The NGSS and Public Garden Education

Katherine Johnson
Youth Education Director

CHICAGO BOTANIC GARDEN

The NGSS and Public Garden Education

1. Write your name on the big chart. Use colored dots to indicate your audience level for STEM programs.*

* *Number of participants, not number of different programs*

- Red Dot = greatest number of students each year / biggest audience
- Blue Dot = moderate number of students each year
- Yellow Dot = few students each year
- No Dot = no programs for this age group

2. On the small chart, indicate your comfort with NGSS

- Use a Green Dot to show: Not at all - Somewhat - Moderate - Very

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Workshop Agenda

1. The *Who, What, Where, When, and How* of the NGSS
2. The “Nature of Science”
3. The Structure of the NGSS
4. Aligning Three Existing Activities with NGSS
5. Small Group Discussion
6. Grade Level “Storylines” and Progressions
7. “Best Fit” Performance Expectations
8. Tips for Navigating the NGSS website (Topic vs. DCI Arrangement)
9. Quick Introduction to Evidence Statements
10. Worksheet for aligning your programs to NGSS

Welcome to the NGSS!

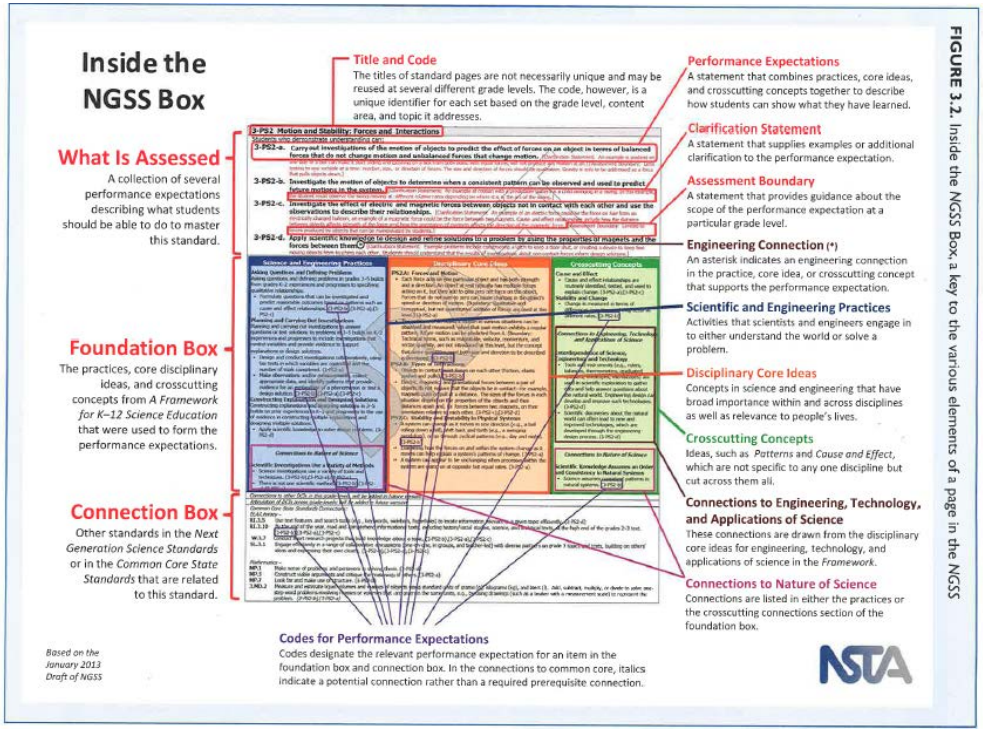


FIGURE 3.2. Inside the *NGSS* Box, a key to the various elements of a page in the *NGSS*

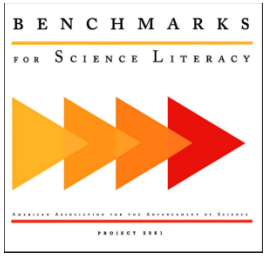
A Brief History of Science Education in the U.S.

