6/18/12

NEXT GENERATION SCIENCE STANDARDS

For States, By States

Developing the Next Generation Science Standards

Chris Embry Mohr

Olympia High School – Stanford, Illinois

Science and Agriculture Teacher, NGSS Writer

chrisembry.mohr@olympia.org   www.nextgenscience.org

Next Generation Science Standards

- Why NGSS?
- A Framework for K-12 Science Education

- Conceptual Shifts
- 3 Dimensions
- Standards & Performance Expectations
- College and Career Readiness
- Next Steps

Current State of Science Standards

Science documents used by states to develop standards are about 15 years old

- National Research Council's *National Science Education Standards* were published in 1996
- American Association for the Advancement of Science's *Benchmarks for Science Literacy* were published in 1993

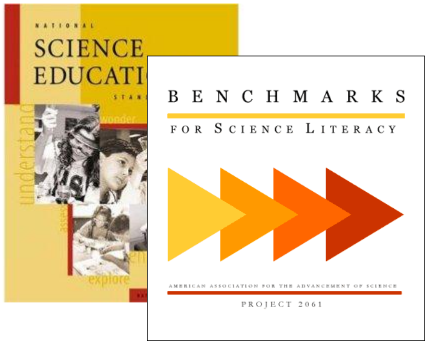
Call for new, internationally-benchmarked standards

- Students in the U.S. have consistently been outperformed on international assessments such as TIMSS and PISA
- States across the country will soon engage in a science revision

Standards Development

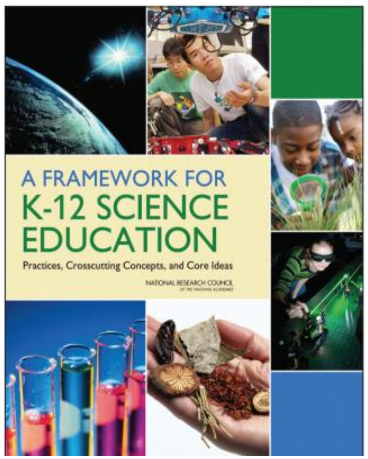
- Funded by the Carnegie Corporation
- Step 1 – Development of Framework by the National Research Council
- Step 2 – Development of Next Generation Science Standards
- State Adoption
- Implementation at Local Level

Building on the Past; Preparing for the Future



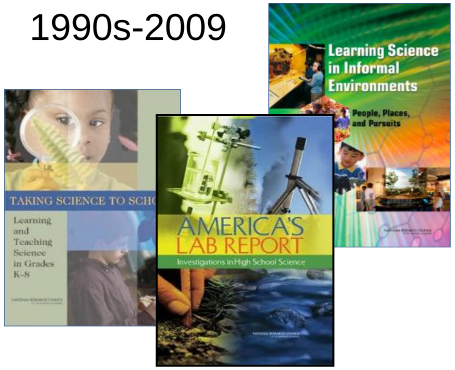
1990s

Phase I



1/2010 - 7/2011

1990s-2009



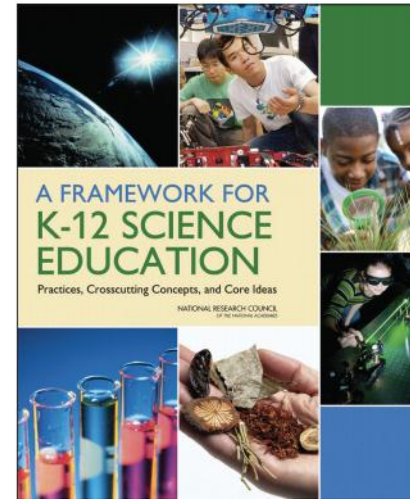
Phase II

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

7/2010 – Early 2013

www.nap.edu/

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**

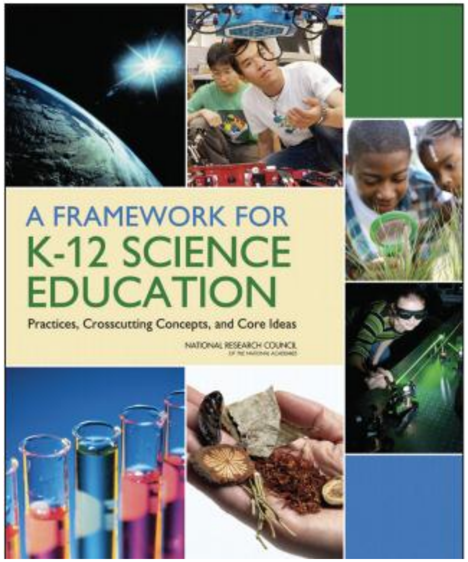
Children are Born Investigators

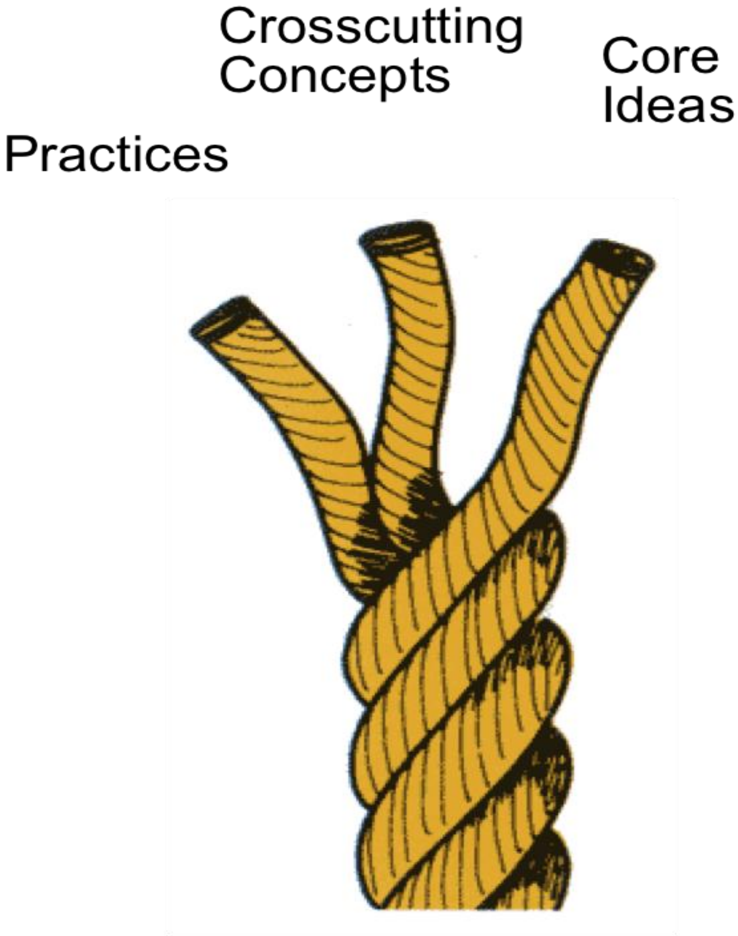
Conceptual Shifts in the NGSS

1. K–12 Science Education Should Reflect the Real World Interconnections in Science
2. Using all practices and crosscutting concepts to teach all core ideas all year
3. Science concepts build coherently across K-12
4. The NGSS Focus on Deeper Understanding and Application of Content
5. Integration of science and engineering
6. Coordination with Common Core State Standards

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Science & Engineering Require Both Knowledge & Content





Dimension 1: Scientific and Engineering Practices

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, Information and Computer Technology, and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Asking Questions. . .

Why are there seasons?

Why did the structure collapse?

