Getting to Know the NGSS

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Introductions to NGSS
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What we will do today

• Explain what is different about NGSS
  • Stress major highlights of Framework for K – 12 Science Education
  • Examine how the Framework has influenced the Next Generation of Science Standards
• Explore various aspects of NGSS
• Discuss how to use NGSS for instruction
Next Generation of Science Standards
All Students

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

See Appendix D – Diversity and Equity
The NRC Framework and NGSS

**What is new?**

1. Organized around core explanatory ideas
2. Central role of scientific practices
3. Use of crosscutting concepts
4. Standards expressed as performance expectations
5. Coherence: building and applying ideas across time
NGSS is Different

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

Fewer, clearer, higher

• Standards and curriculum materials focused on a *limited number* of *core ideas*.

• Ideas develop across time

• Provide a framework for thinking about ideas and adding new ideas

• Allows learners to develop understanding that can be used to solve problems and explain phenomena

Examine the Framework

http://goo.gl/7wiM9
A core idea in K-12 science...

- **Disciplinary significance**
  - Has **broad importance** across multiple science or engineering disciplines, a **key organizing concept** of a single discipline

- **Explanatory Power**
  - Can be used to explain a host of phenomena

- **Generative**
  - Provides a **key tool** for understanding or investigating more complex ideas and solving problems

- **Relevant to peoples’ lives:**
  - Relates to the **interests and life experiences of students**, connected to **societal or personal concerns**

- **Usable from K to 12**
  - Is **teachable and learnable** over multiple grades at increasing levels of depth and sophistication
Value of Using Core Ideas

Allows time for:

• Deep exploration of important concepts and principles,

• Develop integrated understanding (connections among ideas),

• Use practice of science and engineering,

• Reflect on the nature of science and scientific knowledge.

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

Ideas that cut across and important to all science disciplines

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

See Tab Appendix G: Crosscutting Concepts
Scientific ideas are not enough!

• Understanding content is inextricably linked to engaging in practices. Simply “consuming” information leads to declarative, isolated ideas.

• Science is both a body of knowledge and the process that develops and refines that body of knowledge. Understanding both the ideas and process is essential for progress in science.

• The learning of science is similar: students cannot learn one without the other.
Scientific and Engineering Practices

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

The practices work together – they are not separated!

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

See Tab Appendix F: Science and Engineering Practices
Content and Practice Work together to Build Understanding

• Understanding content is inextricably linked to engaging in practices

• Learning practices are inextricably linked to content!

• Content and practices co-develop and work together!
Standards integrate core ideas, crosscutting ideas, & practices

• Referred to as performance expectations
  – Integrate all three dimensions articulated in the framework
  – Require students demonstrate knowledge-in-use

See Tabs: Executive Summary and Introduction
Core idea PS1.B: 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. The total number of each type of atom is conserved, and thus the mass does not change.

Performance expectation: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. (MA PS1-5)
### An Example

**Middle School: Chemical Reactions**

<table>
<thead>
<tr>
<th>Scientific and Engineering Practices</th>
<th>Disciplinary Core Idea</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>PS1.B: Chemical Reactions</strong></td>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.</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. (MS-PS1-5)</td>
<td><strong>Energy and Matter</strong></td>
</tr>
<tr>
<td>• Develop a model to describe unobservable mechanisms. (MS-PS1-5)</td>
<td>• The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)</td>
<td>• Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)</td>
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</table>

**Connections to Nature of Science**

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

• Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

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Connections to other DCIs in this grade-band: MS-PS1.C, MS-PS1.D (MS-PS1-2), (MS-PS1-6), HS.PS1.C (MS-PS1-2), (MS-PS1-5), MS-LS2.B (MS-PS1-5), MS-ESS2.A (MS-PS1-2), (MS-PS1-5)


See tab: *How to Read the NGSS; Topics Page 40*
Learning Develops Over Time

Learning difficult ideas

• Takes time
• Connects made as students work on a task that forces them to synthesize ideas
• Occurs when new and existing knowledge is linked to previous ideas
• Depends on instruction
Build Understanding Over Time

See Tab: Appendix E: Progressions
Go to page 7 of Appendix E
NGSS is Different

- Standards expressed as performance expectations – knowledge in use.
- Combine practices, core ideas, and crosscutting concepts into a single statement of *what is to be assessed at the end of grade for K – 5 and grade band for 6 – 8 and 9 – 12.*
- They are not instructional strategies or objectives for a lesson.
Implication of Expectations

• Performance Expectations guide
  • Assessment development
  • Instruction
  • Curriculum decision

What type of assessment would you expect for?

