An Introduction to The Next Generation Science Standards

National Congress on Science Education
San Juan, Puerto Rico
July 17-20, 2013
Goals of the Workshop

Participants will understand:

• How NGSS was developed
• How the integration of the three dimensions described in the Framework come together in NGSS
• How performance expectations are directives about assessment, but not about instruction
• How the scientific and engineering practices are central to good instruction of NGSS
• How NGSS is related to STEM and the Common Core State Standards
**Key Points**

- This isn’t going to be easy
- It’s worth doing
- When doing PD on NGSS, start with the *Scientific and Engineering Practices*
- When reading NGSS, start with the *Disciplinary Core Ideas*
- There are still a lot of decisions to make
- It’s going to take time
Developing the Standards

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

Achieve

NEXT GENERATION SCIENCE STANDARDS
For States, By States

NSTA National Science Teachers Association

AAAS Advancing Science, Serving Society
About the National Academies

- Chartered by Congress
- Separate Academies dealing with Science, Engineering, and Medicine
- Honorary membership organization with over 6000 members
- Do not conduct independent research
- Serves as advisors producing independent recommendations and policy reports
- The National Research Council carries out most studies done by the Academies
About Achieve

Created in 1996 by the nation's governors and corporate leaders, Achieve is an independent, bipartisan, non-profit education reform organization that helps states raise academic standards and graduation requirements, improve assessments and strengthen accountability.

Achieve is involved in implementation of the Common Core State Standards (CCSS) effort and the Partnership for Assessment of Readiness for College and Careers (PARCC) Consortium.
About AAAS

• The **American Association for the Advancement of Science** was founded in Philadelphia in 1848 and it is the world's largest general science organization.

• Bridges gaps among scientists, policy-makers, and the public to advance science and science education.

• Authoritative source for information on the latest developments in science and publisher of the peer-reviewed journal *Science*

• In 1985, the AAAS launched Project 2061, a long-term effort to reform science, mathematics, and technology education for the 21st century.
The National Science Teachers Association (NSTA), founded in 1944, is the largest organization in the world committed to promoting excellence and innovation in science teaching and learning for all. NSTA's current membership of 60,000 includes science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in and committed to science education.

NSTA holds five conferences every year, publishes four journals, and organizes numerous competitions for teachers and students. In addition the NSTA Learning Center provides a wealth of online resources for educators.
Resources for the Framework

- *Science for All Americans, Benchmarks for Scientific Literacy and Atlas of Science Literacy*

- *National Science Education Standards*

- 2009 NAEP Science Framework  
  (National Assessment of Educational Progress)

- *College Board Standards for College in Science*

- *NSTA’s Science Anchors project*
National Research Council Reports

• How People Learn

• Taking Science to School

• Ready, Set, Science
A Framework for K-12 Science Education

Three-Dimensions:

• Scientific and Engineering Practices

• Crosscutting Concepts

• Disciplinary Core Ideas
Handout about the Three Dimensions

### Three Dimensions of the Framework for K-12 Science Education Being Used to Develop the Next Generation Science Standards (NGSS)

#### Scientific and Engineering Practices

- **Asking Questions and Defining Problems**: A practice of science is to ask and refine questions that lead to descriptions and explorations of how the natural and designed worlds work and can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers ask questions to clarify the ideas of others.

- **Planning and Carrying Out Investigations**: Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

- **Engineering Investigations**: Engineering investigations identify the effectiveness, efficiency, and durability of design under different conditions.

- **Analyzing and Interpreting Data**: Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of skills—such as tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

- **Developing and Using Models**: Developing and using models is a practice of both science and engineering to visualize and construct models as useful tools for representing ideas and explanations. These tools include diagrams, drawings, physical models, mathematical representations, analogies, and computer simulations.

- **Constructing Explanations and Designing Solutions**: The products of science are explanations and the products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multitudes of empirical evidence and greater explanatory power than previous models. The goal of engineering designs is to find systematic solutions to problems that are based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired features, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

- **Engaging in Argument from Evidence**: Argumentation is the process by which explanations and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential for developing the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, reading questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims, methods, and designs.

#### Using Mathematics and Computational Thinking

- **Mathematical and Computational Approaches**: Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish causal relationships.

- **Obtaining, Evaluating, and Communicating Information**: Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a professional activity. Communicating information and ideas can be done in multiple ways—writing, tables, graphs, diagrams, models, and equations as well as verbally, in writing, and through extended discussions. Scientists and engineers employ multiple means to acquire information and communicate their findings in a way that evaluates the merit and validity of claims, methods, and designs.

### Core Ideas in Life Science, Earth and Space Science, and Engineering, Technology, and the Application of Science

#### Core Concepts in Life Science

- **Ecological Systems**: Patterns in interactions among species and their environment. Understanding cause and effect in these relationships helps identify the factors that influence populations, communities, and ecosystems.

- **Ecological Interactions**: Patterns in interactions among species and their environment. Understanding cause and effect in these relationships helps identify the factors that influence populations, communities, and ecosystems.

#### Core Concepts in Earth and Space Science

- **Systems and Systems Models**: Defining the system under study through different perspectives. Understanding cause and effect in these relationships helps identify the factors that influence populations, communities, and ecosystems.