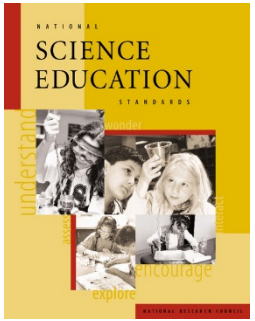
1980's: State Standards, Content Focused

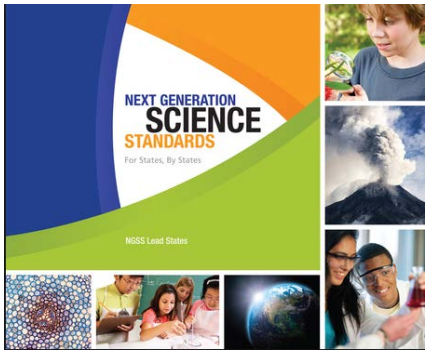
1993: *Benchmarks for Science Literacy*

1995: *National Science Education Standards*

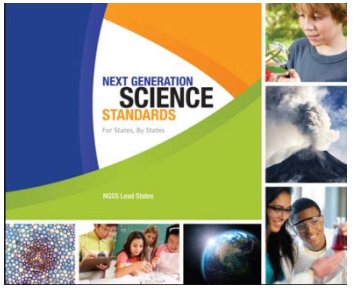
2013: *Next Generation Science Standards*







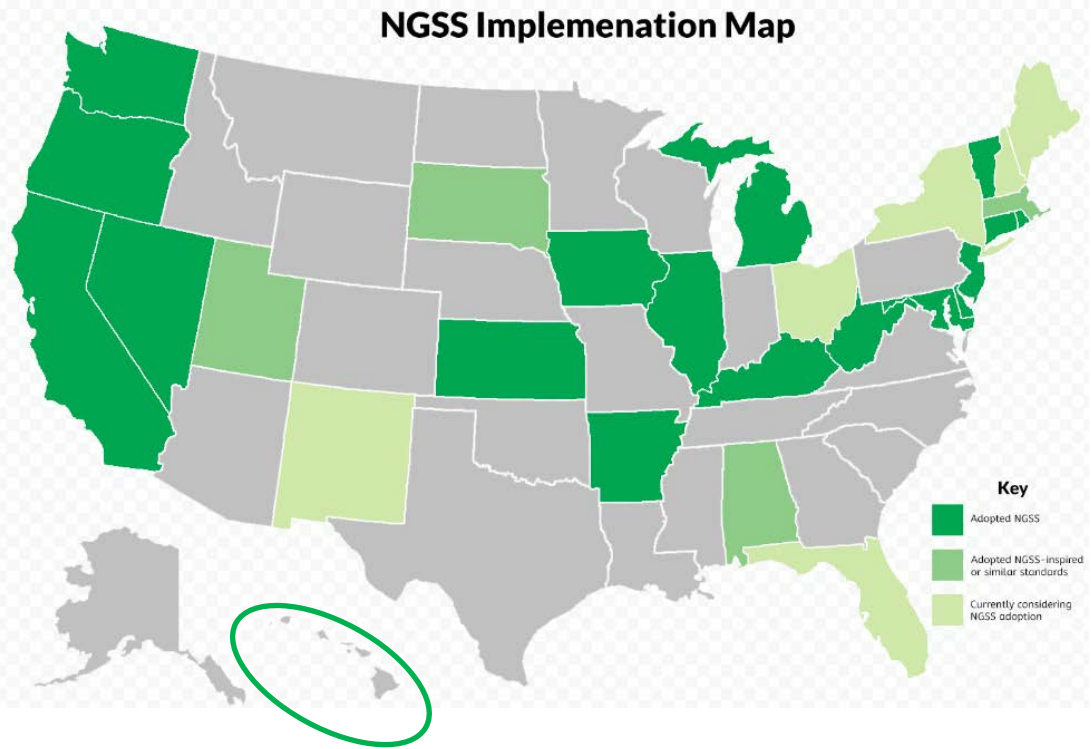
Who Developed the NGSS?