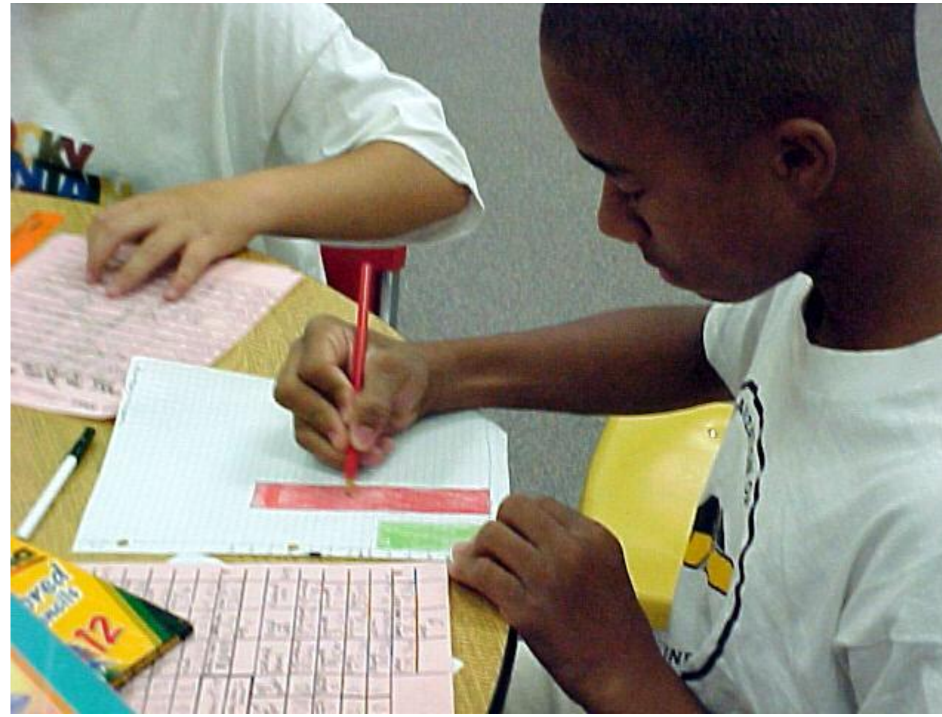
How is electric power generated?

What do plants need to survive?

