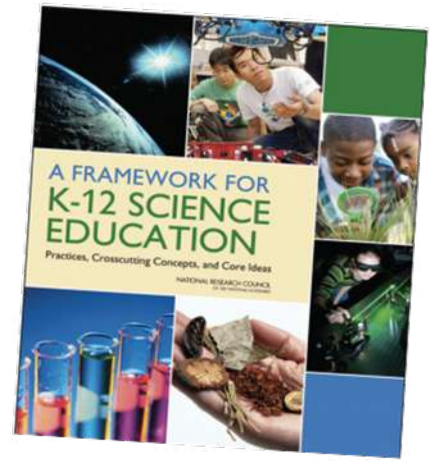
Next Generation Science Standards
January 2013 Public Review

Making Connections to
A Framework for K-12 Science Education
and Having a Voice in the
Next Generation Science Standards Review



A Framework for K-12 Science Education can be found at

http://www7.nationalacademies.org/bose/Standards_Framework_Homepage.html

Welcome

Presenters

Ellen Ebert, Ph.D.
Teaching and Learning Science Director
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ESD 113 Science Coordinator
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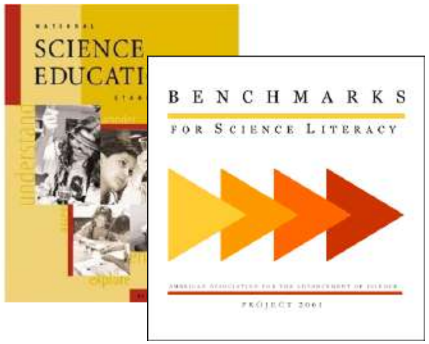
Science Educational Consultant

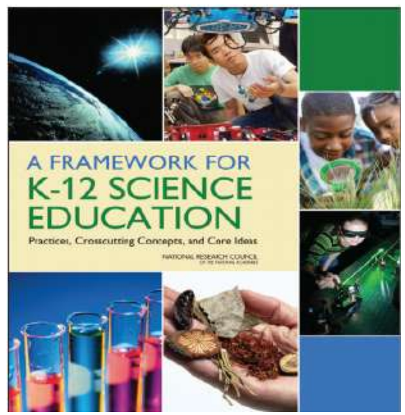
Session Goals

- Review the core principles of *A K12 Framework for Science Education*
- Briefly discuss the major differences among the Framework, NGSS and WA Science Standards
- Discuss how to participate in the review of the public draft
- Review the anatomy of a standard
- Discuss the type of feedback needed
- Update Washington's Role in the NGSS

Timeline



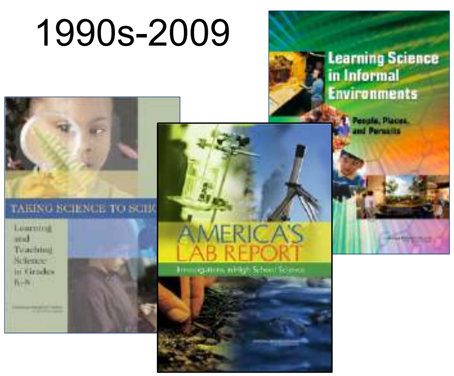
1990s



January 2010 - July 2011

Phase I

1990s-2009



NEXT GENERATION SCIENCE STANDARDS

July 2010 – January 2013

Phase II

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

Council of State Science Supervisors

Achieve

NRC

National Research Council

NSTA

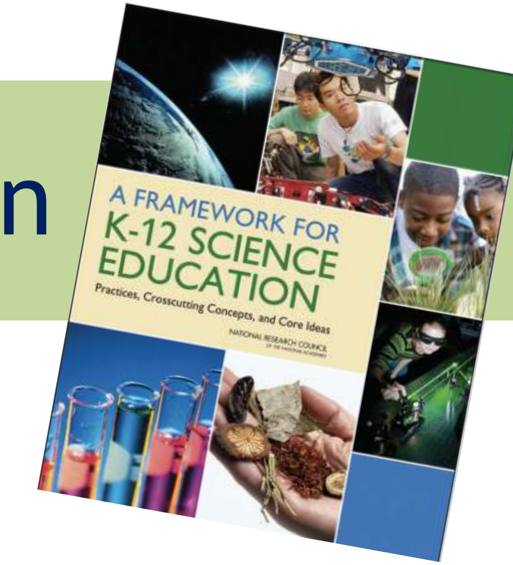
National Science Teachers Association

Connections to research

Research on How People Learn (HPL)

Key Findings	Key Findings for Students	Key Findings for Teachers
HPL 1	Students come to the classroom with preconceptions about how the world works.	Surface student preconceptions and adjust instruction
HPL 2	Students must have a deep foundation of usable knowledge and understand facts in the context of a conceptual framework.	Understand the content and conceptual framework of instructional units
HPL 3	Students must be taught explicitly to take control of their own learning by monitoring their progress.	Teach students to think about their thinking.

Vision for Science Education



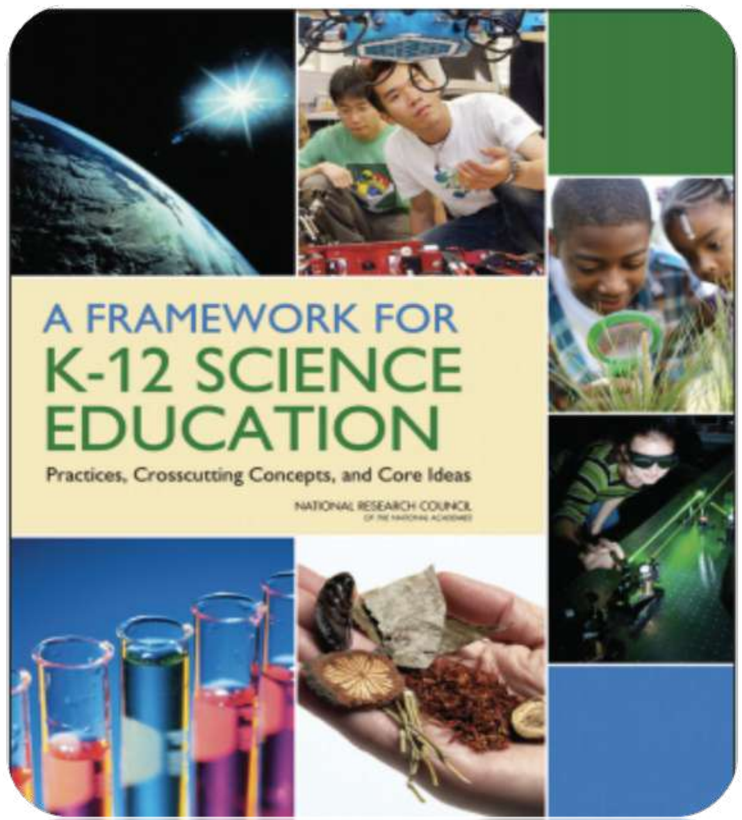
The framework is designed to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