1. The National Research Council (NRC)
2. National Science Teachers Association (NSTA)
3. The American Association for the Advancement of Science (AAAS)
4. Achieve, Inc.
5. Lead State Partners from 26 states
6. A long list of elementary schools, colleges, universities, and educational organizations
7. More than 10,000 individuals who provided feedback on drafts

18 States + D.C. Have Adopted NGSS

Washington
Oregon
California
Nevada
Iowa
Kansas
Arkansas
Hawaii



Michigan
Illinois
Kentucky
West Virginia
Maryland
District of Columbia
Delaware
New Jersey
Connecticut
Rhode Island
Vermont

Source: Lawrence Hall of Science

The Nature of Science

The NOS Matrix

What scientists do

- Scientific investigations use a variety of methods
- Scientific knowledge is based on empirical evidence
- Scientific knowledge is open to revision in light of new evidence
- Scientific models, laws, mechanisms, and theories explain natural phenomena

How scientists think

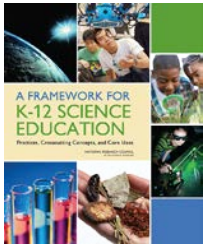
- Science is a way of knowing
- Scientific knowledge assumes an order and consistency in natural systems
- Science is a human endeavor
- Science addresses questions about the natural and material world

Implications for Teaching Science

Scientists and science teachers agree that science is a way of explaining the natural world. …science is both a set of practices and the historical accumulation of knowledge.

…students should develop an understanding of the enterprise of science as a whole—the wondering, investigating, questioning, data collecting and analyzing.

- NRC *Framework,* 2012



Comparison to Existing State Standards

Existing State Standards	Next Generation Science Standards
Provide separate lists of content students should know and processes that they should be able to do	Provide a set of performance expectations that integrate practices, core ideas, and crosscutting concepts
Based on the Benchmarks for Science Literacy (1993) and the National Science Education Standards (1996)	Based on the Framework for K-12 Science Education (2012)
Often assessed with multiple choice questions that emphasized definitions	Designed to be assessed in real world contexts
Engineering often excluded	Engineering integrated with science
Expectations for what some students need to learn	Expectations to prepare all students for college, career, and citizenship
No connections to mathematics and English language arts	Explicit connections to mathematics and English language arts included

What's Inside the NGSS Box?