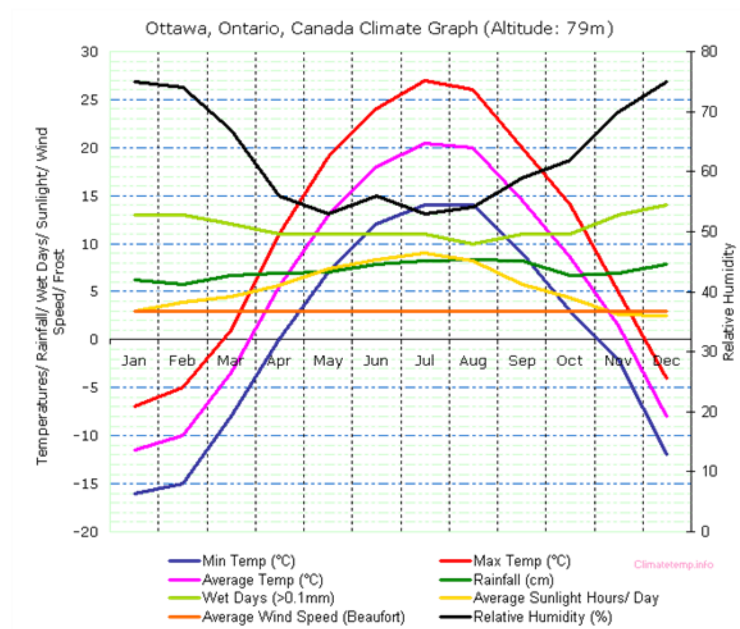
. . . and Defining Problems

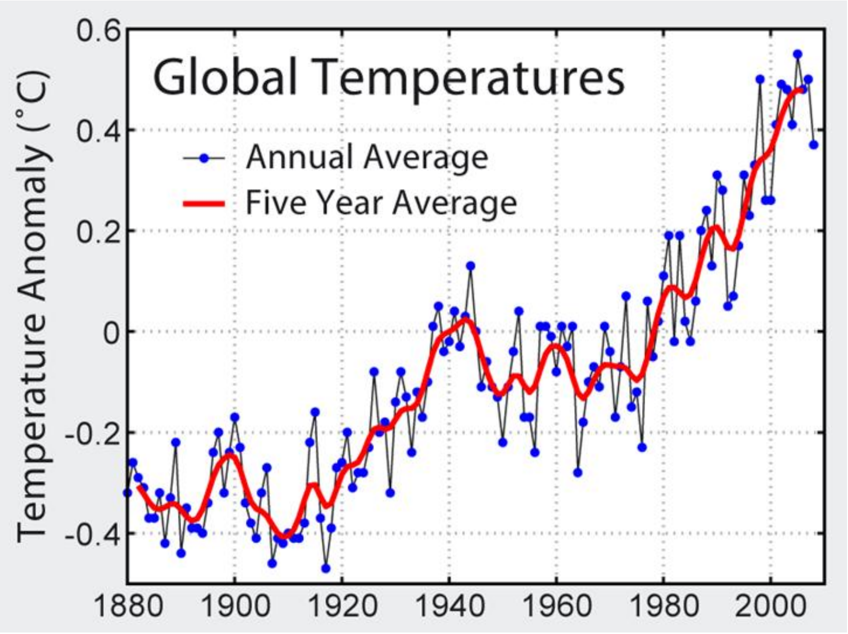
Developing and Using Models

Planning and Carrying Out Investigations

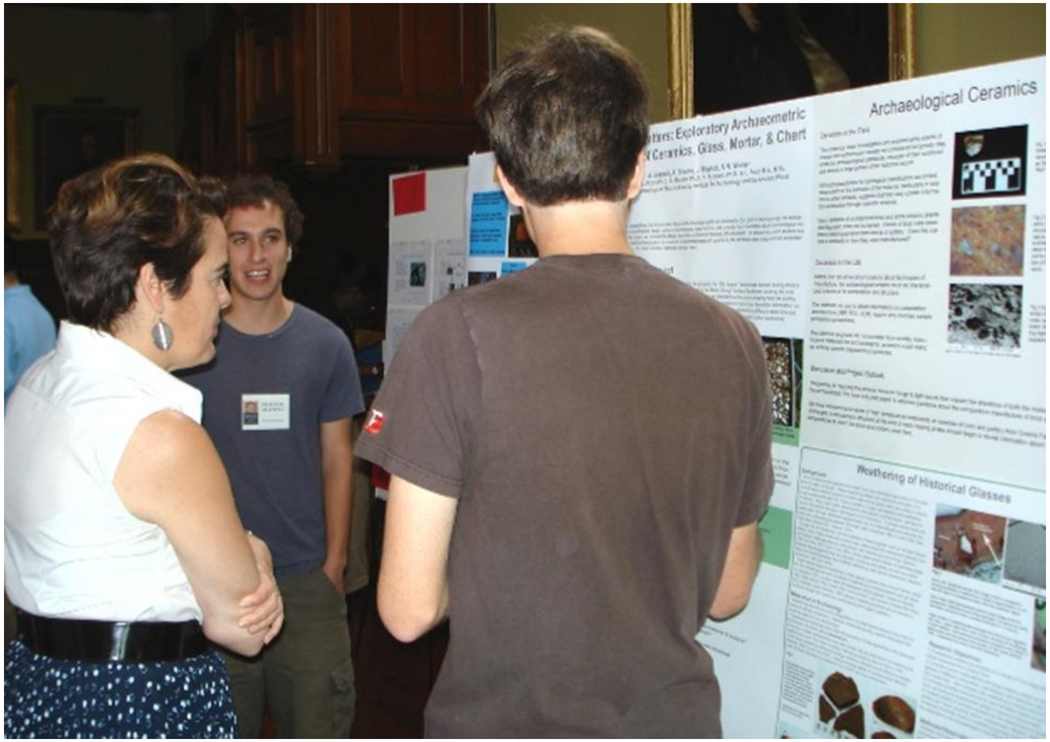


Analyzing and Interpreting Data



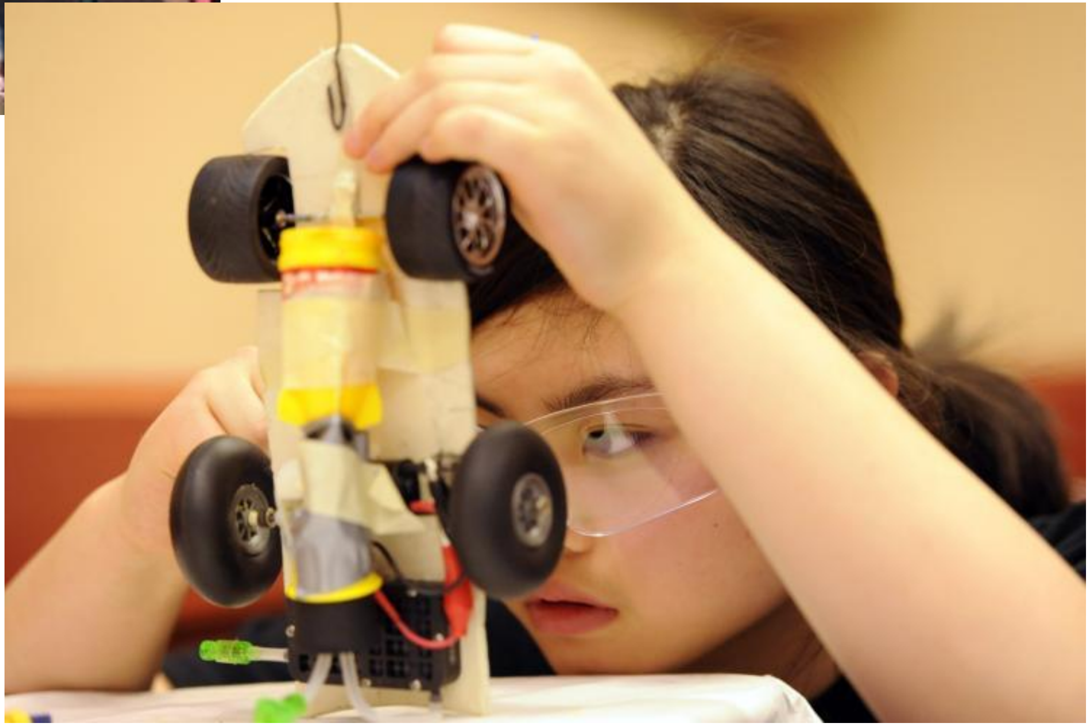


Using Mathematics and Computational Thinking

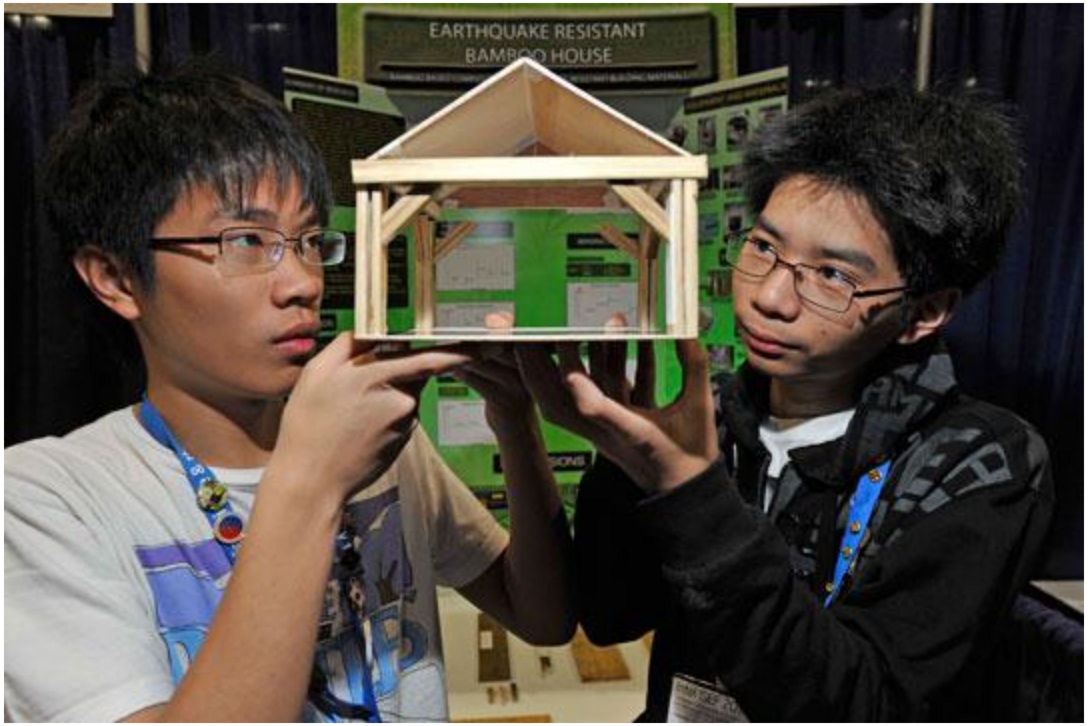


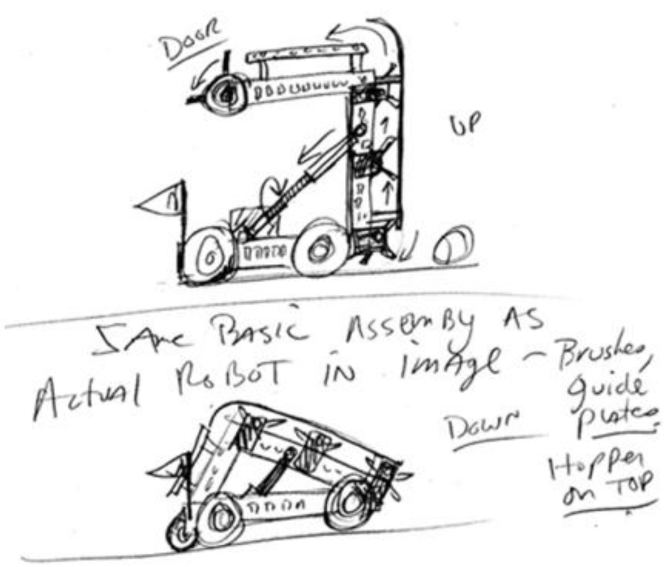
Constructing Explanations (Science) and . . .

. . . Designing Solutions (Engineering)