A Framework for K-12 Science Education p. 1-2

Principles of *A Framework for K-12 Science Education*

- Children are born investigators
- Understanding builds over time
- Science and Engineering require both knowledge and practice
- Connecting to students’ interests and experiences is essential
- Focusing on core ideas and practices
- Promoting equity

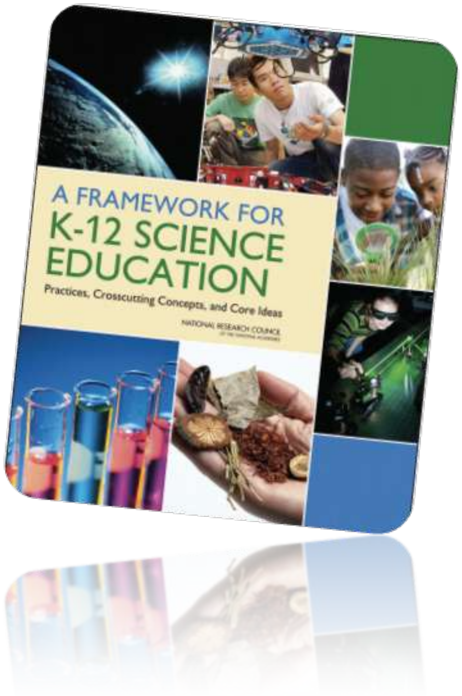
How can the vision and principles of the Framework lead to a new vision of teaching with the NGSS?



Organization of Framework

Dimensions of the Framework

– Scientific and Engineering Practices
– Crosscutting Concepts
– Disciplinary Core Ideas



Realizing the Vision

– Integrating the Three Dimensions
– Implementation
– Equity and Diversity
– Guidance for Standards Development
– Looking Toward the Future: Research to Inform K-12 Science Education Standards



- Eight Practices
  - 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
  - Obtaining, evaluating, and communicating information

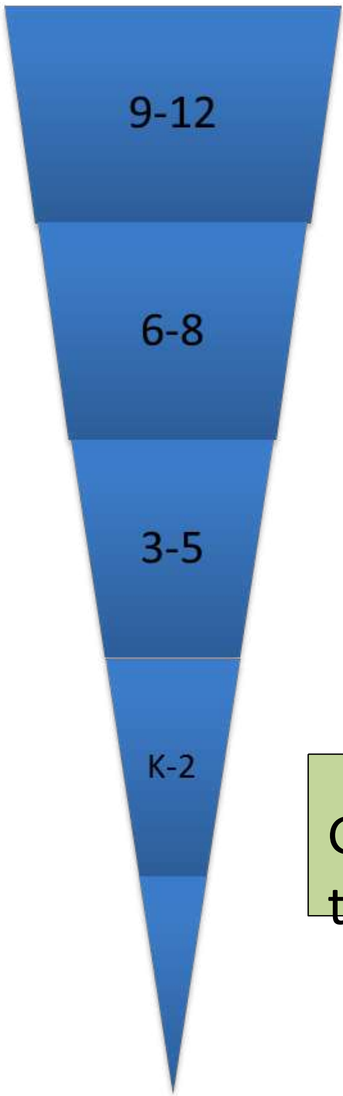
- Seven Crosscutting Concepts
  - Patterns
  - Cause and effect
  - Scale, proportion, and quantity
  - Systems and system models
  - Energy and matter: Flows, cycles, and conservation
  - Structure and function
  - Stability and change

- Four Disciplinary Core Ideas:
  - ✓ Life Science,
  - ✓ Physical Science
  - ✓ Earth and Space Science
  - ✓ Engineering

Promoting Equity

- Equalizing opportunities to learn
- Inclusive science instruction
- Making diversity visible
- Value multiple modes of expression

Developmental Progressions



Molecular model of biochemical reactions for matter and energy in food.

Chemical reactions model for matter and energy in food, drawing on particle model of matter and energy transfer model.

Simple food model: food consumed or produced is made of matter and provides energy for organisms.

General needs model: Organisms get what they need to survive from the environment.

High School Science

Shifts in Science Instruction with the NGSS

- Instruction organized around a limited number of core ideas: depth and coherence,
- not breadth of coverage.

Core ideas will be revisited in increasing depth, and sophistication across years. Focus on connections:

- Careful construction of a storyline – helping learners build sophisticated ideas from simpler explanations using science evidence.
  - Connections between scientific disciplines, using powerful ideas (nature of matter, energy) across life, physical, and earth science
  - Instruction should involve learners in practices that develop, use, and refine the scientific ideas, not “explain” the science *for* students.