- **Core Concepts in Engineering, Technology, and the Application of Science

- **Engineering Design**: Understanding cause and effect in these relationships helps identify the factors that influence populations, communities, and ecosystems.

- **Core Concepts in the Application of Science

- **Science as Inquiry**: Patterns in interactions among species and their environment. Understanding cause and effect in these relationships helps identify the factors that influence populations, communities, and ecosystems.
Scientific and Engineering Practices

1. Asking questions (for science) and defining problems (for 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 (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
Crosscutting Concepts

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

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<td>LS2: Ecosystems: Interactions, Energy, and Dynamics</td>
<td>PS2: Motion and Stability: Forces and Interactions</td>
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<td>LS3: Heredity: Inheritance and Variation of Traits</td>
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<tr>
<th>Earth &amp; Space Science</th>
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<tr>
<td>ESS1: Earth’s Place in the Universe</td>
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<td>ETS2: Links Among Engineering, Technology, Science, and Society</td>
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### Core and Component Ideas

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<td><strong>ESS3: Earth and Human Activity</strong></td>
<td>PS3.B: Conservation of Energy and Energy Transfer</td>
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<td><strong>LS4: Biological Evolution: Unity and Diversity</strong></td>
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<td><strong>PS4: Waves and Their Applications in Technologies for Information Transfer</strong></td>
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<td>LS4.D: Biodiversity and Humans</td>
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</table>

**Note:** In NGSS, the core ideas for Engineering, Technology, and the Application of Science are integrated with the Life Science, Earth & Space Science, and Physical Science core ideas.
Developing the Standards

July 2011
Developing the Standards
NGSS Lead State Partners
NGSS Writers
State Activity (according to NASBE)

Next Generation Science Standards Activity Map*  
* as of 6/26/13

- **Activity Unknown**
- **Have initiated some exploration or review process**
- ** Adopted NGSS**
- **Decided not to adopt**
Conceptual Shifts in NGSS

1. K-12 Science Education Should Reflect the Interconnected Nature of Science as it is Practiced and Experienced in the Real World.

2. The Next Generation Science Standards are student performance expectations – NOT curriculum.

3. The science concepts in the NGSS build coherently from K-12.

4. The NGSS Focus on Deeper Understanding of Content as well as Application of Content.

5. Science and Engineering are Integrated in the NGSS from K–12.

6. The NGSS are designed to prepare students for college, career, and citizenship.

7. The NGSS and Common Core State Standards (Mathematics and English Language Arts) are Aligned.
# Appendices

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Inside
the Box
Inside the NGSS Box

### 3-PS2: Motion and Stability: Forces and Interactions

 Students who demonstrate understanding can:

- **3-PS2-a.** Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced forces that do not change motion and unbalanced forces that change motion. *(Clarification Statement: An example is pushing one side of a box with a force greater than the frictional force; equal, opposite forces act on the box, and the box accelerates.)

- **3-PS2-b.** Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. *(Clarification Statement: An example is a child sliding on a smooth, level surface. For this activity, the child should be observed over time to determine if consistent friction is observed.)

- **3-PS2-c.** Investigate the effect of electric and magnetic forces between objects in contact with each other and use the observations to describe their relationships. *(Clarification Statement: An example is the use of an electrically charged balloon to demonstrate the attraction between objects. The electric force is the force that causes the attraction.)

- **3-PS2-d.** Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them. *(Clarification Statement: Examples problems include a person trying to find a key on a table, or creating a device to keep a plastic object from sliding on a surface.)

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#### Science and Engineering Practices

**Asking Questions and Defining Problems**
- **Identify questions that can be investigated and provide simple, plausible solutions that can be used to test questions or problems such as unbalanced forces.**

**Planning and Carrying Out Investigations**
- **Design and conduct investigations collaboratively, using a variety of models to represent situations involving the number of trained individuals.**

**Analyzing and Interpreting Data**
- **Interpret data on the properties of materials, including the magnetic properties of various materials.**

**Constructing Explanations and Designing Solutions**
- **Design and build a model that demonstrates the relationships between objects and their forces.**

**Developing and Using Models**
- **Develop and use models to solve problems, including the properties of magnets and the forces between them.**

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#### Disciplinary Core Ideas

**PS2.A: Forces and Motions**
- **Each force acts on the body in which it acts (through the direction and the action of the object). Forces and objects are not independent of each other.**

**PS2.D: Energy**
- **The properties of objects depend on how they are connected to other objects.**

**PS2.E: Motion and Stability: Forces and Interactions**
- **An object can change in one or more directions (e.g., a ball rolling down a hill, sliding and rolling, a spinning top, or a thread).**

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#### Crosscutting Concepts

**Causation and Effect**
- **Causation and effect relationships are identified, tested, and used to explain changes (3-PS2-a, 3-PS2-b).**

**Stability and Change**
- **Change in motion depends on the forces acting on the object and can be observed at different rates. (3-PS2-a)**

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#### Connections to Engineering, Technology, and Applications of Science

**Engineering and Development**
- **Technology and engineering (e.g., tools, balances, thermometers, graduated cylinders, microscopes) are used in scientific exploration to gather data and help answer questions about the physical world.**

**Interdependence of Systems, Engineering, and Technology**
- **Models are used to describe, design, develop, and improve technologies.**

**Connections to Nature of Science**
- **Scientific knowledge assumes order and consistency in natural systems.**

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**Based on the January 2013 Draft of NGSS**
Inside the NGSS Box

What is Assessed
A collection of several performance expectations describing what students should be able to do to master this standard.