Engaging in Argument from Evidence



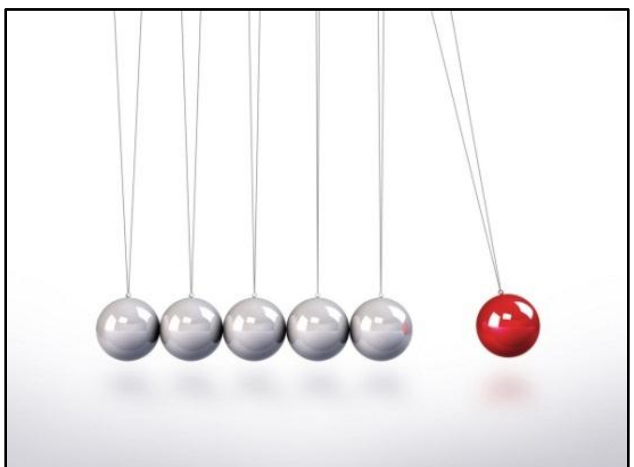


Obtaining, Evaluating, and Communicating Information

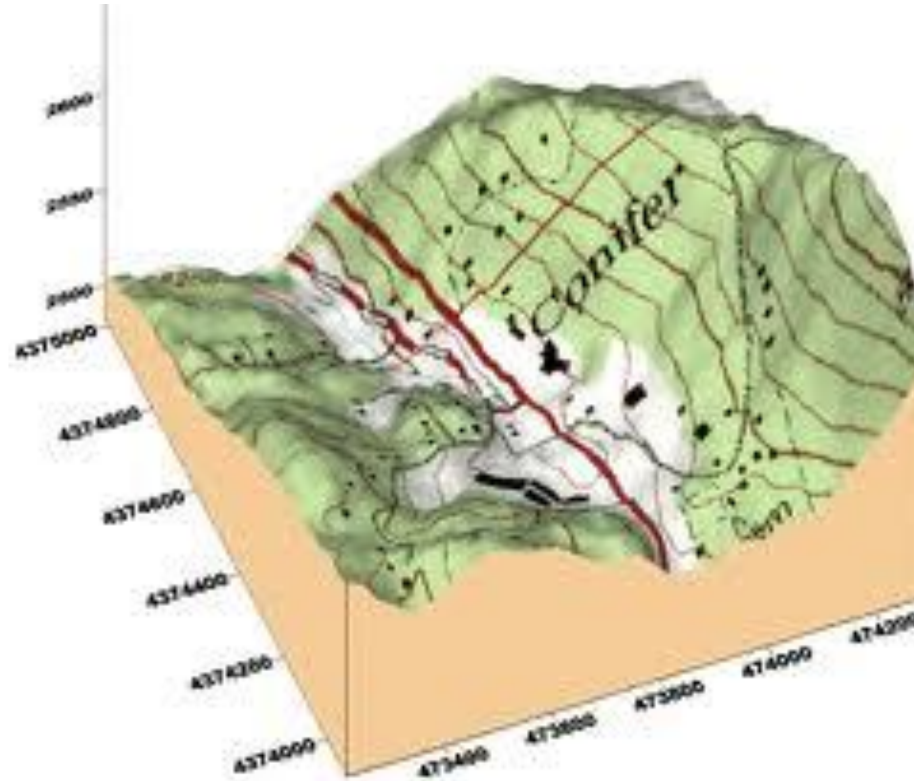
Dimension 2: Crosscutting Concepts

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

Patterns

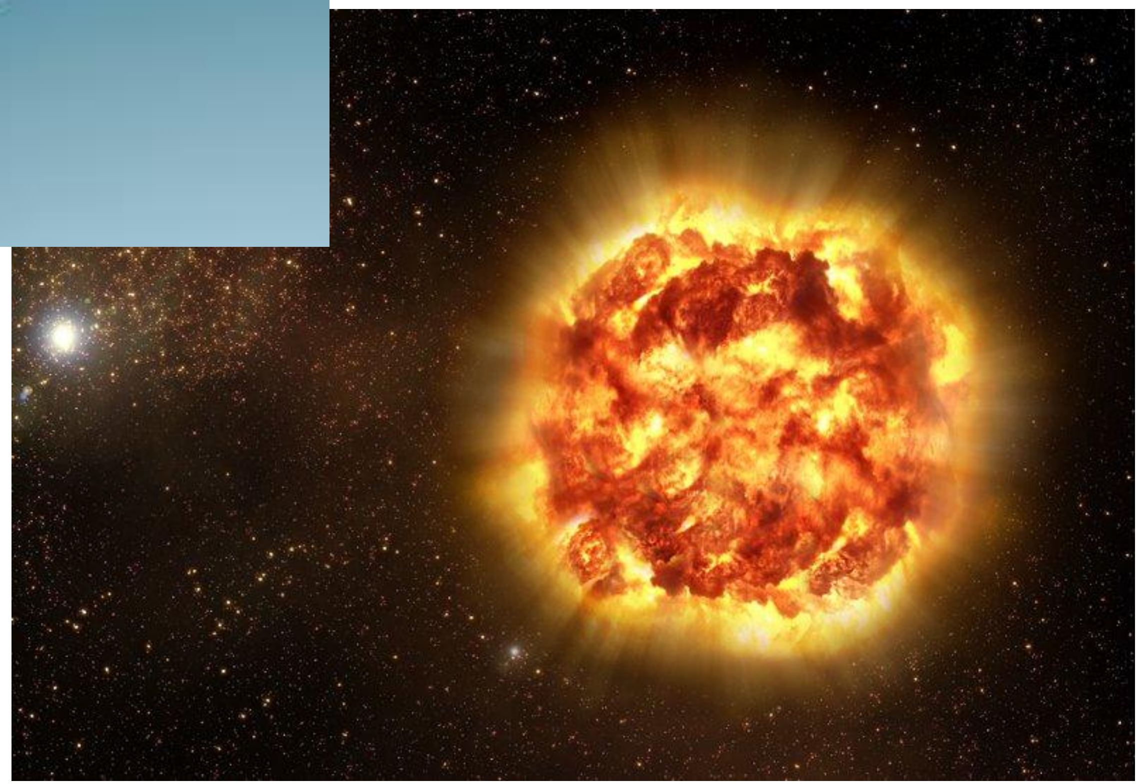


Cause and Effect



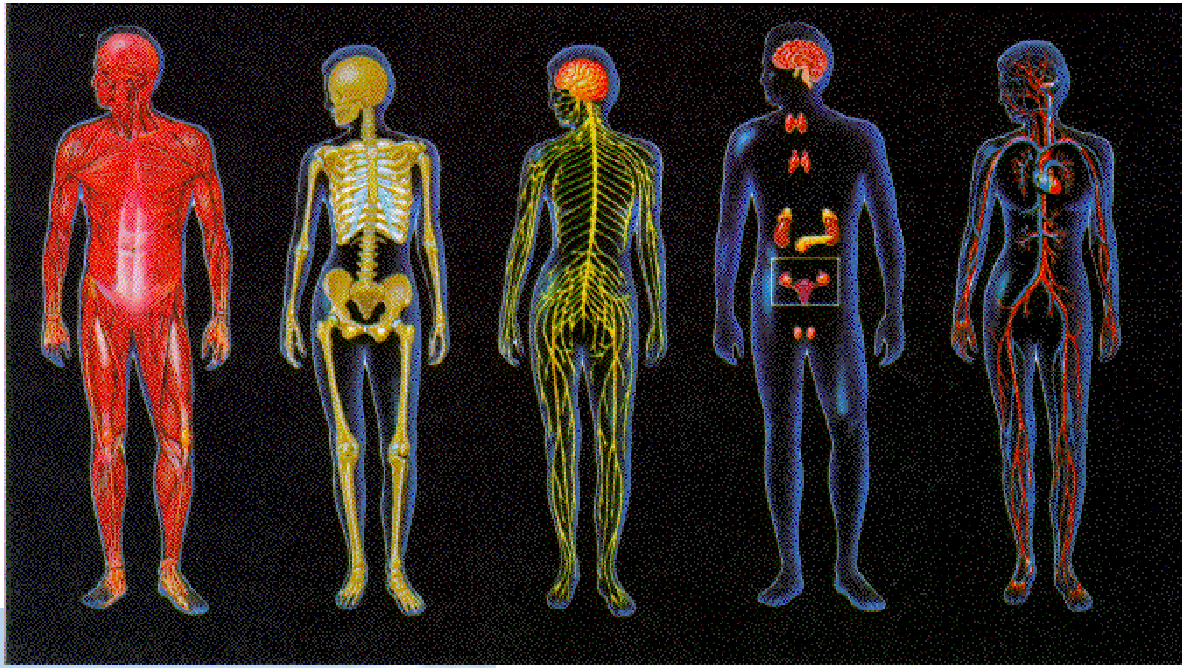
Scale, Proportion, and Quantity

Systems and System Models



Energy and Matter

Structure and Function



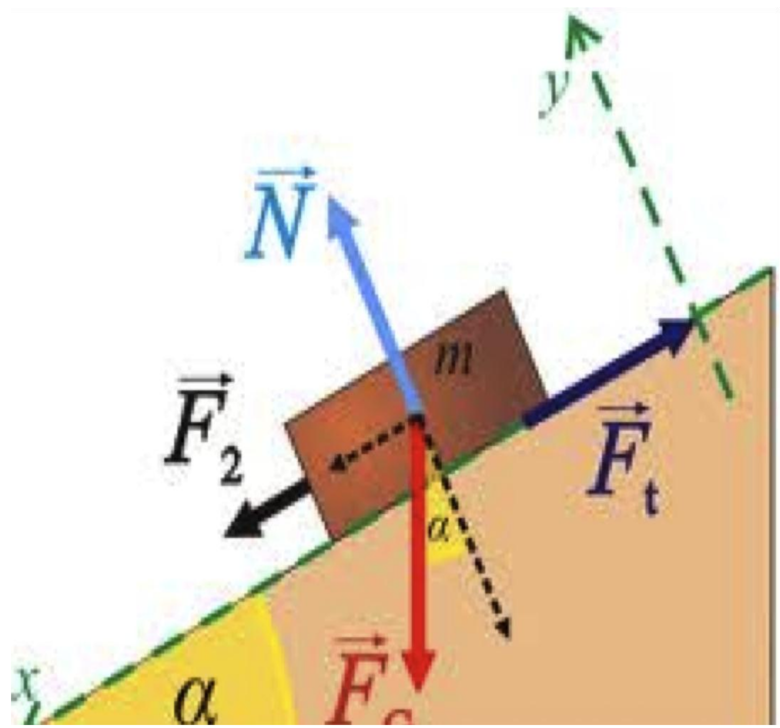
Stability and Change

Dimension 3: Disciplinary Core Ideas

1. Physical Sciences
2. Life Sciences
3. Earth and Space Sciences
4. Engineering, Technology, and Applications of Science