Moving from *A Framework* to NGSS

Integrating the 3 Dimensions

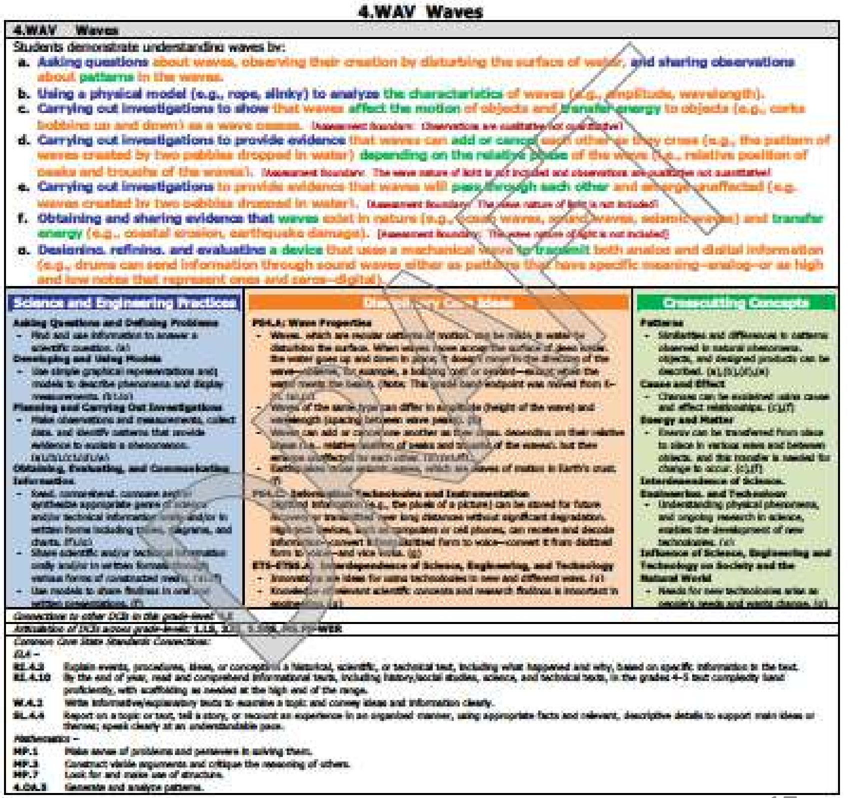
Science & Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

Architecture of a Standard

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts



4.WAV Waves

4.WAV Waves

Students demonstrate understanding waves by:

a. Asking questions about waves, observing their creation by disturbing the surface of water, and sharing observations about patterns in the waves.
b. Using a physical model (e.g., rope, slinky) to analyze the characteristics of waves (e.g., amplitude, wavelength).
c. Carrying out investigations to show that waves affect the motion of objects and transfer energy to objects (e.g., corks bobbing up and down) as a wave passes.
d. Carrying out investigations to provide evidence that waves can add or cancel each other as they cross (e.g., the pattern of waves created by two pebbles dropped in water) depending on the relative phase of the waves (i.e., relative position of peaks and troughs of the waves).
e. Carrying out investigations to provide evidence that waves will pass through each other and emerge unaffected (e.g., waves created by two pebbles dropped in water).
f. Obtaining and sharing evidence that waves exist in nature (e.g., ocean waves, sound waves, seismic waves) and transfer energy (e.g., coastal erosion, earthquake damage).
g. Designing, refining, and evaluating a device that uses a mechanical wave to transmit both analog and digital information (e.g., drums can send information through sound waves either as patterns that have specific meaning—analog—or as high and low notes that represent ones and zeros—digital).

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Common Core State Standards Connections:

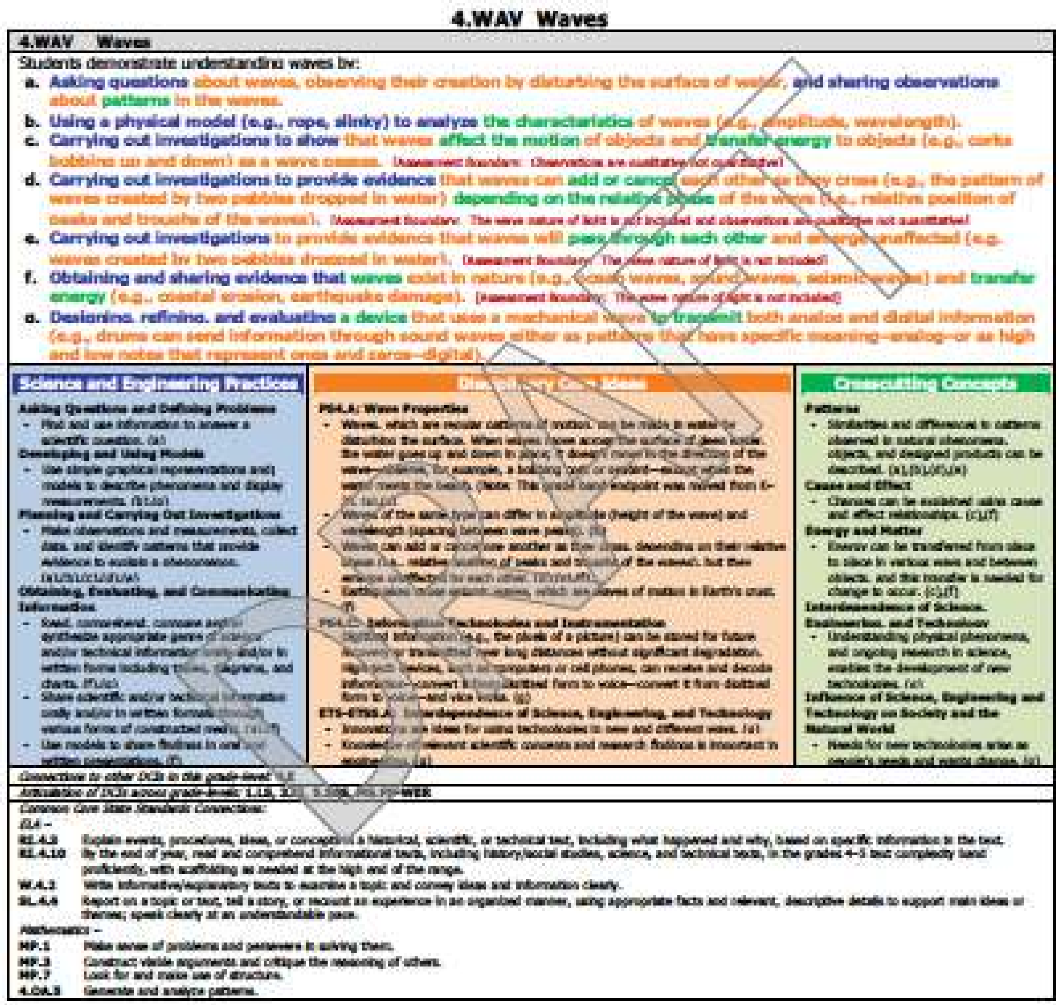
ELA –

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
RI.4.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.
W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
SL.4.4 Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

Mathematics –

MP.1 Make sense of problems and persevere in solving them.
MP.3 Construct viable arguments and critique the reasoning of others.
MP.7 Look for and make use of structure.
4.OA.5 Generate and analyze patterns.

