A Closer Look at the
Next Generation Science Standards
for
Grades 3-5

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Session Objectives

- Deepen your Understanding of NGSS Performance Expectations
- Provide overview of Grades 3-5 standards
- Investigate one Standard from grade 4 – Energy through a think-aloud with an experienced teacher
- Discuss challenges for implementation moving forward
Grade 3-5 Standards
(NGSS Topics)

Grade 3

3. Forces and Interactions
3. Interdependent Relationships in Ecosystems
3. Inheritance and Variation of Traits: Life Cycles and Traits
Grade 3-5 Standards
(NGSS Topics)

- Grade 4
- 4. Energy
- 4. Waves: Waves and Information
- 4. Structure, Function, and Information Processing
- 4. Earth’s Systems: Processes that Shape the Earth
Grade 3-5 Standards
(NGSS Topics)

Grade 5

5. Structure and Properties of Matter
5. Matter and Energy in Organisms and Ecosystems
5. Earth’s Systems
5. Space Systems: Stars and the Solar System
Structure of NGSS

- Expressed as *Performance Expectations* (PEs)
- *Integrate* practices, core ideas, and crosscutting concepts
- Statements of what is to be assessed
- Require demonstration of *knowledge-in-use*
- State what students should be able to do at the *end of instruction*
- Organized by Topic and by DCI (See chart)
Structure of NGSS

- Areas of confusion
  - Next Generation Science Standards are not curriculum
  - They are not instructional strategies
  - They are not lesson objectives

- Rather – they provide support for developing instructional strategies and lesson objectives that consistently include Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts
Supports for Reading a Performance Expectation (PE)

- Two Resources:
  - From NGSS
    - NGSS Structure
      [Link](http://www.nextgenscience.org/sites/ngss/files/How%20to%20Read%20NGSS%20-%20Final%204-19-13.pdf)
  - From NSTA
    - Inside the NGSS Box – Content Description
      [Link](http://nstahosted.org/pdfs/ngss/InsideTheNGSSBox.pdf)
How to Read a PE

- Select one PE. 4.PS3-1 (In 4. Energy)
- Read the PE, the clarification statement, and the assessment boundary.
- Read the applicable DCI in the foundation box.
- Check Appendix E for DCI progression.
How to Read a PE

- Read the associated Practice in the foundation box.
- Check Appendix F for Practice progression.
- Read the associated Crosscutting Concept (CCC) in the foundation box.
- Check Appendix G for CCC progression.
Strategies for Planning Instruction

- Scaffold the development of understanding expressed in the PE(s).
- Develop a series of scaffolded learning tasks that blend various Practices, Disciplinary Core Ideas, and CCC.
- Integrate.
- Consider prior knowledge.
  - Preconception and misunderstandings
Step One: Read and Bundle PE

**Question 1:** What performance expectations are related and can be included in instruction within the lessons/unit? (Cluster PEs)

- **4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
- **4-PS3-3.** Ask questions and predict outcomes about the changes in energy that occur when objects collide.
Step Two: Identify Three Dimensions

Question 2: What are the performance expectations, clarification statements, and assessment boundaries and how are they related in terms of instructional practices?

- 4-PS3-1. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy]

- 4-PS3-3. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy].
Step Two: Identify Three Dimensions

Question 2: What are the performance expectations, clarification statements, and assessment boundaries and how are they related in terms of instructional practices?

- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy]

Thoughts: Using experiences students have acquired, they should be given multiple opportunities to construct explanations to extend their thinking by using qualitative data.
Step Two: Identify Three Dimensions

Question 2: What are the performance expectations, clarification statements, and assessment boundaries and how are they related in terms of instructional practices?

- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Thoughts: Multiple experiences with collisions need to occur before students can ask meaningful questions and predict an outcome.
Step Three: Identify the DCIs

**Question 3**: What are the **disciplinary core idea(s)**, practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

- **PS3.A: Definitions of Energy**
  - The faster a given object is moving, the more energy it possesses.
  - Energy can be moved from place to place by moving objects.
Step Three: Identify the DCIs

**Question 3:** What are the **disciplinary core idea(s)**, practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

- **PS3.B: Conservation of Energy and Energy Transfer**
  
  Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
Step Three: Identify the DCIs

**Question 3:** What are the **disciplinary core idea(s)**, practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

- **PS3.C: Relationship Between Energy and Forces**
  
  When objects collide, the contact forces transfer energy so as to change the object’s motion.
Step Three: Identify the Practices

**Question 3**: What are the disciplinary core idea(s), **practices**, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

**Science and Engineering Practices** –

- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
- Plan and carry out investigations to answer questions or test solutions to problems.
- Use evidence (e.g., measurements, observations, patterns) to construct an explanation.
- Apply scientific ideas to solve design problems.
Step Three: Identify the Crosscutting Concepts

**Question 3**: What are the disciplinary core idea(s), practices, and **crosscutting concepts** coded to the performance expectations and how will they drive instruction?

- **Energy and Matter**
- Energy can be transferred in various ways and between objects.
Step Three: Identify Connections to Instruction

**Question 3:** What are the disciplinary core idea(s), practices, and crosscutting concepts coded to the performance expectations and **how will they drive instruction?**

- **Disciplinary Core Ideas:**
  - Investigate objects travelling at various speeds
  - Evaluate energy transfer in a collision (i.e. bowing balls to pins, students playing Red Rover, students playing marbles, etc.)
Step Three: Identify Connections to Instruction

Question 3: What are the disciplinary core idea(s), practices, and crosscutting concepts coded to the performance expectations and **how will they drive instruction**?