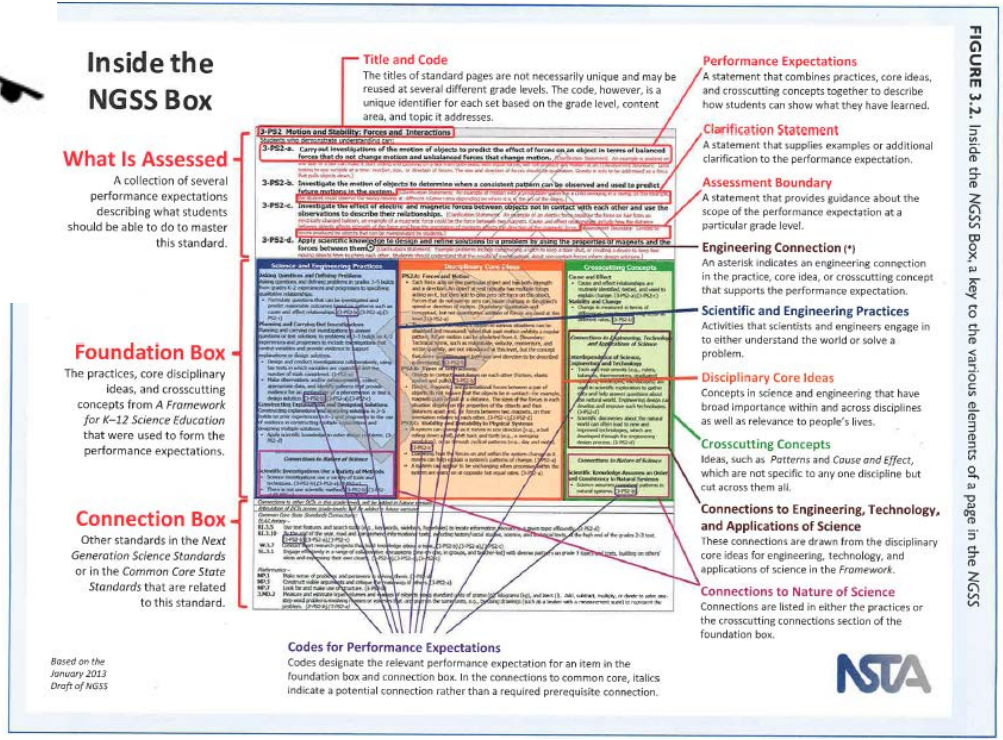


FIGURE 3.2. Inside the NGSS Box, a key to the various elements of a page in the NGSS

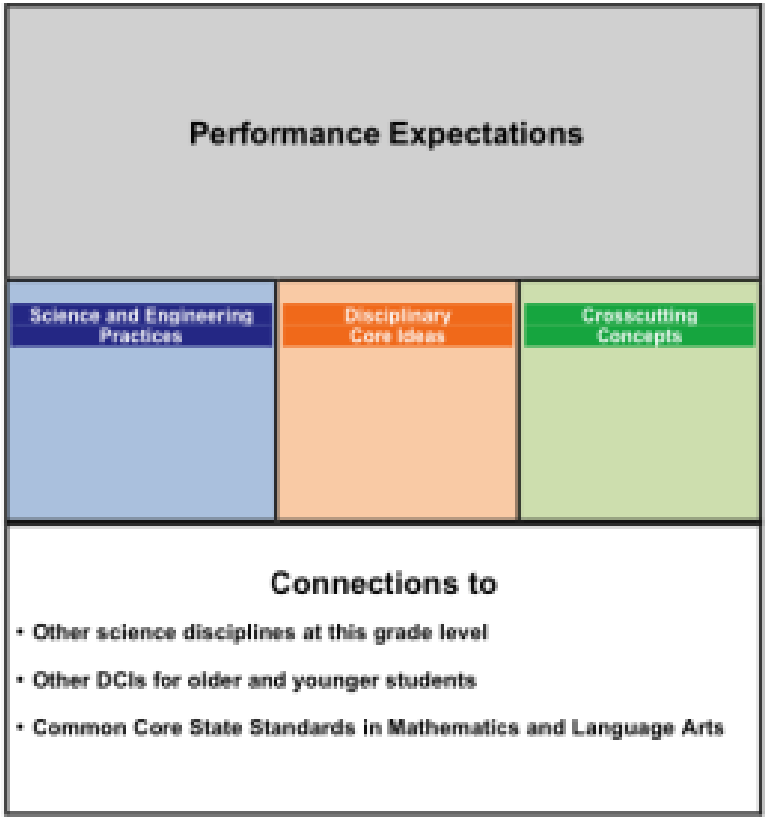
The Structure of the NGSS

The Three “Boxes”