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

How could you prepare students for this?
Developing Lessons to Meet Performance Expectation

1. Select related performance expectations, typically from one topic area. (Bundling)
2. Read and study the performance expectations, clarification statements, and assessment boundaries.
3. Identify disciplinary core idea(s), practices, and crosscutting concepts coded to the PEs.
4. Look more closely at the core idea(s) and PE(s). What understandings need to be developed? What content ideas will students need to know? What must students be able to do?
5. Select practices that work with the core ideas.
6. Develop lesson level expectations. Call these learning performances as they guide lesson development and student learning. Learning performances (knowledge-in-use) are similar to performance expectations in that they blend core ideas, practices, and crosscutting concepts.
7. Determine the acceptable evidence for the assessment of the learning performances.
8. Carefully construct a storyline – help learners build sophisticated ideas from simpler ideas, using evidence that builds to the understanding described in the PEs. Describe how the ideas will unfold. What do students need to be introduced to first? How would the ideas and practices develop over time?
9. Ask: “How does task(s)/lesson(s) help students move towards an understanding of the PE(s)?”
Step 1: Select related performance expectations--Bundling

- Use Topic View to identify performance expectations

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-2. Analyze and interpret data on the properties of substances before and after they interact to determine if a chemical reaction has occurred.

Go to Topic View MS Chemical Reactions, page 40.
Step 2: Read and study the performance expectations, clarification statements, and assessment boundaries.

Step 3: Identify disciplinary core idea(s), practices, and crosscutting concepts coded to the PEs.

Step 4: Look more closely at the core idea(s) and PE(s).
- What understandings need to be developed?
- What content ideas will students need to know?
- What must students be able to do?
  - Examine DCI in the Framework, the DCI progression chart (Appendix E), the Storyline in the Topic View (see page 33 of Topic view), the Practice matrix (F)
Step 5: Select practices that work with the core ideas

- Examine closely the Science and Engineering Practice Matrix (Examine Appendix F)
- Possible Science and Engineering Practices to use
  - Constructing Explanations and Design Solutions
  - Analyzing and Interpreting Data
  - Constructing Models from Evidence
  - Asking and Refining Questions
Step 6: Develop lesson level expectations

- Lesson level expectations (Learning performances)
  - Think of these as learning goals
  - Define, in cognitive terms, the designers’ conception for what it means for learners to “understand” a particular scientific idea
  - Define how the knowledge is used in reasoning about scientific questions and phenomena
- Know or understand is too vague
- Use terms that describe the performance you want students to learn and be able to do.
  - Use the practices
  - Not “know” or “understand”
- Guide instructional decisions
**Core idea PS1:** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

**Practice:** Construct a scientific explanation based on evidence.

**Learning Performance:** Develop a scientific explanation that different substances have different properties.

**Crosscutting Concept:** Cause and Effect.
Students construct a scientific explanation that includes a claim about whether two items are the same substance or different substances, evidence in the form of density, melting point (boiling point), solubility, color and hardness of the substances, and reasoning that different substances have different properties.

**Assessment Task**

Examine the following data table:

<table>
<thead>
<tr>
<th></th>
<th>Density</th>
<th>Color</th>
<th>Mass</th>
<th>Melting Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid 1</td>
<td>0.93 g/cm³</td>
<td>no color</td>
<td>38 g</td>
<td>-98 °C</td>
</tr>
<tr>
<td>Liquid 2</td>
<td>0.79 g/cm³</td>
<td>no color</td>
<td>38 g</td>
<td>26 °C</td>
</tr>
<tr>
<td>Liquid 3</td>
<td>13.6 g/cm³</td>
<td>silver</td>
<td>21 g</td>
<td>-39 °C</td>
</tr>
<tr>
<td>Liquid 4</td>
<td>0.93 g/cm³</td>
<td>no color</td>
<td>16 g</td>
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Write a **scientific explanation** that states whether any of the liquids are the same substance.
My dream: engaging students in constructing models throughout the K – 12 curriculum

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

Greater sophistication

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<tr>
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<th>Grades 3 - 5</th>
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<th>High School</th>
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<td>Develop a simple model that represents a proposed object or tool.</td>
<td>Develop and revise models collaboratively to measure and explain frequent and regular events.</td>
<td>Develop models to describe unobservable mechanisms.</td>
<td>Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system.</td>
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• Business is not the same!
• Framework is different!
• NGSS is different!
• Revolution and not evolution
Questions about NGSS???

• Questions about core ideas?
• Questions about scientific practices?
• Questions about crosscutting concepts?
• Questions about performance expectations?

Slides posted at:  http://create4stem.msu.edu

Contact information:  krajcik@msu.edu
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<td>Students who demonstrate understanding can:</td>
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<td><strong>MS-PS1-5.</strong> Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter, and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]</td>
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The performance expectations above were developed using the following elements from the NRC document A Framework for K–12 Science Education.
What understandings need to be developed?

MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-2. Analyze and interpret data on the properties of substances before and after they interact to determine if a chemical reaction has occurred.

Possible content Ideas:
Properties of substances, chemical reaction, atoms, molecule