
</tr>
</tbody>
</table>

Adapted from A Framework for K-12 Science Education (NRC, 2011)
Evidence to Support Explanations

• Science is distinguished from other ways of knowing by the reliance on evidence as the central tenet.

• Constructing science teaching and learning to value and use science as a process for students to obtain knowledge based on empirical evidence.

• Using the Engineering Design process as a tool for problem solving as described in the Disciplinary Core Ideas relies on evidence to assess solutions.
Break

Equipped with his five senses, man explores the universe around him and calls the adventure Science.

--Edwin Powell Hubble (The Nature of Science)
Crosscutting Concepts

– What are Crosscutting Concepts
– Activity 3) Structure and Function (Seed Dispersal)
What are Crosscutting Concepts?

- Crosscutting concepts cross disciplinary boundaries and contribute to sense making and support students in valuing and using science and engineering practices.

- The Framework describes seven crosscutting concepts that support understanding of the natural sciences and engineering.

- The crosscutting concepts, when made explicit for students, contribute to their understanding of a coherent and scientifically-based view of the world.

- Crosscutting concepts have utility for instruction.

Framework Page 83
So, Which Crosscutting Concepts?

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
The Framework has identified seven key Crosscutting Concepts:

- **Cause and Effect**
- **Patterns**
- **Structure and Function**
- **Systems**
- **Scale**
- **Matter and Energy**
- **Change and Stability**
Crosscutting Concepts

• These concepts should become common and familiar touchstones across the disciplines and grade levels.

• Explicit reference to the concepts, as well as their emergence in multiple disciplinary contexts, can help students develop a cumulative, coherent, and usable understanding of science and engineering.
Science is built on causality. The concept that phenomena have a cause that can be explained with evidence distinguishes science from other ways of knowing.

“Causation invoked to explain larger scale systems must be consistent with the implications of what is known about smaller scale processes within the system”

Framework page 88
Organizing the Crosscutting Concepts

• This set of crosscutting concepts begins with two concepts that are fundamental to the nature of science: that observed **patterns** can be explained and that science investigates **cause and effect** relationships by seeking the mechanisms that underlie them.

• The next concept—**scale, proportion, and quantity**—concerns the sizes of things and the mathematical relationships among disparate elements.

• The next four concepts—**systems and system models, energy and matter flows, structure and function, and stability and change**—are interrelated in that the first is illuminated by the other three. Each concept also stands alone as one that occurs in virtually all areas of science and is an important consideration for engineered systems as well.

Framework Page 85
Causality
Cause and Effect
Structure and Function

Systems
Scale
Change and Stability
Matter and Energy

Patterns
## Crosscutting Concepts – Activity 3

<table>
<thead>
<tr>
<th>TASK: Exploring Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION: Compare the cockle burr to the sand burr seed pods and develop a possible explanation for the differences you observed. Use the appropriate Crosscutting Concepts to help you make sense of the similarities and differences.</td>
</tr>
<tr>
<td>ORGANIZATION: Use the Crosscutting Concepts and your knowledge of seeds to investigate these seeds.</td>
</tr>
<tr>
<td>EXPLANATION: Provide an explanation for the structures of the two seeds.</td>
</tr>
<tr>
<td>TOOLS: Magnifying glass, nails</td>
</tr>
<tr>
<td>QUESTIONS: What was the role of Crosscutting Concepts in the sense making for the seed activity? What is the role of Crosscutting Concepts in generalizing findings from investigations?</td>
</tr>
</tbody>
</table>
• The cockle burrs are growing on the perimeter of the alfalfa fields, outside the fences near the road, under trees in thick wooded areas.
• The sand burrs are growing everywhere except where the alfalfa is cut.
Cause and Effect or Structure and Function

Structure and Function – The barbs on a sand burr seed (structure) determine the way it is transported by animals (function).

Cause and Effect – The barbs on a sand burr seed (cause) allow them to be transported by animals with fur or socks (effect). The structure of the dandelion seed is altogether different and is transported in very different ways.
Using Other Crosscutting Concepts

• The **structure** of the seeds determine how well they survive digestion.

• The **function** of the pod is to protect the seeds from digestion.

• The **patterns** in the area where they grow and the animals in those areas provide evidence to the dispersal mechanism.

• The differences in **growth pattern (effect)** must have a **cause**.
Connecting the Practices and Crosscutting Concepts

• Providing empirical evidence to support assertions and listening to others’ arguments and analyzing the evidence they provides comes to use from the practices.

• The Crosscutting Concepts help generate evidence to support arguments.

Making Thinking Visible is important for all 3 dimension of science
Making Sense

Science is about making sense of things.

• Crosscutting Concepts such as Structure and Function provide the tools for students to make sense of things and construct understanding.

• Patterns can be used to support explanations and develop questions and support explanations.
We hope the day has been useful and interesting.

This evening, we would like you to carefully observe a phenomena in your universe and think about how the Practices and Crosscutting Concepts can be useful in explaining it.

We will start the day with a discussion of your phenomena.
Vision for Science Education
A Framework for K-12 Science Education:
Practices, Crosscutting Concepts, and Core Ideas

Professional Development
Framework 2 Day Workshop
Understanding the Vision of the Framework for Science Education

Science Education for a New Generation
Produced by the Council of State Science Supervisors www.csss-science.org
Good Morning!

Well what phenomena did you observe and what is your explanation of the phenomena?