Physical Sciences

- PS 1: Matter and Its Interactions
- PS 2: Motion and Stability
- PS 3: Energy
- PS 4: Waves and Their
  Applications

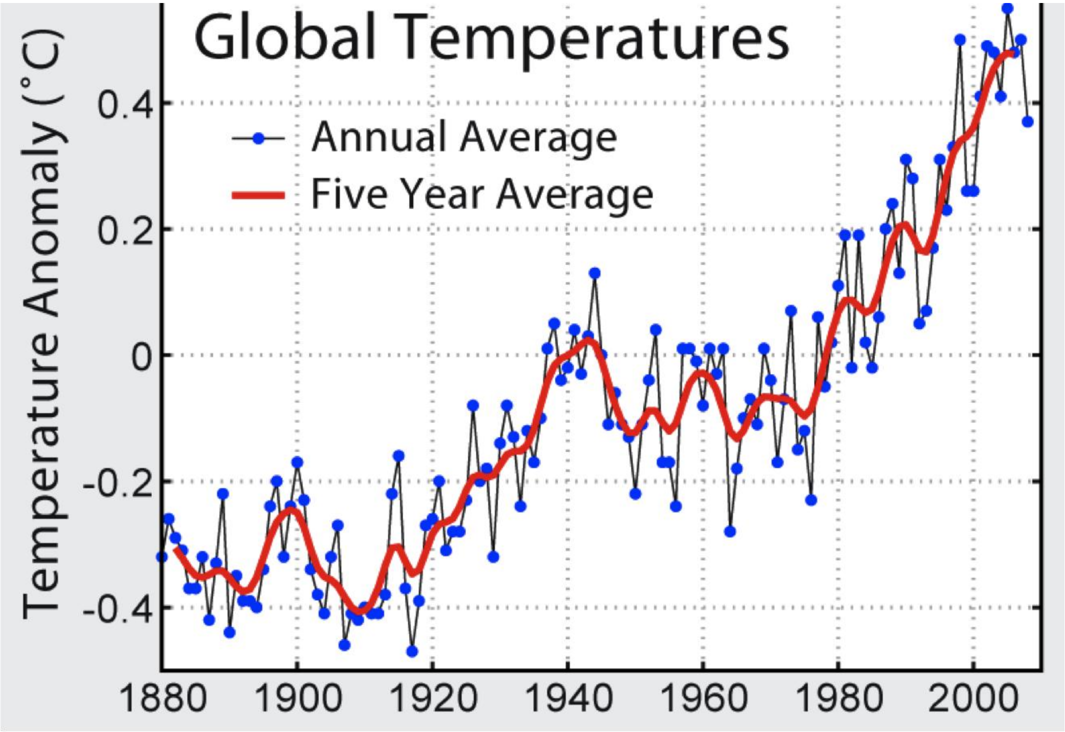


Life Sciences

- LS 1: From Molecules to Organisms: Structures and Processes
- LS 2: Ecosystems: Interactions, Energy, and Dynamics
- LS 3: Heredity: Inheritance and Variation of Traits
- LS 4: Biological Evolution: Unity and Diversity

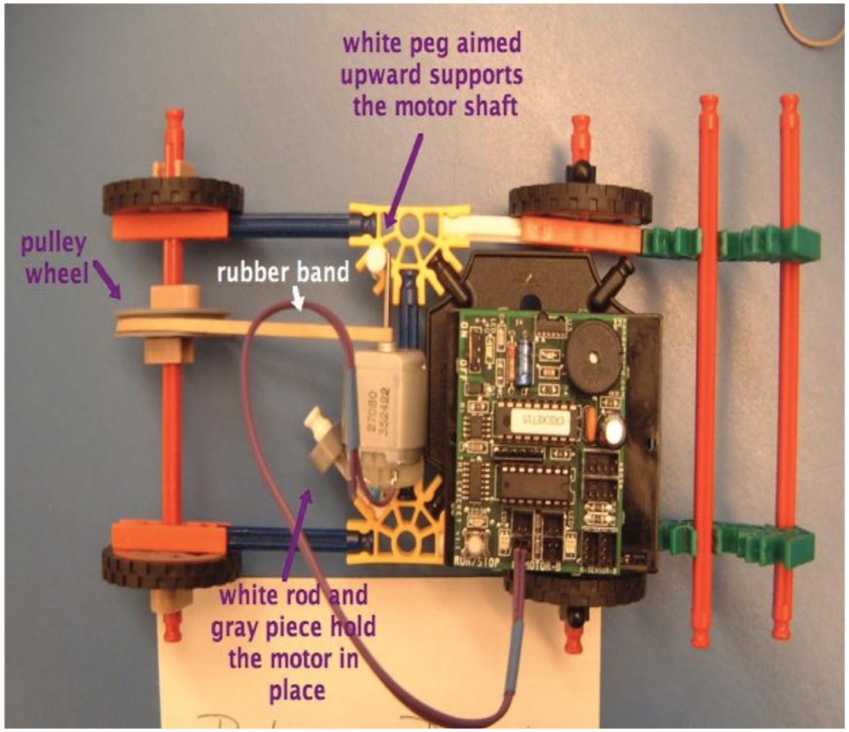
Earth and Space Sciences

- ESS 1: Earth's Place in the Universe
- ESS 2: Earth Systems
- ESS 3: Earth and Human Activity



Engineering, Technology and Applications of Sciences

- ETS 1: Engineering Design
- ETS 2: Links Among Engineering, Technology, Science and Society



Disciplinary Core Ideas

A core idea for K-12 science instruction is a scientific idea that:

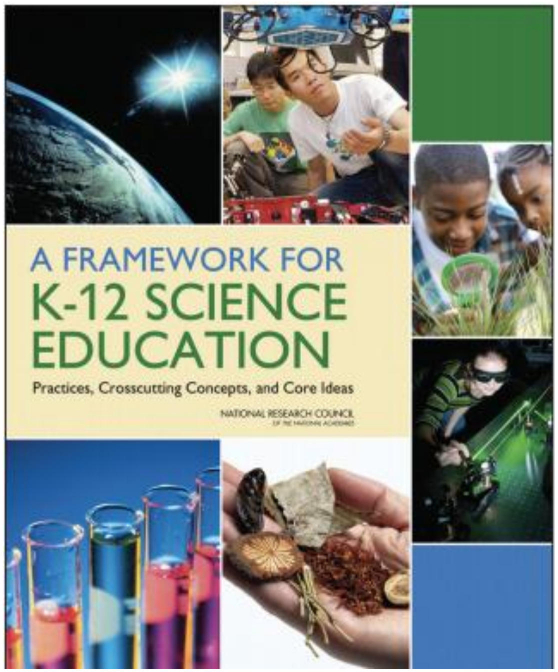
- Has <u>broad importance</u> across multiple science or engineering disciplines or is a <u>key organizing concept</u> of a single discipline
- Provides a <u>key tool</u> for understanding or investigating more complex ideas and solving problems
- Relates to the <u>interests and life experiences of students</u> or can be connected to <u>societal or personal concerns</u> that require scientific or technical knowledge
- Is <u>teachable</u> and <u>learnable</u> over multiple grades at increasing levels of depth and sophistication

Process for Development of *Next Generation Science Standards*

States and other key stakeholders are engaged in the development and review of the new college and career ready science standards

- State Led Process
- Writing Teams
- Critical Stakeholder Team
- Achieve is managing the development process

NRC Study Committee members to check the fidelity of standards based on framework



NEXT GENERATION
SCIENCE
STANDARDS

Current State Science Standard
Sample

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.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Standards Comparison: Structure and Properties of Matter

Current State Middle School Science Standard

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.

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.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Standards Comparison: Structure and Properties of Matter

Current State Middle School Science Standard

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.

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.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Standards Comparison: Structure and Properties of Matter

Current State Middle School Science Standard

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.

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.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Standards Comparison: Structure and Properties of Matter

Current State Middle School Science Standard	NGSS Middle School Sample
a. Distinguish **between atoms and molecules**.	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. Describe the difference between **pure substances (elements and compounds) and mixtures**.	b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
c. Describe the **movement of particles in solids, liquids, gases, and plasmas states**.	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. Distinguish between **physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility**).	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.
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**.	

