NGSS OUTSIDE THE CLASSROOM

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Today's Talk

1. NGSS Overview
2. Informal Science & the NGSS

PART 1: THE NGSS

What is the NGSS?

- Policy document developed with input from researchers, policymakers, and educators from all 50 states
- Research-based standards based on the National Research Council's *A Framework for K-12 Science Education*
- A set of performance expectations that embody "3-dimensional learning" of disciplinary cores ideas (DCIs), science & engineering practices (SEPs), and cross-cutting concepts (CCC)
- An option for states to adopt/adapt for their state science standards
- A guide for selecting curriculum materials, designing instruction, and assessing student learning

Why the NGSS?

- **It's time:** Previous *National Science Education Standards* were published in the mid-90s, and since that time there have been major developments in science, science education, and technology.
- **Scientific literacy is important for college and career readiness:** Implementing up-to-date K–12 science standards will better prepare high school graduates for the rigors of college and careers. In turn, employers will be able to hire workers with strong science-based skills—including specific content areas but also skills such as critical thinking and inquiry-based problem solving.
- **The US needs to be a leader in STEM:** Achievement lags behind other nations in science & math achievement, and too few students enter STEM majors and careers at every level—from those with relevant postsecondary certificates to PhD's.

7 Major Shifts

1. Focus on "figuring out" rather than "learning about"
2. Importance placed on phenomena as anchoring features of lessons & units
3. Use of 'storylines' and learning progressions to develop coherence
4. Explicit integration of science & engineering
5. Emphasis on a smaller set of 'core ideas' versus breadth of knowledge
6. Students engage in the practices of scientists and engineers
7. Connections cutting across science disciplines

Students who demonstrate understanding can:

4-PS3-4. **Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.** Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy or use stored energy to cause motion or produce light or sound.*]

Grade 4

Performance Expectation

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

and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Apply scientific ideas to solve design problems.	**PS3.B: Conservation of Energy and EnergyTransfer** • Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. **PS3.D: Energy in Chemical Processes and Everyday Life** • The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.	**Energy and Matter** • Energy can be transferred in various ways and between objects. ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Engineering, Technology, and Science on Society and the Natural World** • Engineers improve existing technologies or develop new ones. ***Connections to Nature of Science*** **Science a Human Endeavor** Scientists and engineers work in teams. Science affects everyday life.

Three Dimensions

Connections to other DCIs in fourth grade: N/A

Articulation of DCIs across grade-levels:
K.ETS1.A ; **2.ETS1.B** ; **5.PS3.D** ; **5.LS1.C** ; **MS.PS3.A** ; **MS.PS3.B** ; **MS.ETS1.B** ; **MS.ETS1.C**

Common Core State Standards Connections:

ELA/Literacy -

W.4.7 Conduct short research projects that build knowledge through investigation

W.4.8 Recall relevant information from experiences or gather relevant information provide a list of sources. (4-PS3-4)

Mathematics -

4.OA.A.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. *(4-PS3-4)*

Connections to Common Core

Performance Expectations

- Some states use "standards" to mean *performance expectations* in the NGSS
- PEs are statements of what students should know and be able to do *after* instruction
- Can be achieved through a variety of learning tasks and contexts
- Embody "3 dimensional learning"

Students who demonstrate understanding can:

4-PS3-4. **Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.*]

Disciplinary Core Ideas

Old WA Standards

- 4-5 PS3A Energy has many forms, such as heat, light, sound, motion, and electricity.
- 4-5 PS3B Energy can be transferred from one place to another.
- 4-5 PS3C Heat energy can be generated a number of ways and can move (transfer) from one place to another. Heat energy is transferred from warmer things to colder things.
- 4-5 PS3D Sound energy can be generated by making things vibrate.
- 4-5 PS3E Electrical energy in circuits can be changed to other forms of energy, including light, heat, sound, and motion. Electric circuits require a complete loop through conducting materials in which an electric current can pass.