One Standard



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c. **Carrying out investigations to show** that waves affect the motion of objects and transfer energy to objects (e.g., corks bobbing up and down) as a wave passes. [Assessment Boundary: Observations are qualitative not quantitative]
d. **Carrying out investigations to provide evidence** that waves can add or cancel each other as they cross (e.g., the pattern of waves created by two pebbles dropped in water) depending on the relative phase of the waves (e.g., relative position of peaks and troughs of the waves). [Assessment Boundary: The wave nature of light is not included and observations are qualitative not quantitative]
e. **Carrying out investigations** to provide evidence that waves will pass through each other and emerge unaffected (e.g., waves created by two pebbles dropped in water). [Assessment Boundary: The wave nature of light is not included]
f. **Obtaining and sharing evidence that** waves exist in nature (e.g., ocean waves, sound waves, seismic waves) and transfer energy (e.g., coastal erosion, earthquake damage). [Assessment Boundary: The wave nature of light is not included]
g. **Designing, refining, and evaluating** a device that uses a mechanical wave to transmit both analog and digital information (e.g., drums can send information through sound waves either as patterns that have specific meaning—analog—or as high and low notes that represent ones and zeros—digital).

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems - Find and use information to answer a scientific question. (a) **Developing and Using Models** - Use simple graphical representations and models to describe phenomena and display measurements. (b)(c) **Planning and Carrying Out Investigations** - Make observations and measurements, collect data, and identify patterns that provide evidence to explain a phenomenon. [illegible] **Obtaining, Evaluating, and Communicating Information** - Read, comprehend, compare and/or synthesize appropriate pieces of science and/or technical information orally and/or in written forms including tables, diagrams, and charts. [illegible] - Share scientific and/or technical information orally and/or in written formats through various forms of constructed media. [illegible] - Use models to share findings in oral and written presentations. (f)	**PS4.A: Wave Properties** - Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it doesn't move in the direction of the wave—observe, for example, a bobbing cork or seabird—except when the water meets the beach. [illegible] - Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (b) - Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. [illegible] - Earthquakes cause seismic waves, which are waves of motion in Earth's crust. (f) **PS4.C: Information Technologies and Instrumentation** Digitized information (e.g., the pixels of a picture) can be stored for future recovery or transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—convert it from digitized form to voice—and vice versa. (g) **ETS-ETS2.A: Interdependence of Science, Engineering, and Technology** - Innovations are ideas for using technologies in new and different ways. (a) - Knowledge of relevant scientific concepts and research findings is important in engineering. (g)	**Patterns** - Similarities and differences in patterns observed in natural phenomena, objects, and designed products can be described. [illegible] **Cause and Effect** - Changes can be explained using cause and effect relationships. (c)(f) **Energy and Matter** - Energy can be transferred from place to place in various ways and between objects, and this transfer is needed for change to occur. (c)(f) **Interdependence of Science, Engineering, and Technology** - Understanding physical phenomena, and ongoing research in science, enables the development of new technologies. (g) **Influence of Science, Engineering and Technology on Society and the Natural World** - Needs for new technologies arise as people's needs and wants change. (g)

Connection to other DCIs in this grade-level: [illegible]

Articulation of DCIs across grade-levels: 1.LS, [illegible] WER

Common Core State Standards Connections:

ELA –

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
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SL.4.4 Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

Mathematics –

MP.1 Make sense of problems and persevere in solving them.
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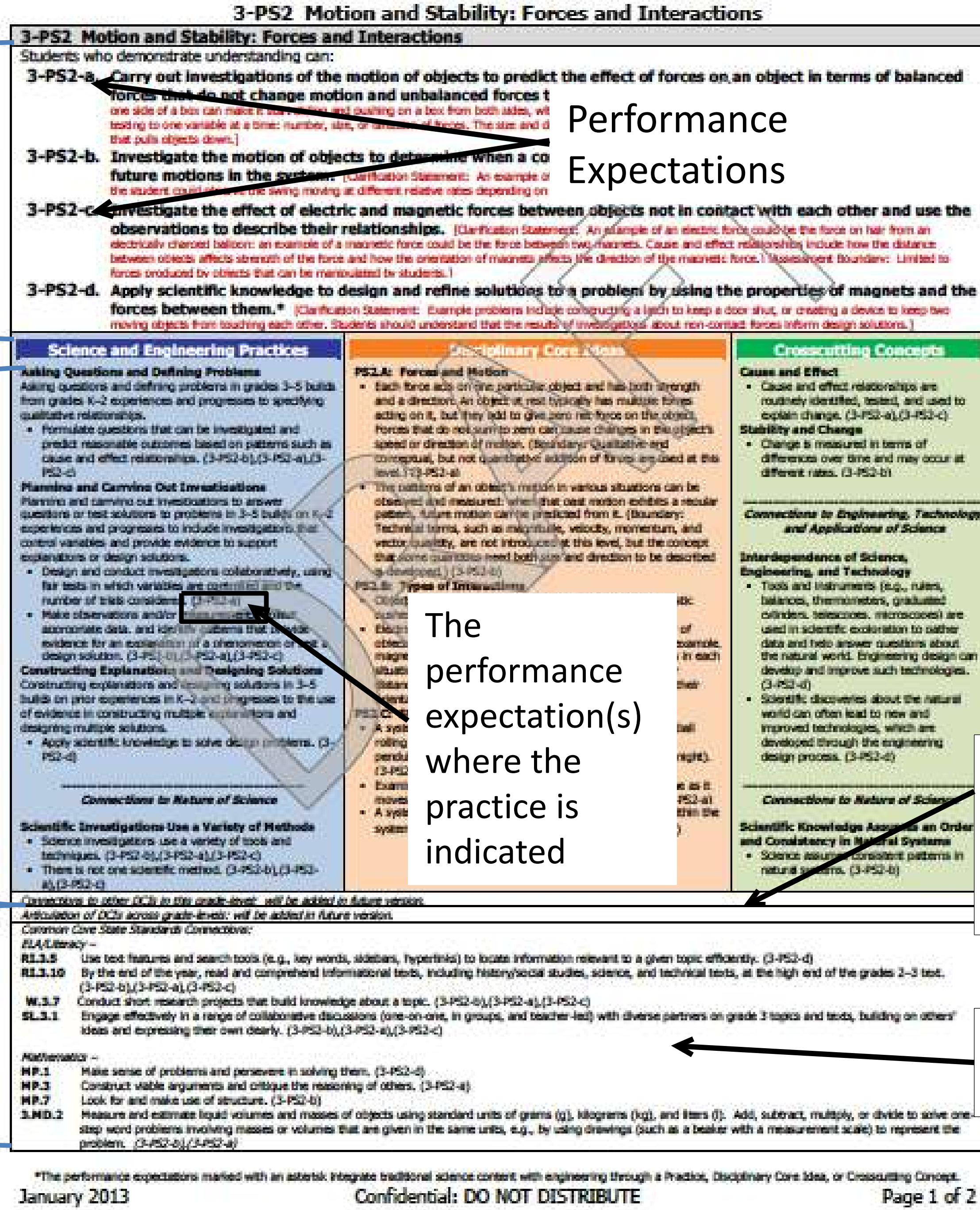
MP.7 Look for and make use of structure.
4.OA.5 Generate and analyze patterns.