Foundation Box
The practices, core disciplinary ideas, and crosscutting concepts from the Framework for K-12 Science Education that were used to form the performance expectations.

Connection Box
Other standards in the Next Generation Science Standards or in the Common Core State Standards that are related to this standard.

Title and Code
The titles of standard pages are not necessarily unique and may be reused at several different grade levels. The code, however, is a unique identifier for each set based on the grade level, content area, and topic it addresses.

Performance Expectations
A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned.

Clarification Statement
A statement that supplies examples or additional clarification to the performance expectation.

Assessment Boundary
A statement that provides guidance about the scope of the performance expectation at a particular grade level.

Engineering Connection (*)
An asterisk indicates an engineering connection in the practice, core idea or crosscutting concept that supports the performance expectation.

Scientific & Engineering Practices
Activities that scientists and engineers engage in to either understand the world or solve a problem.

Disciplinary Core Ideas
Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people’s lives.

Crosscutting Concepts
Ideas, such as Patterns and Cause and Effect, which are not specific to any one discipline but cut across them all.

Connections to Engineering, Technology and Applications of Science
These connections are drawn from the disciplinary core ideas for engineering, technology, and applications of science in the Framework.

Connections to Nature of Science
Connections are listed in either the practices or the crosscutting connections section of the foundation box.

Codes for Performance Expectations
Codes designate the relevant performance expectation for an item in the foundation box and connection box. In the connections to common core, italics indicate a potential connection rather than a required prerequisite connection.

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Based on the January 2013 Draft of NGSS
Inside the NGSS Box

What is Assessed
A collection of several performance expectations describing what students should be able to do to master this standard

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Inside the NGSS Box

The practices, core disciplinary ideas, and crosscutting concepts from the Framework for K-12 Science Education that were used to form the performance expectations.

### Foundation Box

**Disciplinary Core Ideas**

- **Forces and Motions**
  - Each force acts on the part of the object that it interacts with and directs the object.
  - For example, forces can be directed on the object, and they add up to the net force on the object.
  - Forces that do not act in pairs cannot cause changes in the object's position or motion if the net force is zero.
  - **(3-PS1-2)**: Forces and Motion

- **Patterns**
  - Patterns are visible in different processes and can be observed in nature or systems.
  - For example, patterns can be observed in the movement of objects or the behavior of systems.

- **Cause and Effect**
  - Identifying cause and effect relationships can help explain phenomena and predict outcomes.
  - For example, cause and effect relationships can be observed in the movement of objects or the behavior of systems.

### Crosscutting Concepts

- **Patterns**
  - Patterns are visible in different processes and can be observed in nature or systems.

- **Causality**
  - Causality is the relationship between two events or processes, where one event or process causes the other event or process.

- **Systems**
  - Systems are composed of components that interact with each other to achieve a common goal.

### Scientific & Engineering Practices

- **Planning and Carrying Out Investigations**
  - Planning and carrying out investigations to answer questions or solve problems.
  - For example, planning and carrying out investigations to understand the behavior of objects or systems.

### Connections to Nature of Science

- **Scientific Knowledge Acquires an Order Consistent with Natural Systems**
  - Scientific knowledge is ordered in a way that is consistent with natural systems.

- **Scientific Knowledge has a Consistent Framework**
  - Scientific knowledge is structured in a way that is consistent with frameworks.

- **Scientific Knowledge is a Process of Interdisciplinary Connections**
  - Scientific knowledge is interconnected with other disciplines and processes.

Based on the January 2013 Draft of NGSS
Inside the NGSS Box

**Foundation Box**
The practices, core disciplinary ideas, and crosscutting concepts from the Framework for K-12 Science Education that were used to form the performance expectations.

**Disciplinary Core Ideas**
Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people’s lives.

**Crosscutting Concepts**
Ideas, such as Patterns and Cause and Effect, which are not specific to any one discipline but cut across them all.

**Scientific & Engineering Practices**
Activities that scientists and engineers engage in to either understand the world or solve a problem.

**Based on the January 2013 Draft of NGSS**
Inside the NGSS Box

The practices, core disciplinary ideas, and crosscutting concepts from the Framework for K-12 Science Education that were used to form the performance expectations based on the January 2013 Draft of NGSS.
Inside the NGSS Box

3-PS2 Motion and Stability, Forces, and Interactions

Students who demonstrate understanding can:

- 3-PS2-a. Carry out investigations of the motion of objects to predict the effect of forces on an object in terms of balanced and unbalanced forces that change motion. (Clarification Statement: An example is pushing one side of a box to make it start sliding and pushing on a box from both sides, with equal forces, will not produce motion and is not at all the same as the given scenario.) (Measurement Boundary: Limit to one variable at a time, namely, net force or directions of forces. The size and direction of forces should be qualitative.) (Grades only: to be addressed as a force that pulls objects downward.)

- 3-PS2-b. Investigate the motion of objects to determine when a consistent pattern can be observed and used to predict future motions in the system. (Clarification Statement: An example of motion with a probability of success—such as a child swinging in a swing. In this example, the child could change the swinging motion at different minor rates depending on where in the arc of the swing.)