What is Assessed →

Foundation Box →

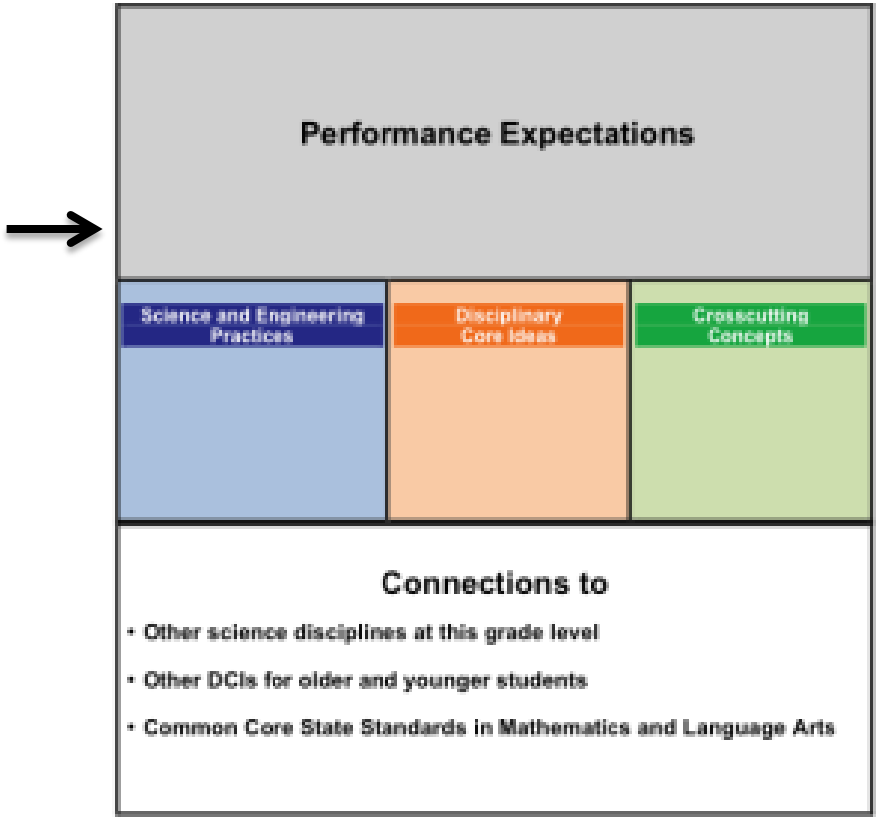
Connections Box →



Performance Expectations (What is Assessed)

Sample PE

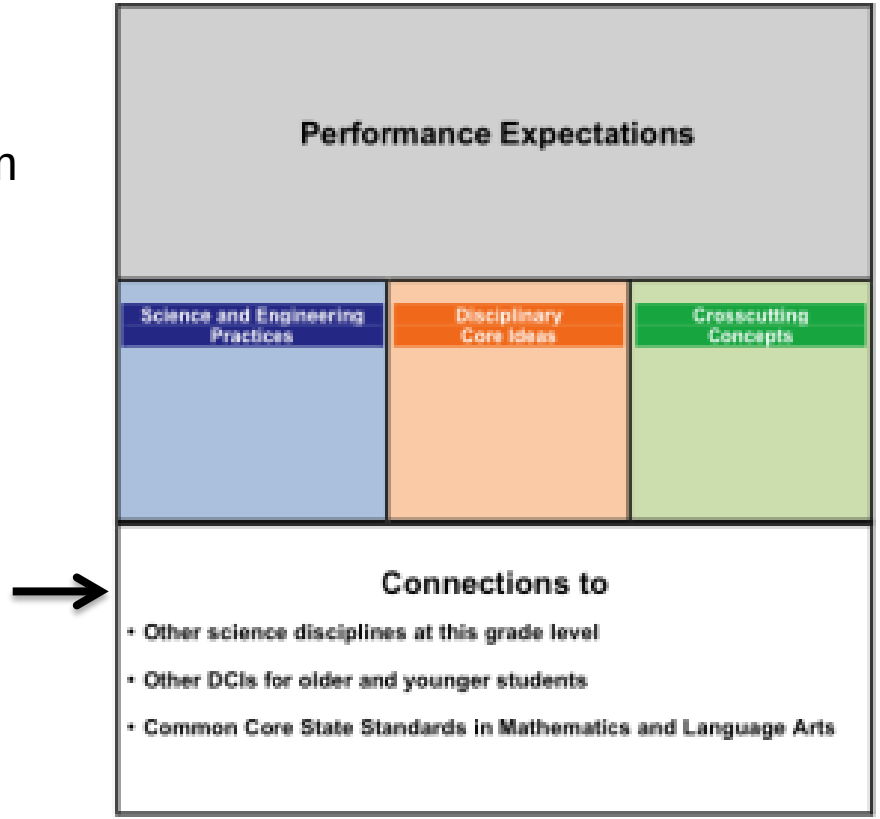
4-LS1-1. *Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.*