Assessable Performance Expectations

Foundation Boxes

Connections Box


3-PS2 Motion and Stability: Forces and Interactions

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 t… one side of a box can make it start moving, and pushing on a box from both sides, wi… testing to one variable at a time: number, size, or direction of forces. The size and d… that pulls objects down.]

3-PS2-b. Investigate the motion of objects to determine when a co… future motions in the system. [Clarification Statement: An example o… the student could predict the swing moving at different relative rates depending on…

3-PS2-c. Investigate the effect of electric and magnetic forces between objects not in contact with each other and use the observations to describe their relationships. [Clarification Statement: An example of an electric force could be the force on hair from an electrically charged balloon; an example of a magnetic force could be the force between two magnets. Cause and effect relationships include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [Assessment Boundary: Limited to forces produced by objects that can be manipulated 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 latch to keep a door shut, or creating a device to keep two moving objects from touching each other. Students should understand that the results of investigations about non-contact forces inform design solutions.]

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds from grades K–2 experiences and progresses to specifying qualitative relationships.
- Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
- Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered. (3-PS2-a)
- Make observations and/or measurements to produce appropriate data, and identify patterns that provide evidence for an explanation of a phenomenon or test a design solution. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.
- Apply scientific knowledge to solve design problems. (3-PS2-d)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods
- Science investigations use a variety of tools and techniques. (3-PS2-b),(3-PS2-a),(3-PS2-c)
- There is not one scientific method. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Disciplinary Core Ideas

PS2.A: Forces and Motion
- Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-a)
- The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-b)

PS2.B: Types of Interactions
…

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships are routinely identified, tested, and used to explain change. (3-PS2-a),(3-PS2-c)

Stability and Change
- Change is measured in terms of differences over time and may occur at different rates. (3-PS2-b)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
- Tools and instruments (e.g., rulers, balances, thermometers, graduated cylinders, telescopes, microscopes) are used in scientific exploration to gather data and help answer questions about the natural world. Engineering design can develop and improve such technologies. (3-PS2-d)
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process. (3-PS2-d)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science assumes consistent patterns in natural systems. (3-PS2-b)

Connections to other DCIs in this grade-level: will be added in future version.

Articulation of DCIs across grade-levels: will be added in future version.

Common Core State Standards Connections:

ELA/Literacy –

RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. (3-PS2-d)

RI.3.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text. (3-PS2-b),(3-PS2-a),(3-PS2-c)

W.3.7 Conduct short research projects that build knowledge about a topic. (3-PS2-b),(3-PS2-a),(3-PS2-c)

SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (3-PS2-b),(3-PS2-a),(3-PS2-c)

Mathematics –

MP.1 Make sense of problems and persevere in solving them. (3-PS2-d)

MP.3 Construct viable arguments and critique the reasoning of others. (3-PS2-a)

MP.7 Look for and make use of structure. (3-PS2-b)

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. (3-PS2-b),(3-PS2-a)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice, Disciplinary Core Idea, or Crosscutting Concept.

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Performance Expectations

* Science PEs with engineering through a practice, DCI or crosscutting concept

The performance expectation(s) where the practice is indicated

Connections to other Disciplinary Core Ideas

Connections to Common Core

Responding to Feedback from all stakeholders

Integration of Engineering

MS.Forces and Interactions

Students who demonstrate understanding can:

MS-PS2-a. Develop a graphical or physical model, based on Newton's Third Law, to test solutions to a practical problem by predicting the motion of two interacting objects.* [Clarification Statement: Examples of practical problems could include safety tests on cars that collide with other cars or stationery objects; or the impact of a meteor on a space vehicle.] [Assessment Boundary: Restricted to vertical or horizontal interactions in one dimension.]

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to support explanations, describe, test, and predict more abstract phenomena and design systems. ▪ Use and/or develop models to predict, describe, support explanations, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	**PS2.A: Forces and Motion** ▪ For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). **ETS1.B: Developing Possible Solutions** ▪ Models of all kinds are important for testing solutions, and computers are a valuable tool for simulating systems. ▪ Simulations are useful for predicting what would happen if various parameters of the model were changed, as well as for making improvements to the model based on peer and leader (e.g., teacher) feedback.	**Systems and System Models** ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. ▪ Models are limited in that they only represent certain aspects of the system under study.