- 3-PS2-c. Investigate the effect of electric and magnetic forces on objects not in contact with each other and use the observations to describe their relationships. (Clarification Statement: An example of an electric field causes the force on an electrically charged balloon: an example of a magnetic force might be the force between magnets. Causes and effect relationships include how the distance between objects affects the strength of the force and how the orientation of magnets affects the direction of the magnetic force.) (Measurement Boundary: Limited to forces produced by objects that can be quantified by students.)

- 3-PS2-d. Apply scientific knowledge to design and refine solutions to a problem by using the properties of magnets and the forces between them. (Clarification Statement: Example problems include constructing a device to keep a door shut, or creating a device to keep two moving objects from bumping into each other. Students should understand that the resulting configuration about one contact forces opens the solution.)

**Codes for Performance Expectations**

Codes designate the relevant performance expectation for an item in the foundation box and connection box. In the connections to common core, italics indicate a potential connection rather than a required prerequisite connection.
Inside the NGSS Box

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Disciplinary Core Ideas
Concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people’s lives.

Crosscutting Concepts
Ideas, such as Patterns and Cause and Effect, which are not specific to any one discipline but cut across them all.

Connections to Engineering, Technology and Applications of Science
These connections are drawn from the disciplinary core ideas for engineering, technology, and applications of science in the Framework.

Connections to Nature of Science
Connections are listed in either the practices or the crosscutting connections section of the foundation box.

Based on the January 2013 Draft of NGSS
Closer Look at NGSS
## 2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

**2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

### Planning and Engineering Practices

- Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
  - Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)

### Disciplinary Core Ideas

- **PS1.A: Structure and Properties of Matter**
  - Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)

### Crosscutting Concepts

- **Patterns**
  - Patterns in the natural and human designed world can be observed. (2-PS1-1)

**Connections to other DCIs in second grade:** N/A

**Articulation of DCIs across grade-levels:** 5.PS1.A

**Connections to Common Core State Standards in ELA/Literacy:**

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)

- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1)

**Connections to Common Core State Standards in Mathematics:**

- **MP.4** Model with mathematics. (2-PS1-1)

- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1)
## Closer Look at a NGSS (Grade 2)

### 2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

2-PS1-1. **Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

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

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<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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<tbody>
<tr>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</td>
<td>• Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)</td>
<td>• Patterns in the natural and human designed world can be observed. (2-PS1-1)</td>
</tr>
</tbody>
</table>

**Note:** 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.

**Connections to other DCIs in second grade:** N/A

**Articulation of DCIs across grade-levels:** 5.PS1.A

**Connections to Common Core State Standards in ELA/Literacy:**

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)
- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1)

**Connections to Common Core State Standards in Mathematics:**

- **MP.4** Model with mathematics. (2-PS1-1)
- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1)
## 2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

### 2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

[Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

<table>
<thead>
<tr>
<th>Planning and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</td>
<td>PS1.A: Structure and Properties of Matter • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)</td>
<td>Patterns • Patterns in the natural and human designed world can be observed. (2-PS1-1)</td>
</tr>
</tbody>
</table>

**Connections to other DCIs in second grade:** N/A

**Articulation of DCIs across grade-levels:** 5.PS1.A

**Connections to Common Core State Standards in ELA/Literacy:**

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)

- **W.2.8** Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1)

**Connections to Common Core State Standards in Mathematics:**

- **MP.4** Model with mathematics. (2-PS1-1)

- **2.MD.D.10** Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1)

---

**Note:** 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.
**2.PS1 Matter and Its Interactions**

Students who demonstrate understanding can:

2-PS1-1. Plan and conduct an investigation to describe and **classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

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

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</td>
<td>• Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)</td>
<td>• Patterns in the natural and human designed world can be observed. (2-PS1-1)</td>
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</table>

**Note:** 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.

**Connections to other DCIs in second grade:** N/A

**Articulation of DCIs across grade-levels:** 5-PS1.A

**Connections to Common Core State Standards in ELA/Literacy:**

| W.2.7 | Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1) |
| W.2.8 | Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1) |

**Connections to Common Core State Standards in Mathematics:**

| MP.4 | Model with mathematics. (2-PS1-1) |
| 2.MD.D.10 | Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (2-PS1-1) |
### 2.PS1 Matter and Its Interactions

Students who demonstrate understanding can:

**2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]

<table>
<thead>
<tr>
<th>Planning and Carrying Out Investigations</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
</table>
| Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. | PS1.A: Structure and Properties of Matter  
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- Patterns in the natural and human designed world can be observed. (2-PS1-1) |

**Note:** 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.

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: 5.PS1.A

Connections to Common Core State Standards in ELA/Literacy:

- **W.2.7** Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1)
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Connections to Common Core State Standards in Mathematics:

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An Analogy
An Analogy between NGSS and a Cake

Baking a Cake
(Performance Expectation)

Cake
(Core Ideas)

Frosting
(Crosscutting Concepts)

Baking Tools & Techniques
(Practices)
An Analogy between NGSS and Cooking

Preparation of a Meal
(Performance Expectation)

Kitchen Tools & Techniques
(Practices)

Basic Ingredients
(Core Ideas)