Were you able to utilize the practices or concepts to develop explanations for the phenomena you observed?
Making Thinking Visible

– Activity 4) Making Thinking Visible (RSS PLC)
Making Thinking Visible

Making thinking visible through writing and classroom discourse is an important way to provide models for student expectations of engaging in science and engineering practices. The Practices make the science classroom more science like.

It is essential that the questions posed by the teachers engage students and provide opportunities to inform instruction.
PLC Talk and Argument - Activity 4

• Let’s look at a PLC on Talk and Argument
• Groups of 4 to 6
• Read Chapter 5 pages 87 to 94
• Respond to questions
• Discussion
• Move to next section of PLC
• Discussion
• Reflection
Making Thinking Visible

• What does it mean to make thinking visible?
  – Writing
  – Classroom discourse
  – Modeling understanding
  – Student discussion
  – Assessing to Inform instruction
  – Role of evidence in thinking
  – Etc.
Break

The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them.

Sir William Lawrence Bragg
Disciplinary Core Ideas

– What are the Core Concepts?
– Activity 5) Mapping the Concepts (Chart Papers and Framework or Laptops)
A Few Core Ideas

Matter
- Matter is made of particles
- Matter is conserved
- Matter cycles

Energy
- Energy flows from high to low
- Energy is conserved
- Energy is involved in changing matter

Forces
- Electromagnetic
- Gravity
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
Activity 5 Mapping the Core Ideas

• In this activity, each group takes one disciplinary grade-band endpoint and develops a map of the relationships within the content.

• This might be the grouping and organizing of DCIs into pieces that work together in an instructional unit.

• Place the thinking on chart paper and share at the end of the session.
Lunch

It is reported that Copernicus' parents said the following to him at the age of twelve: "Copernicus, young man, when are you going to come to terms with the fact that the world does not revolve around you."
MS.PS-E Energy

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]

Science and Engineering Practices

Analyzing and Interpreting Data
- Use standard techniques for displaying, analyzing, and interpreting data including appropriate statistical techniques.

Disciplinary Core Ideas

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.

Crosscutting Concepts

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.

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-EE, 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.
### 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.**

**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.
- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system.

**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.
- 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.

**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.

### 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.
- Animals obtain food from eating plants or eating other animals.
- 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.
- 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.

**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.
- 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.

**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.

### 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.
- Models are limited in that they only represent certain aspects of the system under study.

**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.
- The transfer of energy can be tracked as energy flows through a designed or natural system.

**Stability and Change**
- Small changes in one part of a system might cause large changes in another part.
Three Dimensions to Standards – Activity 6

• In this activity, each group takes one grade-band endpoint, practice, and crosscutting concept and develops a student performance expectation.

  1. Select the grade-band endpoint for your group.
  2. Discuss the CCC and Practices that most naturally connect to this DCI.
  3. Write a few performance expectations.
Science Standards

Activity 6: Writing a Standard

In pairs:

1. Select a grade-level
2. Identify a Disciplinary Core Idea in that grade-band
3. Use one Practice and one Crosscutting Concept to develop a standard that describes a student performance expectation.
4. The statement must be one sentence long!
5. Contain all three dimensions.
6. Be of an appropriate grain size.

Now exchange the standard with another pair and discuss:

a. What will instruction look like to support the standard?

b. What is an assessment item that will provide evidence the student has met the standard?

Scientific inquiry is one form of scientific practice.

So, the perspective presented in the Framework is not one of replacing inquiry; rather, it is one of expanding and enriching the teaching and learning of science.
Framework           Standards

Core Ideas

Cross-cutting Concepts

Practices

Framework → Standards
Where can we find the Framework?

• Framework
• Summary

• http://www.nap.edu/catalog.php?record_id=13165
Example of Intersection

Cause and Effect intersection with Forces/Matter

• **Activity**
  – Place sand in bottom of a cup of water, freeze the cup. Rub the sand ice and just ice on sedimentary rock. Observe the weathering.
  – Compare this to the same process with other types of rocks

• **Science Practices** – Observe, compare, and make inferences

• **Crosscutting – Cause and Effect**
  Movement of glaciers causes rocks of various types to weather at different rates.

• **Core Idea – Matter is made of particles**
  Particles of matter in the sand and ice weather the particles of matter in the rocks. Forces act to change matter.
The whole history of science has been the gradual realization that events do not happen in an arbitrary manner, but that they reflect a certain underlying order, which may or may not be divinely inspired.

Stephen W. Hawking (A Brief History of Time)
What is the Vision?

– Putting it All Together
– Discussion of Your Vision for the Classroom
Goals for Science Education

The Framework’s vision takes into account two major goals for K-12 science education:

(1) Educating all students in science and engineering.
(2) Providing the foundational knowledge for those who will become the scientists, engineers, technologists, and technicians of the future.

The framework principally concerns itself with the first task—what all students should know in preparation for their individual lives and for their roles as citizens in this technology-rich and scientifically complex world.
Distinguishing meaningful science instruction from meaningless activities requires knowledge of the intent of science education. The vision for science instruction should be clear to all in the education system. Only they know the difference.
Using Evidence

• Value and use science as a process of obtaining knowledge based on observable evidence.

• Supporting science argumentation with evidence is a key practice of science.

• Using models and core ideas to make sense of novel phenomena is an essential aspect of science.

• Developing science explanations based on evidence.
Closure and Final Questions

- What is your vision for science education?
- Reflect back on your experiences in science teaching and learning as well as the Framework and write a short response in your science journal.
• What insights about the Framework and vision for science education have you had over the past two days?