- **Science and Engineering Practices:**
  - Ask questions and predict outcomes
  - Determine cause and effect relationships (i.e. impact of a slow moving car versus a fast moving car in a collision)
Step Three: Identify Connections to Instruction

**Question 3**: What are the disciplinary core idea(s), practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

- **Crosscutting Concepts:**
- Investigate how energy changes when objects collide.
Step Four: Identify the Content Ideas

**Question 4:** What understandings need to be developed for students to be successful in the performance expectation(s)? What **content ideas** will students need to know and what skills will they need to learn?

- Energy is present whenever there are moving objects
- Understand energy transfer
- Concepts of motion, force, and speed
Step Four: Identify the Skills

**Question 4:** What understandings need to be developed for students to be successful in the performance expectation(s)? What content ideas will students need to know and what skills will they need to learn?

- To write a scientific explanation based upon evidence presented
- To predict outcomes based upon cause and effect relationships
- To observe and analyze the relationship between energy speed and energy levels.
Step Five: Identify Appropriate Practices

**Question 5:** What *Science and Engineering Practices* are appropriate with the instruction of the disciplinary core ideas?

**Practice #1**

- *Asking questions and defining problems:* Students will ask questions and investigate how an object’s motion is related to the speed of the colliding object.
Step Five: Identify Appropriate Practices

Question 5: What Science and Engineering Practices are appropriate with the instruction of the disciplinary core ideas?

Practice #3

- Planning and carrying out investigations: Students will investigate how height can affect change in energy when objects collide.
Step Five: Identify Appropriate Practices

Question 5: What **Science and Engineering Practices** are appropriate with the instruction of the disciplinary core ideas?

Practice #6

- **Constructing explanations and designing solutions:** Students will make observations and collect data (i.e., example of a cart descending down a ramp on a track) to demonstrate how speed and energy are related.

- Students will design an investigation to test their hypothesis. (Materials can be as simple as a notched ruler and marbles.)
Step Six: Identify Lesson Expectations

Question 6: What are the lesson level expectations (learning performances) and how will they build to meet the performance expectations?

- Share ideas about speed and collisions
- Design a model that will change the speed of an object
- Develop a model that will provide evidence of lost energy
- Create an investigation that demonstrates the relationship between height and speed
- Investigate the effect of speed on the severity of a collision
- Design a model which provides evidence that energy changes when objects collide
Step Seven: Match Expectations to Assessment

**Question 7:** What assessment (formative and summative) will provide evidence of the understanding and/or ability to perform lesson level expectations (learning performances)?

- Given a picture or video of a vehicle collision, students will make a determination of the vehicle’s speed
- Students will draw a picture of their solution. How did the speed change? Provide data of multiple trials as evidence.
- Draw a picture of the model and indicate where energy was lost and explain why
Step Seven: Match Expectations to Assessment

Question 7: What **assessment** (formative and summative) will provide evidence of the understanding and/or ability to perform **lesson level expectations** (learning performances)?

- Multiple trials with similar results will justify data accuracy. Students will write a scientific explanation for the phenomena they observe.

- Use evidence to write an explanation for why speed in a collision can make a difference in the amount of damage.

- Given a diagram of two objects colliding, students should be able to make predictions about energy change.
Step Eight: Create a Storyline

Question 8: What is the **storyline** that helps learners apply what they know, build new, sophisticated ideas from observation and evidence, and use information to solve an engineering problem?

- In kindergarten students learn that pushes and pulls (force) can have different strengths and directions.

- Now in the fourth grade students concentrate on what happens when a force is applied to speed and energy of an object. Students will design models and investigations to understand how speed, distance, and force are connected to changes in mass and height...
Step Nine: Evaluate the Lessons and Tasks

**Question 9:** How do the **lessons and tasks** help students move towards an understanding of the performance expectation(s)?

- The sequence of lessons engages students in multiple opportunities to ask higher order questions and allows for creative investigations and design to support the performance standards that:
  - Speed of an object relates to the energy of that object
  - When objects collide, speed and energy impact the severity of the collision
  - Students will collect data, refine hypotheses, and reflect on evidence. Finally the students will possess the tools to predict outcomes in related situations.
Lesson Development Example

**Transition Activity**: Merging current unit of fifth grade Force and Motion with fourth grade Standard of Energy.

- This activity will begin to address the 4-PS3-1 and 4-PS3-3 and Science and Engineering Practices. Use evidence (i.e. measurements, observations, patterns, etc.) to construct an explanation.
Lesson Development Example

- Students have ideas about a person with lots of energy:
  - Active
  - Gets things done
  - On the move
  - Learning as much as they can
  - Applying their knowledge
Lesson Development Example

Bowling Ball Example:

- Movements of a bowling ball:
- What happens with a slow moving bowling ball?
- What happens with a fast moving bowling ball?
- Does it take more/less energy to knock down bowling pins?

www.123rf.com/
Lesson Development Example

Red Rover

Lesson Development Example

Runners Racing
For More Information

- All NGSS official documents are available at
  - http://www.nextgenscience.org/

- NGSS at NSTA:
  - Standards and Supporting Materials Tab
  - http://www.nsta.org/about/standardsupdate/standards.aspx
For More Information

- All materials, videos, ppt, etc. from this Conference will be available for future use by attendees and those who could not attend at:

- [http://www.create4stem.msu.edu/ngss](http://www.create4stem.msu.edu/ngss)
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