Herbs, Spices, & Seasonings
(Crosscutting Concepts)
An Analogy between NGSS and Cooking

Life Science (Vegetables)

Physical Science (Meats)

Earth & Space Science (Grains)

Engineering & Technology (Dairy)
Writing a Performance Expectation
Directions:

1. Select a core idea from the *Sample Disciplinary Core Ideas* handout
2. Review the *Three Dimensions of NGSS* handout and select a practice and a crosscutting concept that go well with the disciplinary core idea
3. Write an example of a performance expectation

When finished, discuss the following questions:

- How did you go about selecting a practice and crosscutting concept?
- What challenges did you encounter?
- What are the advantages of incorporating all of the dimensions into a performance expectation?
<table>
<thead>
<tr>
<th>Life Science</th>
<th>Earth and Space Science</th>
<th>Physics</th>
<th>Chemistry</th>
<th>Engineering Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.</td>
<td>Seasonal patterns of sunrise and sunset can be observed, described, and predicted.</td>
<td>Pushes and pulls can have different strengths and directions.</td>
<td>Before beginning to design a solution, it is important to clearly understand the problem.</td>
</tr>
<tr>
<td></td>
<td>Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.</td>
<td>Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.</td>
<td>Objects in contact exert forces on each other.</td>
<td>When two or more different substances are mixed, a new substance with different properties may be formed.</td>
</tr>
<tr>
<td></td>
<td>In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.</td>
<td>All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.</td>
<td>The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ETS1.C: Optimizing the Design Solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.</td>
</tr>
</tbody>
</table>
## Sample Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>Life Science</th>
<th>Earth and Space Science</th>
<th>Physics</th>
<th>Chemistry</th>
<th>Engineering Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K-2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Earth and the Solar</td>
<td>Forces and Motion</td>
<td>Structure and Properties</td>
<td>Defining and Delimiting Engineering</td>
</tr>
<tr>
<td>and Energy</td>
<td>System</td>
<td>Pushes and pulls can have different strengths and directions.</td>
<td>of Matter</td>
<td>Problems</td>
</tr>
<tr>
<td>Flow in</td>
<td>Seasonal patterns of</td>
<td></td>
<td>Different kinds of matter exist and many of them can be either</td>
<td>Before beginning to design a solution, it is important to</td>
</tr>
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<td>Organisms</td>
<td>sunrise and sunset can be observed, described, and predicted.</td>
<td></td>
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<td>clearly understand the problem.</td>
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<td>All animals</td>
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<td></td>
<td>described and classified by its observable properties.</td>
<td></td>
</tr>
<tr>
<td>need food in</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>order to</td>
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<tr>
<td>live and</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grow. They</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>obtain their</td>
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<tr>
<td>food from</td>
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</tr>
<tr>
<td>plants or</td>
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<td></td>
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<tr>
<td>from other</td>
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<td>animals.</td>
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<tr>
<td>grow.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **3-5**      |                         |         |           |                   |
| Structure    | Earth Materials and     | Types of | Chemical Reactions | Optimizing the Design |
| and Function | Systems                  | Interactions | When two or more different | Solution |
| Plants and    | Rainfall helps to shape the land and affects the types of living | Objects in contact exert | substances are mixed, a new | Different solutions need to be |
| animals have | things found in a region. Water, ice, wind, living | forces on each other. | substance with different | tested in order to determine |
| both internal | organisms, and gravity break |         | properties may be formed. | which of them best solves the |
| and external | rocks, soils, and sediments into smaller particles and move |         |         | problem, given the criteria |
| structures    | them around.            |         |         | and the constraints. |
| that serve     |                         |         |           |                   |
| various       |                         |         |           |                   |
| functions in  |                         |         |           |                   |
| growth,       |                         |         |           |                   |
| survival,     |                         |         |           |                   |
| behavior,     |                         |         |           |                   |
| and          |                         |         |           |                   |
| reproduction. |                         |         |           |                   |

| **6-8**      |                         |         |           |                   |
| Interdependent | The Universe and Its   | Definitions of | Chemical Reactions | Developing Possible |
| Relationships | Stars                   | Energy     | Substances react chemically in | Solutions |
| in Ecosystems | Patterns of the apparent | Motion energy is properly | characteristic ways. In a chemical | A solution needs to be tested, |
|               | motion of the sun, the moon, | called kinetic energy; it is | process, the atoms that make up | and then modified on the basis |
|               | and stars in the sky can be | proportional to the mass of | the original substances are | of the test results, in order |
|               | be observed, described, predicted, | the moving object and grows with | regrouped into different | to improve it. |
|               | explained with models. | the square of its speed. | molecules, and these new |                   |
|               |                         |         |         |                   |

| **9-12**     |                         |         |           |                   |
| Natural      | Natural Resources      | Wave Properties | Structure and Properties | Optimizing the Design |
| Selection     | All forms of energy    | The wavelength and | of Matter | Solution |
|               | production and other  | frequency of a wave are | The periodic table orders | Criteria may need to be broken |
|               | resource extraction    | related to one another by | elements horizontally by the | down into simpler ones that |
|               | have associated        | the speed of travel of the | number of protons in the atom's | can be approached |
|               | economic, social,      | wave, which depends on | nucleus and places those with | systematically, and decisions |
|               | environmental, and     | the type of wave and the | similar chemical properties in | about the priority of certain |
|               | geopolitical costs and | medium through which it is | columns. The repeating patterns | criteria over others (trade-offs) |
|               | risks as well as       | passing.                | of this table reflect patterns | may be needed. |
|               | benefits. New         |                         | of outer electron states. |                   |
| technologies | technologies and social |         |         |                   |
| and social   | regulations can change |         |         |                   |
| regulations  | the balance of these   |         |         |                   |
|               | factors.              |         |         |                   |
Handout about the Three Dimensions
Exploring at the Practices
Exploring the Practices