NEXT GENERATION SCIENCE STANDARDS For States, By States

Standards Comparison: Structure and Properties of Matter

Current State Middle School Science Standard

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**.

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**.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

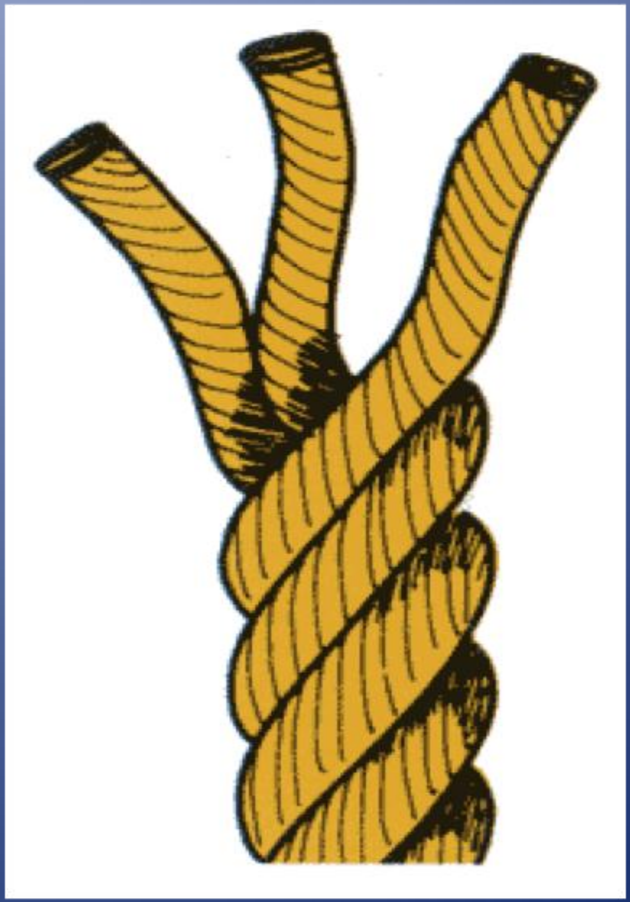
NGSS Architecture

Integration of…

Crosscutting Concepts

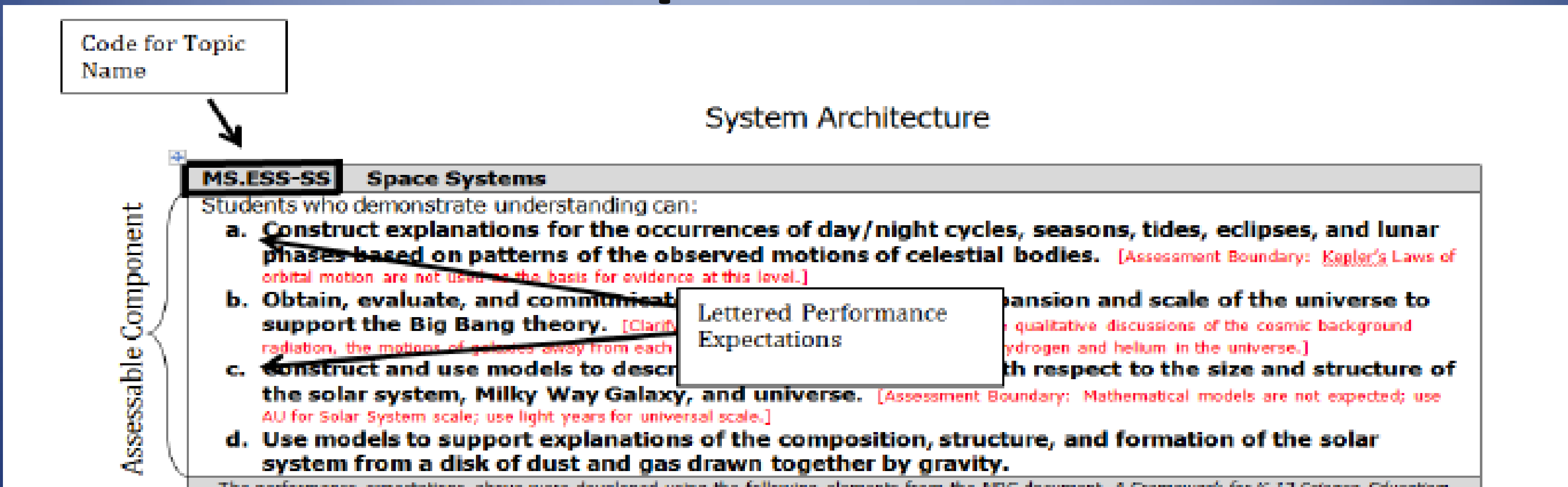
Core Ideas

Practices



To create Performance Expectations that make up Standards

Reading NGSS – Performance Expectations



- Each performance Expectation incorporates a practice, a disciplinary core idea, and a crosscutting concept

Reading NGSS – Performance Expectations

MS.PS-SPM Structure and Properties of Matter

MS.PS-SPM Structure and Properties of Matter
Students who demonstrate understanding can:
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. [Clarification Statement: Examples of atoms combining can include Hydrogen (H_2) and Oxygen (O_2) combining to form hydrogen peroxide (H_2O_2) or water (H_2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]

- ***Assessment Boundary Statements* are included with individual performance expectations where appropriate, to provide further guidance or to specify the scope of the expectation at a particular grade level.**

Reading NGSS – Performance Expectations

MS.PS-SPM Structure and Properties of Matter

MS.PS-SPM Structure and Properties of Matter
Students who demonstrate understanding can: **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.** [Clarification Statement: Examples of atoms combining can include Hydrogen (H_2) and Oxygen (O_2) combining to form hydrogen peroxide (H_2O_2) or water (H_2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]

- ***Clarification Statements*** **are designed to supply examples or additional clarification to the performance expectations.**

Reading NGSS – Foundation Boxes
Science and Engineering Practices

Performance Expectations

MS.PS-SPM Structure and Properties of Matter

MS.PS-SPM Structure and Properties of Matter

Students who demonstrate understanding can:

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. [Clarification Statement: Examples of atoms combining can include Hydrogen (H_2) and Oxygen (O_2) combining to form hydrogen peroxide (H_2O_2) or water (H_2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]

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

Foundation Boxes

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 explain, explore, and predict more abstract phenomena and design systems. ▪ Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a)	**PS1.A: Structure and Properties of Matter** ▪ All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (a) ▪ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (a)	**Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (a)

- **Language based on Framework and expanded into matrices - further explain the science and engineering practices**
- **Most topical groupings of performance expectations emphasize only a few of the practices; however, all practices are emphasized within a grade band**
- **Teachers are encouraged to utilize several practices in any instruction**

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Reading NGSS – Foundation Boxes
Disciplinary Core Ideas

Performance Expectations

Foundation Boxes

MS.PS-SPM Structure and Properties of Matter

MS.PS-SPM Structure and Properties of Matter		
Students who demonstrate understanding can: **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.** [Clarification Statement: Examples of atoms combining can include Hydrogen (H_2) and Oxygen (O_2) combining to form hydrogen peroxide (H_2O_2) or water (H_2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]		
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 explain, explore, and predict more abstract phenomena and design systems. ▪ Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a)	**PS1.A: Structure and Properties of Matter** ▪ All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (a) ▪ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (a)	**Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (a)

- **Language comes straight from the Framework and further explains the Disciplinary Core Idea**

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Reading NGSS – Foundation Boxes
Crosscutting Concepts

MS.PS-SPM Structure and Properties of Matter

Performance Expectations

MS.PS-SPM Structure and Properties of Matter
Students who demonstrate understanding can: **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.** [Clarification Statement: Examples of atoms combining can include Hydrogen (H_2) and Oxygen (O_2) combining to form hydrogen peroxide (H_2O_2) or water (H_2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Foundation Boxes

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 explain, explore, and predict more abstract phenomena and design systems. ▪ Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a)	**PS1.A: Structure and Properties of Matter** ▪ All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (a) ▪ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (a)	**Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (a)

- **derived from the *Framework* to further explain the crosscutting concepts important to emphasize in each grade band**
- **Most topical groupings of PEs emphasize only a few of the crosscutting concept categories, however all are emphasized within a grade band**
- **the list is not exhaustive nor is it intended to limit instruction**

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Performance Expectations

Foundation Boxes

Connection Boxes

MS.PS-SPM Structure and Properties of Matter

MS.PS-SPM Structure and Properties of Matter		
Students who demonstrate understanding can: **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.** [Clarification Statement: Examples of atoms combining can include Hydrogen (H_2) and Oxygen (O_2) combining to form hydrogen peroxide (H_2O_2) or water (H_2O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]		
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 explain, explore, and predict more abstract phenomena and design systems. ▪ Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a)	**PS1.A: Structure and Properties of Matter** ▪ All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (a) ▪ Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (a)	**Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (a)
Connections to other DCIs in this grade-level: **MS.ESS-ESP, MS.ESS-SS, MS.LS-MEOE**		
Articulation of DCIs across grade-levels: **3.IF, 5.SPM, HS.PS.SPM, HS.PS-NP, HS.PS-E**		

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA –

W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.6.1 Write arguments to support claims with clear reasons and relevant evidence.