NGSS

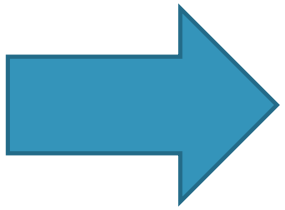
PS3.B: Conservation of Energy and Energy Transfer

- Energy can be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

Science & Engineering Practices

BEFORE:

- The Scientific Method
- Science Process Skills
  - Observing
  - Measuring
  - Inferring
  - Classifying
  - Predicting



- Asking Questions and Defining Problems.
- Developing and Using Models.
- Planning and Carrying Out Investigations.
- Analyzing and Interpreting Data.
- Using Mathematics and Computational Thinking.
- Constructing Explanations and Designing Solutions.
- Engaging in Argument from Evidence.

Cross-Cutting Concepts

Themes that transcend disciplinary boundaries of biology, chemistry, physics, etc.

- Patterns
- Cause and effect
- Energy and matter
- Structure and function
- Stability and change
- Scale, proportion, and quantity
- Systems and system models

PART 2

What is the role of informal science education in supporting NGSS outside the classroom?

Informal Science Learning

School is not the only place students learn! Out of school learning can represent a significant portion of early learners' exposure to science, and can help connect 'school' learning with the 'real world'.

Learning experiences across informal environments may positively influence children's science learning in school, their attitudes toward science, and the likelihood that they will consider science-related occupations or engage in lifelong science learning through hobbies and other everyday pursuits.

Informal environments for science learning may be particularly effective for youth from historically nondominant groups—groups with limited sociopolitical status in society, who are often marginalized because of their cultural, language, and behavioral differences.

https://www.nap.edu/download/12190
https://www.narst.org/NGSSpapers/Informal_Science_Education_June2014.pdf

Informal Science Learning

How can informal educational partners support NGSS implementation?

1. Field trips
2. Professional development
3. Curriculum materials
4. Innovative resources

See also http://www.astc.org/astc-dimensions/can-museums-help-teachers-next-generation-science-standards/

Field Trips

Alignment of exhibits and programs with the NGSS

Examples:

- Exploratorium, San Francisco "*Systems and Interactions"* – guides led visitors on tours of selected exhibits and facilitated discussions of how exhibits related to the theme
- Spanel Planetarium, WWU "*NGSS Program*" designed in cooperation with school district officials and faculty to coordinate with the latest science curriculum of 4th and 5th grade students.

Professional Development

Providing teachers with science knowledge necessary to implement the NGSS

Examples:

- American Museum of Natural History – collaborating with WestEd and BSCS to develop PD tools and 'teaching cases' to support NGSS implementation
- Head Start on Engineering (HSE) provides comprehensive services for parents, children, and their teachers, including professional development (PD) for preschool educators, to catalyze long-term, enduring family interests related to science and engineering.

Curriculum Materials

Providing teachers with science knowledge necessary to implement the NGSS

Examples:

- The Tech Museum of Innovation (San Jose) provides lesson plans related to design challenges aligned with the NGSS
- The Museum of Science Boston has created the Engineering is Elementary (EiE) curriculum (https://www.eie.org/)

Innovative Resources

Providing teachers with tools and resources to help them more effectively implement the NGSS

Examples:

- University of California Museum of Paleontology - Understanding Science 101 website (https://undsci.berkeley.edu/)
- SciStarter (https://scistarter.com) helps link students and teachers to citizen science projects – like the *Girl Scouts Think Like a Citizen Science journey*

Partnerships

- Building a critical mass
- Creating connections
- Sharing expertise
- Leveraging resources
- Meeting multiple needs

Where to find other examples and information about linking in-school and out-of school STEM learning?

LINKING IN-SCHOOL AND OUT-OF-SCHOOL STEM LEARNING.

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Additional Links & Resources

- Next Generation Science Standards
- NGSS Fact Sheet
- How to read the NGSS
- NGSS Hub @ NSTA – find curated collections, rubrics to guide alignment, samples assessments, and more!
- STEM Teaching Tools – Practice Brief 38 (informal science & the vision of the NGSS)
- Learning Science in Informal Environments (a report from the National Academies)

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