Review the following information about one practice:

A. Section from Chapter 3 of the Framework
B. Matrix for the practices from Appendix F of the NGSS
C. Example performance expectations that use the practice

Use these discussion questions:

1. What are the key elements of this practice?
2. How will engaging in this practice support the learning of a disciplinary core idea?
3. To what extent do you currently provide opportunities for students to engage in this practice during instruction?

Prepare a poster and be prepared to make a 2 minute presentation about your practice to the whole group
Practice 1 Asking Questions and Defining Problems

Questions are the engine that drive science and engineering.

Science asks:
- What exists and what happens?
- Why does it happen?
- How does one know?

Engineering asks:
- What can be done to address a particular human need or want?
- How can the need be better specified?
- What tools and technologies are available, or could be developed, for addressing this need?

Both science and engineering ask:
- How does one communicate about phenomena, evidence, explanations, and design solutions?

Asking questions is essential to developing scientific habits of mind. Even for individuals who are not scientists or engineers, the ability to ask well-defined questions is an important component of critical thinking, helping to make them more informed consumers of scientific knowledge.

Scientific questions arise in a variety of ways. They can be driven by curiosity about the world (e.g., why is the sky blue?). They can be inspired by a model or a theory’s predictions or by attempting to falsify a model or theory (e.g., how does the particle model of matter explain the incompressibility of the hydrogen atom?). They can result from the need to provide better solutions to a problem. For example, the quest to improve the efficiency of water-flushing toilets led to the discovery of the “waterless” toilet by the inventor. They can also arise from the desire to explain phenomena that cannot be explained by existing models or theories (e.g., how do black holes work?).

Questions are also important in engineering. Engineers must be able to ask probing questions to identify an engineering problem. For example, they may ask: What is the need or desire that the product should satisfy? What are the constraints when generating possible solutions? Will this solution meet the design criteria? Can we combine the best aspects of two different solutions? What is the trade-off of combining solutions? Which ideas should be tested? What evidence is needed to show whether the given constraints are met?

The experience of learning science and engineering should therefore develop students’ ability to ask questions. Indeed, encouraging them to ask—and to use—well-formulated questions that can be investigated empirically can help students learn to recognize the distinction between questions that can be answered empirically and those that cannot, as well as the need to formulate these questions only in the context of knowledge or experience.

GOALS

By grade 12, students should be able to:
- Ask questions about the natural and human-built worlds—for example: Why do bees do? Why did that structure collapse? How is electric power generated?
- Distinguish a scientific question (e.g., “What is helium’s density?”) from a philosophical question (e.g., “Which of these colored balloons is the prettier?”).
- Formulate and refine questions that can be answered empirically in a science or engineering context to design an inquiry or construct a pragmatic solution.
- Ask probing questions that seek to identify the premises of an argument, reframe a research question or engineering problem, or challenge the interpretive frameworks. (e.g., How do you know? What evidence supports that argument?)
- Note features, patterns, or conflicting claims in observations and ask questions about the need or desire to be met in order to test the specifications for a solution.

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NGSS Science and Engineering Practices (March 2013 Draft)

Science and Engineering Practices:
- Asking questions and defining problems in K-2 builds on prior experiences and progresses to simple descriptive questions that can be tested.
- Asking questions based on observations to find more information about the natural world, and/or designed world(s).
- Asking questions about what would happen if a variable is changed.
- Asking questions about conditions required for an event to occur.
- Asking questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or test additional information.

K-2 Condensed Practices:
- Asking questions and defining problems in K-2 builds on K-1 experiences and progresses to identifying qualitative relationships between variables, clarify arguments and models.
- Asking questions and defining problems in K-2 builds on K-1 experiences and progresses to identifying qualitative relationships between variables, clarify arguments and models.
- Asking questions and defining problems in K-2 builds on K-1 experiences and progresses to identifying qualitative relationships between variables, clarify arguments and models.

3-5 Condensed Practices:
- Asking questions and defining problems in 3-5 builds on K-2 experiences and progresses to specifying causal relationships between variables, clarify arguments and models.
- Asking questions and defining problems in 3-5 builds on K-2 experiences and progresses to specifying causal relationships between variables, clarify arguments and models.

6-8 Condensed Practices:
- Asking questions and defining problems in 6-8 builds on K-2 experiences and progresses to specifying causal relationships between variables, clarify arguments and models.
- Asking questions and defining problems in 6-8 builds on K-2 experiences and progresses to specifying causal relationships between variables, clarify arguments and models.