W.7.1 Write arguments to support claims with clear reasons and relevant evidence.

SL.5.4 Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

WHST.6-8.1 Write arguments focused on discipline-specific content.

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Mathematics –

MP.4 Model with mathematics.

MP.8 Look for and express regularity in repeated reasoning.

6.SP Develop understanding of statistical variability

Summarize and describe distributions

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Reading NGSS – Connections Boxes

Connections Boxes

Connections to other DCIs in this grade-level: **MS.LS-GDRO, MS.PS-FM, MS.PS-IF, MS.PS-E**

Articulation to DCIs across grade-levels: **1.PCS, 5.SSS, HS.ESS-SS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA –

W.6.1 Write arguments to support claims with clear reasons and relevant evidence.

W.6.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

W.7.1 Write arguments to support claims with clear reasons and relevant evidence.

W.7.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

W.8.1 Write arguments to support claims with clear reasons and relevant evidence.

W.8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

Mathematics –

MP.4 Model with mathematics

8.F Use functions to model relationships between quantities

- ***Connections to other DCIs in this grade level*:**
- **contains names of science topics in other disciplines that have corresponding disciplinary core ideas at the same grade level.**
- **this box will provide links to specific performance expectations**

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Reading NGSS – Connections Boxes

Connections Boxes

Connections to other DCIs in this grade-level: **MS.LS-GDRO, MS.PS-FM, MS.PS-IF, MS.PS-E**

Articulation to DCIs across grade-levels: **1.PCS, 5.SSS, HS.ESS-SS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA –

W.6.1	Write arguments to support claims with clear reasons and relevant evidence.
W.6.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
W.7.1	Write arguments to support claims with clear reasons and relevant evidence.
W.7.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.7.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1	Write arguments to support claims with clear reasons and relevant evidence.
W.8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

Mathematics –

MP.4	Model with mathematics
8.F	Use functions to model relationships between quantities

- ***Articulation of DCIs across grade levels*:**
- **will contain the names of other science topics that either provide a foundation or build on the foundation of this standard**

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Reading NGSS – Connections Boxes

Connections Boxes

Connections to other DCIs in this grade-level: **MS.LS-GDRO, MS.PS-FM, MS.PS-IF, MS.PS-E**

Articulation to DCIs across grade-levels: **1.PCS, 5.SSS, HS.ESS-SS**

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

ELA –

W.6.1 Write arguments to support claims with clear reasons and relevant evidence.
W.6.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
W.7.1 Write arguments to support claims with clear reasons and relevant evidence.
W.7.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
W.8.1 Write arguments to support claims with clear reasons and relevant evidence.
W.8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

Mathematics –

MP.4 Model with mathematics
8.F Use functions to model relationships between quantities

- ***<u>Connections to the Common Core State Standards</u>*:**
- **will contain the coding and names of Common Core State Standards in English Language Arts & and Literacy and Mathematics that align to the performance expectations**

The May 2012 draft standard above is now obsolete, as the standards are currently under revision.

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

NEXT GENERATION

SCIENCE

STANDARDS

www.nextgenscience.org

NEXT GENERATION SCIENCE STANDARDS

News | FAQ | Contact

SIGN UP TODAY FOR EMAIL UPDATES

HOME | ABOUT THE DEVELOPMENT | WHY SCIENCE STANDARDS? | NEXT GENERATION SCIENCE STANDARDS | IMPLEMENTATION

1 2 3

CURRENT PHASE

The draft standards are ready for public review

Click here to review the NGSS draft and provide feedback

4 5 6 7 8 9

About NGSS

Next Generation Science Standards for Today's Students and Tomorrow's Workforce: Through a collaborative, state-led process managed by Achieve, new K–12 science standards are being developed that will be rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education. The NGSS will be based on the *Framework for K–12 Science Education* developed by the National Research Council.

Latest News

The First Public Draft of the NGSS is Ready for Your Review
May 11, 2012

New Poll Shows Strong Support for Improving Science Education
March 30, 2012

Final Print Version of A Framework for K-12 Science Education is Now Available
March 07, 2012

Resources

Watch a webinar about the NGSS

Contact Us | Press | Site Map

It was a DRAFT!

NEXT GENERATION SCIENCE STANDARDS
For States, By States

NEXT GENERATION SCIENCE STANDARDS

For States, By States

Defining College and Career Readiness for the Next Generation Science Standards

June 11- 13, 2012

Washington DC

Purpose

State teams, including representatives from 2-year and 4-year post-secondary education institutions and businesses, will evaluate the NGSS to determine whether these standards are college and career ready or if changes are needed.

CCR Meeting

- 135 Participants from 2-year, 4-year colleges and business/employers
- 60 colleges, universities, and technical colleges/programs represented
- 14 hiring managers
- 7 education-based organizations not affiliated with the state education agencies

NEXT GENERATION SCIENCE STANDARDS For States, By States

Common Core State Standards defined CCR according to students' next steps

"College ready" indicates preparation for credit-bearing course work in two- or four-year colleges, without the need for remediation and with a strong chance for earning credit toward a designated program or degree.

"Career ready" indicates preparation for entry-level positions in quality jobs and career pathways that often require further education and training.

Science is different!

- Entry-level college science courses do not generally have pre-requisites
- Most colleges do not offer remedial courses in science

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Expert Group Convening – February 2012

- **Steve Barkanic**, Senior Director of STEM Policy and Programs, Business Higher Education Forum
- **Jeanne Contardo**, Director of Programs and Policy Analysis, Business Higher Education Forum
- **Robert Goodman**, Executive Director, New Jersey Center for Teaching and Learning
- **Kim Green**, Executive Director, National Association of State Directors of Career and Technical Education Consortium
- **Stan Jones**, President, Complete College America
- **Bill Schmidt**, University Distinguished Professor; Co-Director Education Policy Center, Michigan State University
- **Heidi Schweingruber**, Deputy Director, Board on Science Education (BOSE), National Research Council (NRC)

Preliminary Observations:

- **The Disciplinary Core Ideas (DCI) are based on research and the grade band endpoints are designed for all students.**

- ***Students need a knowledge of science to navigate the world and open the maximum number of career paths (Scientific Literacy).***

- ***Scientific Literacy = College and Career Readiness***

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Commissioned Studies

Review the assumptions of the NRC's *A Framework for K-12 Science Education* and propose a baseline definition for college and career readiness in science