Nature of Science

MS.Weather and Climate Systems		
Students who demonstrate understanding can: **MS-ESS2-m. Apply concepts of statistics to analyze weather data and identify the variability that requires weather forecasts to be issued in terms of probabilities.** [Clarification Statement: Analyzing measurements (e.g., value, mean, median, mode, range) of weather data (e.g., temperature, pressure, humidity, precipitation, wind speed) and comparing them to weather forecasts (e.g., a projected high of 35°C with 40% chance of rain) demonstrate the nature of the unpredictability of weather; data can be for local areas or for other regions, and be on a daily basis or obtained from regional NOAA National Weather Service online databases.] [Assessment Boundary: Computing weather forecasts is not assessed.]		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. **Using Mathematics and Computational Thinking** Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. ▪ Apply concepts of ratio, rate, percent, basic operations, and simple algebra to scientific and engineering questions and problems. -- *Connections to Nature of Science* **Scientific Knowledge is Open to Revision in Light of New Evidence** ▪ Science findings are frequently revised and/or reinterpreted based on new evidence.	**ESS2.D: Weather and Climate** Because these patterns are so complex, weather can only be predicted probabilistically.	**Cause and Effect** ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.
Connections to other DCIs in this grade-level: will be added in future version.		
Articulation to DCIs across grade-levels: will be added in future version.		

Navigating the Survey

- Accessing the survey
  - http://www.nextgenscience.org/
  - Read front matter; note that there are options for how you can access the survey (we will go over)
- Key survey questions
  - Achieve is asking specific questions
    - ✓ Is the PE too prescriptive or too vague?
    - ✓ How grade appropriate is this PE?
    - ✓ How relevant is this crosscutting concept to the core idea?
    - ✓ How well would this PE demonstrate a student's understanding of the DCI?

Approaches to Feedback

- Follow one Disciplinary Core Idea vertically K-12. (e.g. pick energy and see how the standards progress)
- Examine standards in your grade band of expertise (e.g. K-5, MS, or HS) and +/- a grade
- Examine just the engineering standards.
- Just start clicking on random criteria in the search tool and see what you get.. aka NGSS roulette.

All is too much

Responding to the Survey

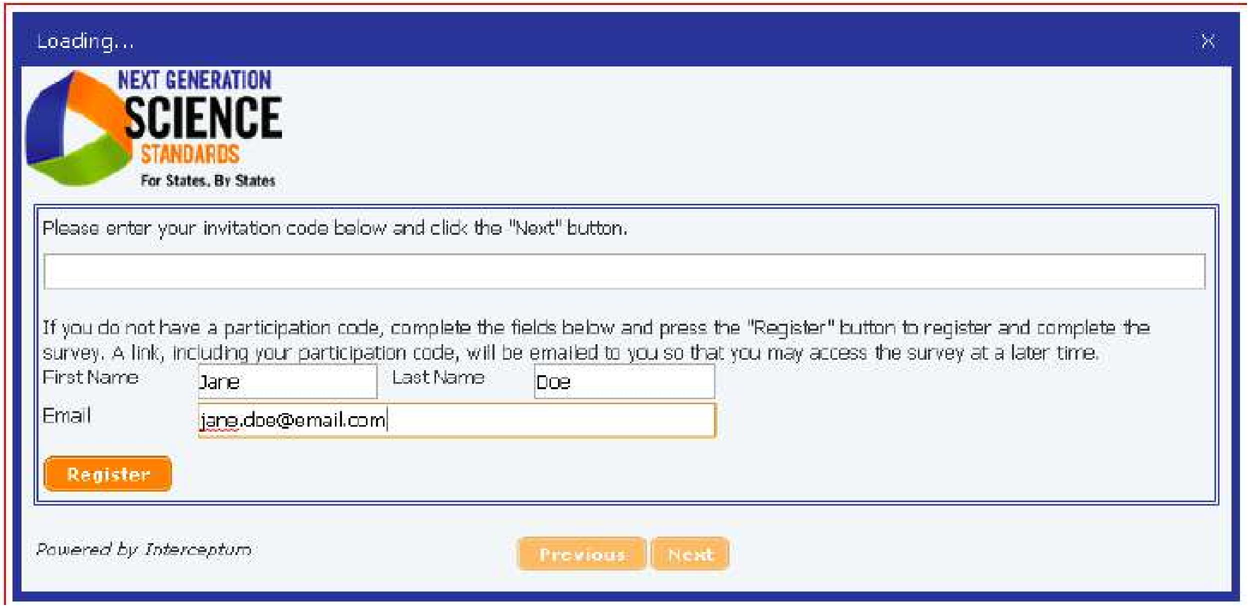
- ✓ Read the standards looking for the integration of each of the three dimensions (DCI, Crosscutting Concepts, and Science and Engineering Practices)
  - Make a claim, provide evidence
- ✓ Respond in complete sentences
- ✓ Do not abbreviate or use acronyms

What constitutes good feedback?

- Draw example from spreadsheet of good & bad feedback
  - The DCI content in standard PS5 exceeds what is expected at the previous grade-level. Suggest that the learning progression be re-examined for coherency. Good.
  - An elementary cannot be expected to teach all of this content. Who is going to do the needed training? Bad.

- Use another example from spreadsheet of good & bad feedback
  - Another specific issue: the argumentation practice does not show up until second grade (and then only once and once again in third grade), but the evidence is clear (e.g., Taking Science to School) that very young children (i.e., in preschool and kindergarten) can productively engage in argumentation. In the early grades, there is a classic imbalance towards observation (cf. our Piagetian history in the 60s / 70s). There should be deep use of explanation in K-2 as well as argumentation. Students need to be engaged in knowledge synthesis processes. Good.
  - Professional development would be needed for the support of the ETS framework in the disciplinary core ideas. Bad.