9-12 Condensed Practices:
- Asking questions and defining problems in 9-12 builds on K-2 experiences and progresses to specifying causal relationships between variables, clarify arguments and models.
Exploring the Crosscutting Concepts
Exploring the Crosscutting Concepts

Review the following about one Crosscutting Concept:

A. Section from Chapter 4 of the Framework
B. Matrix for the practices from Appendix G of the NGSS
C. Example performance expectations that use this crosscutting concept

Use these discussion questions:

1. What are the key elements of this crosscutting concept?
2. What are some science concepts and contexts that would provide good opportunities for students to explore this crosscutting concept?
3. In what ways could you change your current methods of instruction to include more opportunities for students to improve their understanding of this crosscutting concept?

Prepare a poster and be prepared to make a 2 minute presentation about your practice to the whole group
Handouts

Crosscutting Concept 1: Patterns

Patterns exist everywhere—in regularly occurring shapes or structures and in repeating events and relationships. For example, patterns are discernible in the symmetry of flowers and snowflakes, the cycling of the seasons, and in the repeated base pairs of DNA. Noticing patterns is often the first step to organizing and asking scientific questions about why and how the patterns occur.

One major use of pattern recognition is in classification, which depends on careful observation of similarities and differences; objects can be classified into groups on the basis of similarities of visible or microscopic features or on the basis of similarities of function. Such classifications are useful in predicting relationships and organizing a multitude of objects or processes into a limited number of groups. Patterns of similarity and difference and the resulting classifications may change, depending on the scale at which a phenomenon is being observed.

For example, insects of a given element are different—they contain different neurotransmitters—but from the perspective of chemistry, they can be classified as equal if they have identical patterns of chemical interaction. Once patterns and variations are noted, they lead to questions, scientific seek explanations for observed patterns, and diversity within them. BIOLOGY often looks for and analyzes patterns in nature, they may diagnose patterns of failure of a designed system under stress or the failure to identify patterns of success. The ways in which data are represented can facilitate pattern recognition and the development of a mathematical representation, which can then be used as a potential explanation for what causes the pattern to occur. For example, bird populations in an area of a particular species are seen to increase based on the availability of food resources. If the same pattern were observed in other areas, they could be used to identify potential threats to the species.

Progression

Human beings are good at recognizing patterns. Indeed, young children begin to recognize patterns in their everyday lives even before they start school. They observe, for example, that certain patterns follow certain patterns of appearance in their environment. Once these patterns are observed and recorded, they can be used to predict future patterns. For instance, if a child observes that every time it rains, the sky becomes dark and the clouds move in a certain direction, they can use this pattern to predict future rain. Similarly, they can observe the patterns between different types of observations and make predictions about future events.

Students can be encouraged to recognize patterns in their everyday lives and to use these patterns to make predictions. For example, if a child observes that every time it rains, the sky becomes dark and the clouds move in a certain direction, they can use this pattern to predict future rain. Similarly, they can observe the patterns between different types of observations and make predictions about future events. The use of patterns in everyday life is also important in developing mathematical representations, which can then be used as a potential explanation for what causes the pattern to occur.

Matrix of Crosscutting Concepts in NGSS

<table>
<thead>
<tr>
<th>Cause and Effect: Mechanism and Prediction</th>
<th>K-2</th>
<th>3-5</th>
<th>6-8</th>
<th>9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patterns are observed in natural systems and can be used to identify causal relationships and effects.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Similarities and differences can be identified and used to classify phenomena, such as species or types of animals.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Patterns of change can be used to predict future outcomes.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Patterns can be used to identify causal relationships and effects.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Patterns can be used to predict phenomena in natural systems.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Patterns can be used to identify causal relationships and effects.</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Scale, Proportion, and Quantity

Identifying phenomena, it is critical to recognize what is relevant at different scales, time, and energy scales, and to recognize proportional relationships between different quantities or scales. Change.

| Relative sizes allow objects and events to be compared and described as large, small, or moderate in size. | Yes | Yes | Yes | Yes |
| Standard units are used to measure length. | Yes | Yes | Yes | Yes |
| Natural objects and materials are observed through the microscope to understand their properties and functions. | Yes | Yes | Yes | Yes |
| Time, space, and energy phenomena can be observed at different scales using models to study systems that are too large or too small. | Yes | Yes | Yes | Yes |
| The observed behavior of natural and designed systems may change with scale. | Yes | Yes | Yes | Yes |
| Proportional relationships (e.g., speed) observed as the scale of distance traveled increases or decreases. | Yes | Yes | Yes | Yes |
| Scientific methods can be represented in many ways and thought of as a set of rules to understand how a model of one scale relates to other scales. | Yes | Yes | Yes | Yes |

Connections to Common Core and STEM
Choose a topic and join a group focusing on that Topic:

1. Mathematics
2. English Language Arts (ELA)
3. Engineering

Review the Sample Standards Page for your Topic

Use these discussion questions:

1. What connections are there between science and your topic (Math, ELA, or Engineering)?
2. How do the standards show connections between science and your topic?
3. How could you make those connections explicit to students during instruction?
Sample Performance Expectations

MS-PS1-1 Matter and its Interactions
Develop models to describe the atomic composition of simple matter (Clarification Statement: Emphasis is on developing models of molecules that vary in numbers and arrangements. Examples of extended structures could include sodium chloride, SiO2 ball and stick structures, or computer representations shown in Assessment Boundary. Assessment does not include valence electrons and bonds or the complete description of all individual atoms in a complex molecule.) Science and Engineering Practices

Science and Engineering Practices

Crosscutting Core

PEA: Structure and Properties

PSL.A: Structure and Properties

Modeling in 6–8 builds on 5–6 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to predict and/or describe phenomena.