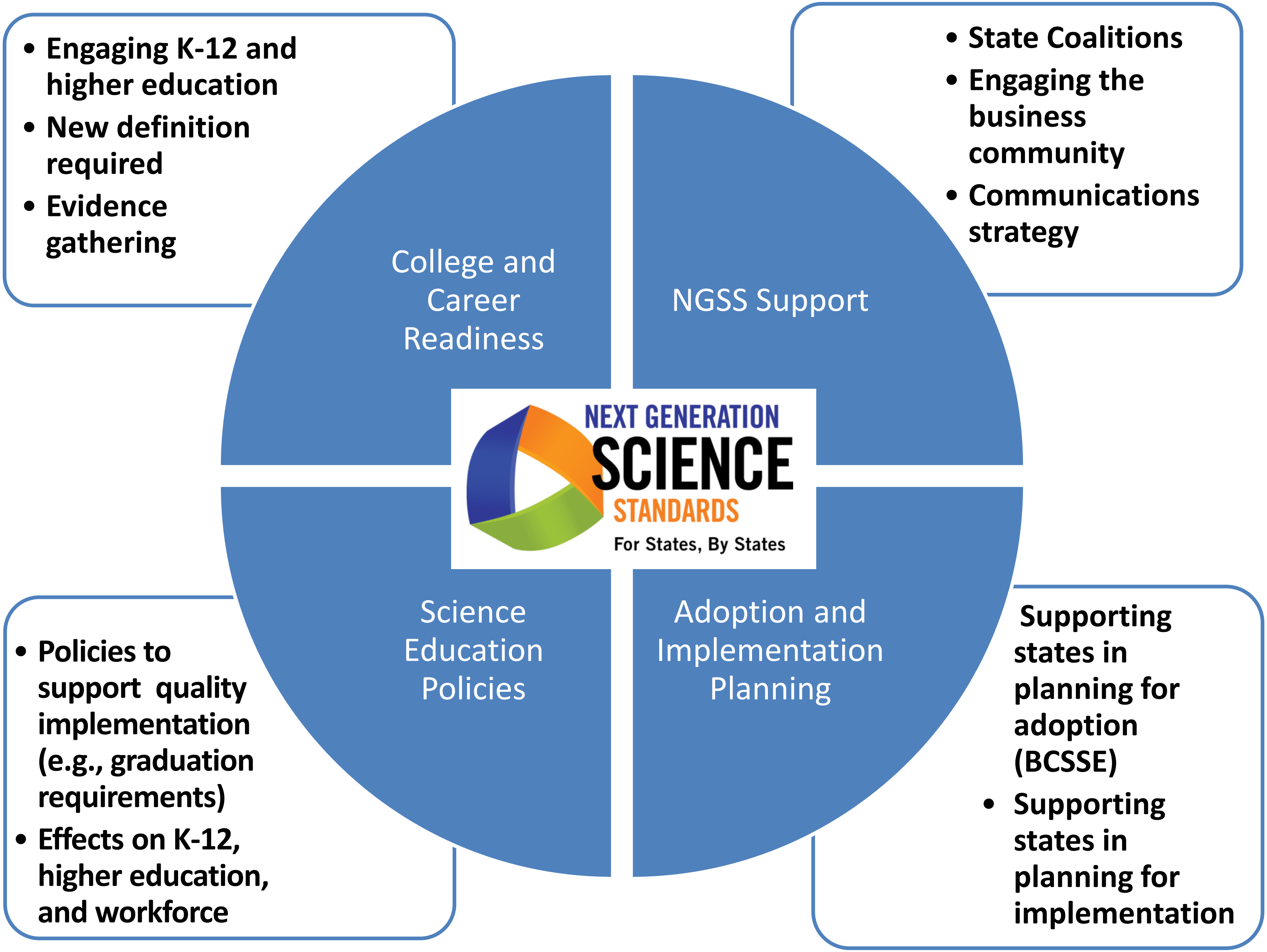
- ❑ ACT
- ❑ The College Board

What are the next steps?

CCR Next Steps

- **Present findings to states and writing team**
- **Most performance expectations were seen as college and career ready; some performances recommended for students pursuing STEM fields/majors; some additional performances recommended for STEM fields/majors**
- **Continue to gather evidence of CCR through smaller meetings with postsecondary faculty and employers through the next 6-8 months**

NEXT GENERATION SCIENCE STANDARDS For States, By States



• Engaging K-12 and higher education
• New definition required
• Evidence gathering
College and Career Readiness
• State Coalitions
• Engaging the business community
• Communications strategy
NGSS Support
NEXT GENERATION SCIENCE STANDARDS
For States, By States
Science Education Policies
• Policies to support quality implementation (e.g., graduation requirements)
• Effects on K-12, higher education, and workforce
Adoption and Implementation Planning
Supporting states in planning for adoption (BCSSE)
• Supporting states in planning for implementation

NGSS and CTE

- Develop common understanding of College and Career Readiness
- Increase Communication and Information Sharing
- Align Expectations
- Encourage and Support Collaboration (vertical and horizontal)
- Create and Update Instructional and Curricular Resources
- Synthesis of CTE and Science

Thank you!!

Chris Embry Mohr

Olympia High School

7832 N 100 East Road

Stanford, IL 61774

309.379.5911 x9334

Cell 309.275.5189

chrisembry.mohr@olympia.org

www.nextgenscience.org

NEXT GENERATION SCIENCE STANDARDS

Thank you!!

Science and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

NEXT GENERATION SCIENCE STANDARDS

www.nextgenscience.org

Science and Engineering Practices Matrix

Science Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
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 multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.	Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence in constructing explanations and designing solutions. • Use information from observations to construct explanations about investigations. • Use tools and materials provided to design a solution to a specific problem.	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. • Use quantitative relationships to construct explanations for observed events. • Use evidence (e.g., measurements, observations, patterns) to construct a scientific explanation or solution to a problem. • Distinguish evidence-based explanations from non-evidence based explanations. • Apply scientific knowledge to solve design problems.	Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. • Use qualitative and quantitative relationships between variables to construct explanations for phenomena. • Apply scientific reasoning to link evidence to claims and show why the data is adequate for the explanation or conclusion. • Generate and revise causal explanations from data (e.g., observations, sources of reliable information) and relate these explanations to current knowledge. • Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. • Undertake design projects, engaging in the design cycle, to construct and implement a solution that meets specific design criteria and constraints. • Apply scientific knowledge to explain real-world examples or events and solve design problems. • Construct explanation from models or representations.	Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent sources of evidence consistent with scientific knowledge, principles, and theories. • Make quantitative claims regarding the relationship between dependent and independent variables. • Apply scientific reasoning, theory, and models to link evidence to claims and show why the data is adequate for the explanation or conclusion. • Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review. • Base casual explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. • Apply scientific knowledge to solve design problems by taking into account possible unanticipated effects.

The May 2012 draft above is now obsolete, as the standards are currently under revision.

Crosscutting Concepts Matrix

2. Cause and Effect: Mechanism and Prediction – Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.			
K-2 Crosscutting Statements	**3-5 Crosscutting Statements**	**6-8 Crosscutting Statements**	**9-12 Crosscutting Statements**
Events have causes that generate observable patterns. Simple tests can be designed to gather evidence to support or refute student ideas about causes.	Cause and effect relationships are routinely identified, tested, and used to explain change. Events that occur together with regularity might or might not be a cause and effect relationship.	Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.

3. Scale, Proportion, and Quantity – In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.			
K-2 Crosscutting Statements	**3-5 Crosscutting Statements**	**6-8 Crosscutting Statements**	**9-12 Crosscutting Statements**
Relative scales allow objects to be compared and described (e.g. bigger and smaller; hotter and colder; faster and slower). Standard units are used to measure length.	Natural objects and observable phenomena exist from the very small to the immensely large. Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. The observed function of natural and designed systems may change with scale. Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Scientific relationships can be represented through the use of algebraic expressions and equations.	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Patterns observable at one scale may not be observable or exist at other scales. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g. linear growth vs. exponential growth).

NEXT GENERATION SCIENCE STANDARDS For States, By States

The May 2012 draft above is now obsolete, as the standards are currently under revision.

Connections to Engineering, Technology, and Applications of Science Matrix

1. ***Interdependence of Science, Engineering, and Technology*** –The fields of science and engineering are mutually supportive. Advances in science offer new capabilities, new materials, or new understandings that can be applied through engineering to produce advances in technology. Advances in technology by engineers, in turn, provide scientists with new capabilities to probe the natural world.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
Science and engineering involve the use of tools to observe and measure things.	Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.	Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. Science and technology drive each other forward.	Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

2. ***Influence of Engineering, Technology, and Science on Society and the Natural World*** – Advances in science and engineering have influenced the ways in which people interact with one another and with their surrounding natural and designed environments. Society's decisions about technology (whether made through market forces or political processes) influence the work of scientists and engineers.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. Taking natural materials to make things impacts the environment.	People's needs and wants change over time, as do their demands for new and improved technologies. Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. When new technologies become available, they can bring about changes in the way people live and interact with one another.	All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region.	Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

The May 2012 draft above is now obsolete, as the standards are currently under revision.