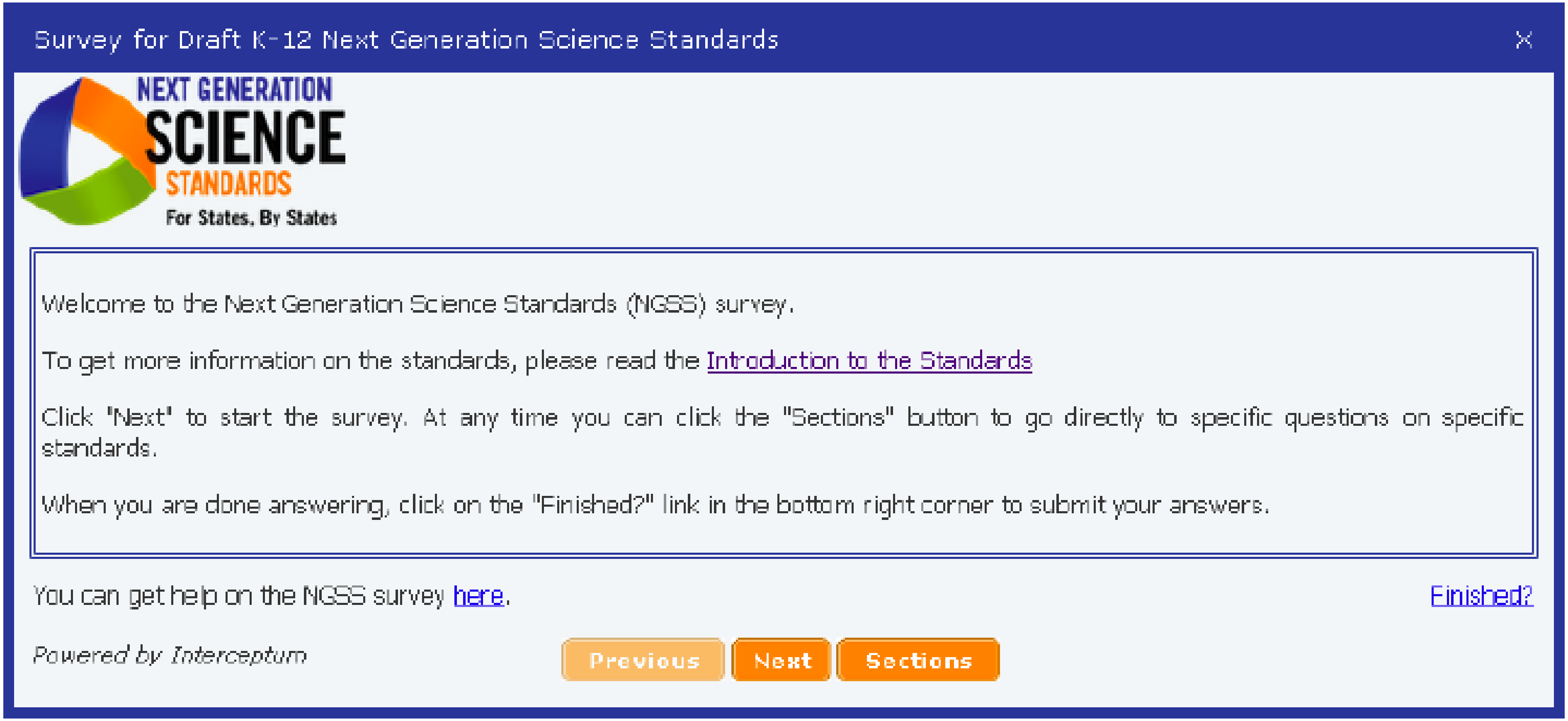
Survey Registration



If you don't complete the survey in one sitting, check email for your invitation code.

Use this code to return to the survey.