Connections to other DCIs in this grade-band:

RI.5.2.C: RI.5.7.C: RI.5.3

RST.6–8.1 Cite specific textual evidence to support analysis of science and technology (STS) or engineering (E) text. Make specific claims in text, support them with relevant and sufficient to support the claims. (MS-LS2-4)

WHST.6–8.1: Write arguments to support claims with clear reasons and relevant evidence.

WHST.6–8.9: Draw evidence from literary or informational texts to support analysis of text.
Practices in Science, Mathematics, and English Language Arts (ELA)
Venn Diagram Activity

- Have participants review the list of practices in Science, Mathematics, and English Language Arts.
- Give them a blank Venn diagram and ask them to fill it out.
- If you wish, you can have them compare it to the one prepared by the English Language Learners group at Stanford University. Note that there is no one right answer. The goal is to stimulate discussion.
## Practices in Math, Science, and ELA*

<table>
<thead>
<tr>
<th>Math</th>
<th>Science</th>
<th>English Language Arts</th>
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<tbody>
<tr>
<td><strong>M1.</strong> Make sense of problems and persevere in solving them.</td>
<td><strong>S1.</strong> Asking questions (for science) and defining problems (for engineering).</td>
<td><strong>E1.</strong> They demonstrate independence.</td>
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<td><strong>M2.</strong> Reason abstractly and quantitatively.</td>
<td><strong>S2.</strong> Developing and using models.</td>
<td><strong>E2.</strong> They build strong content knowledge.</td>
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<td><strong>M3.</strong> Construct viable arguments and critique the reasoning of others.</td>
<td><strong>S3.</strong> Planning and carrying out investigations.</td>
<td><strong>E3.</strong> They respond to the varying demands of audience, task, purpose, and discipline.</td>
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<td><strong>M4.</strong> Model with mathematics.</td>
<td><strong>S4.</strong> Analyzing and interpreting data.</td>
<td><strong>E4.</strong> They comprehend as well as critique.</td>
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<td><strong>M5.</strong> Use appropriate tools strategically.</td>
<td><strong>S5.</strong> Using mathematics, information and computer technology, and computational thinking.</td>
<td><strong>E5.</strong> They value evidence.</td>
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<td><strong>M6.</strong> Attend to precision.</td>
<td><strong>S6.</strong> Constructing explanations (for science) and designing solutions (for engineering).</td>
<td><strong>E6.</strong> They use technology and digital media strategically and capably.</td>
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<td><strong>M7.</strong> Look for and make use of structure.</td>
<td><strong>S7.</strong> Engaging in argument from evidence.</td>
<td><strong>E7.</strong> They come to understanding other perspectives and cultures.</td>
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<td><strong>M8.</strong> Look for and express regularity in repeated reasoning.</td>
<td><strong>S8.</strong> Obtaining, evaluating, and communicating information.</td>
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* The Common Core English Language Arts uses the term “student capacities” rather than the term “practices” used in Common Core Mathematics and the Next Generation Science Standards.
Commonalities Among the Practices in Science, Mathematics, and English Language Arts

Based on work by Tina Chuek,  ell.stanford.edu
Reflections
Goals of the Workshop

Participants will understand:

• How NGSS was developed
• How the integration of the three dimensions described in the Framework come together in NGSS
• How performance expectations are directives about assessment, but not about instruction
• How the scientific and engineering practices are central to good instruction of NGSS
• How NGSS is related to STEM and the Common Core State Standards
Key Points

• This isn’t going to be easy
• It’s worth doing
• When doing PD on NGSS, start with the *Scientific and Engineering Practices*
• When reading NGSS, start with the *Disciplinary Core Ideas*
• There are still a lot of decisions to make
• It’s going to take time
Reflecting on the Process

Reporting Out:

What was a major “Head scratcher”? OR

What was a major “Ah Ha!” moment?
Looking at the Activities

Reporting Out:

How useful was these activities?

Could you use them with the educators you work with?
Standards are Only the Start
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On the Web

nextgenscience.org

nsta.org/ngss
NSTA Resources on NGSS

www.nsta.org/ngss
NSTA Resources on NGSS

**Web Seminars**
- Practices (Archive from Fall 2012)
- Crosscutting Concepts (Archive from Spring 2013)
- Disciplinary Core Ideas (Coming in the 2013-2014 School Year)

**Journal Articles**
- Science and Children
- Science Scope
- The Science Teacher
From the NSTA Bookstore

Available Now

Available this summer
Preorder Now

Available Now

Available Now
Connect & Collaborate with Colleagues

NSTA Member-only Listserv on NGSS

Discussion forum on NGSS in the Learning center
Future Conferences

Portland, OR
October 24–26

Charlotte, NC
November 7–9

Denver, CO
December 12–14

National Conference
Boston – April 3-6, 2014
END
Comparison between NGSS and Traditional Standards
Inquiry Standards

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

Content Standards

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

Current State Middle School Science Standard

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NGSS Middle School Sample

a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.
b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
c. Use a simulation or mechanical model to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.
d. Construct an argument that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.
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