Introduction to the Survey



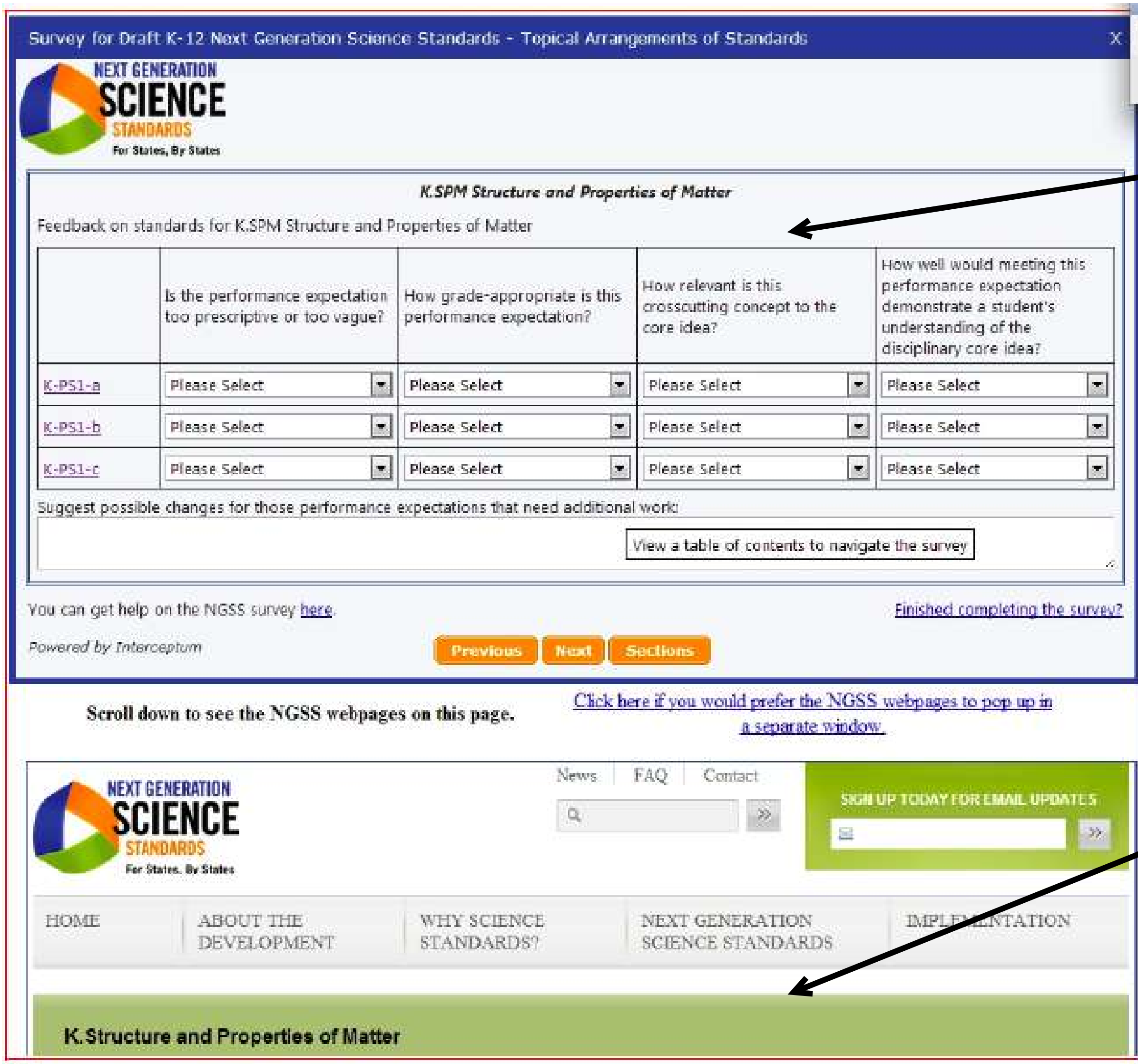
Three Part Survey

1. Respondent information

2. General survey about all the standards

3. Specific questions about Performance Expectations that interest you

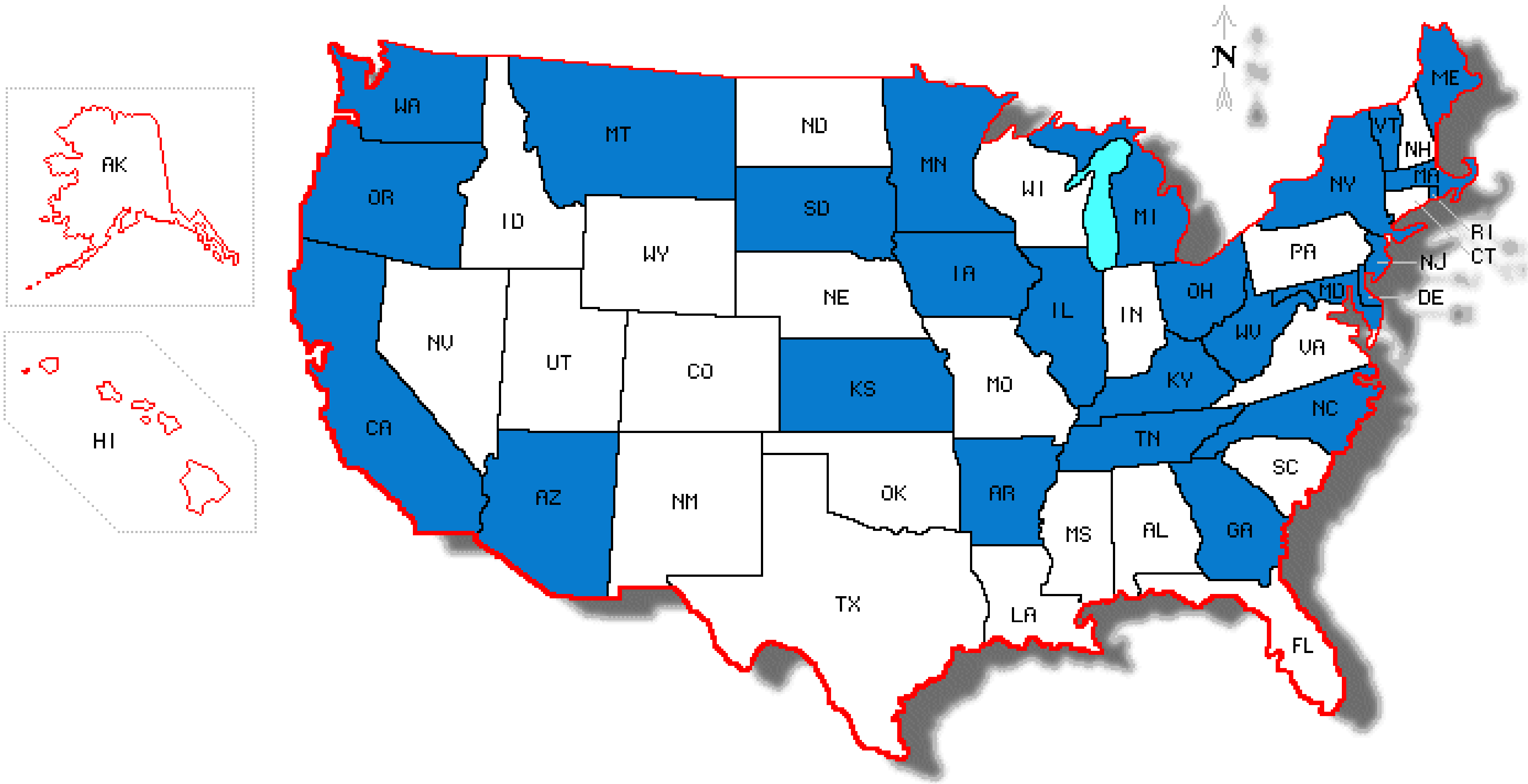
Performance Expectations Questions

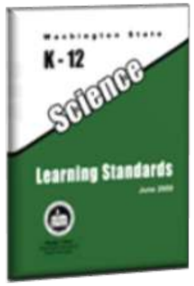


Questions about K.SPM

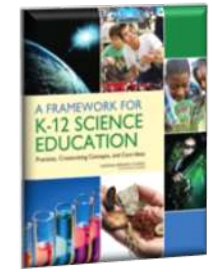
Online version of K.SPM

NGSS Lead States





Standards Connections



Washington Standards → **Next Generation Science Standards**

Four Essential Academic Learning Requirements

- **Systems**
- **Inquiry**
- **Application**
- **Domains**
  - **Life Science**
  - **Physical Science**
  - **Earth and Space Science**

Science and Engineering Practices

- **Identifies 8 Practices**
  - **Subsumes WA Inquiry**

Disciplinary Core Ideas

- **Adds Engineering and Technology**
  - **Subsumes WA Application**

Crosscutting Concepts

- **Adds 7 crosscutting concepts**
  - **Subsumes WA Systems and Application**

Thank you!

- For updated information on the NGSS, please check http://www.k12.wa.us/Science/NGSS.aspx