The Connections Box

Relationships across the curriculum

- Physical, Life, Earth & Space Sciences, Engineering & Technology
- Grade Levels
- Common Core English and Math



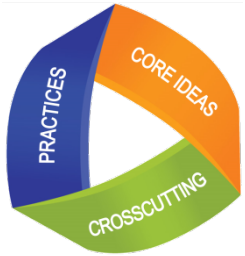
The Foundations Box

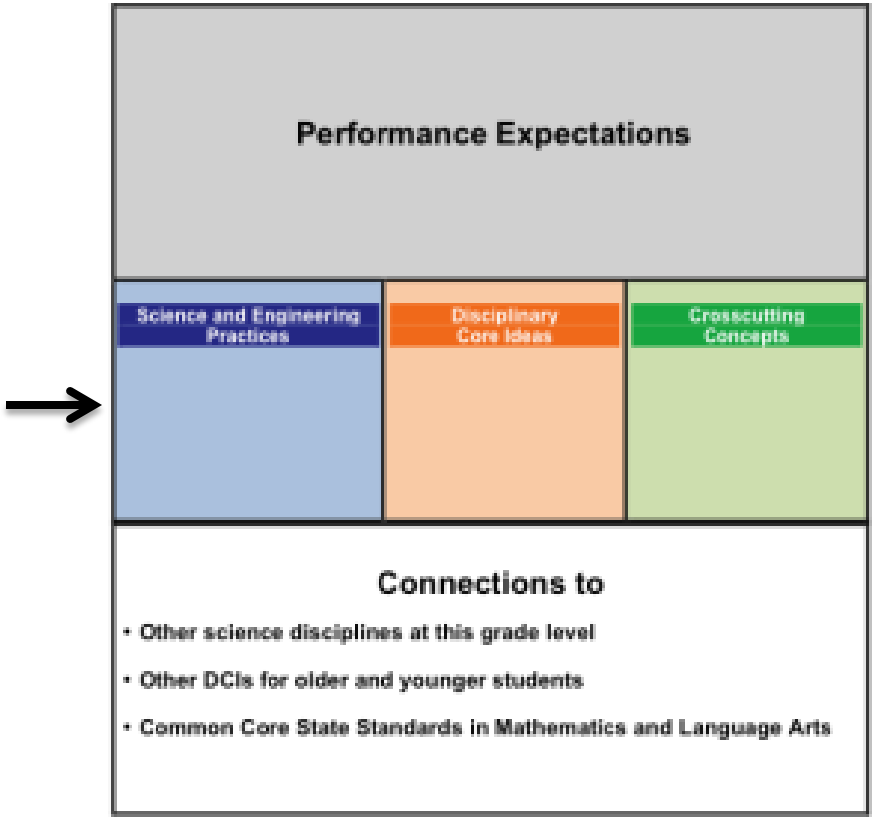
The Three Dimensions

Scientific and Engineering Practices (SEP)

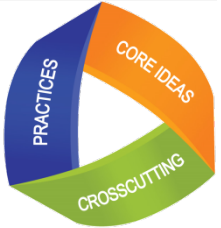
Disciplinary Core Ideas (DCI)

Crosscutting Concepts (CC)





The Disciplinary Core Ideas

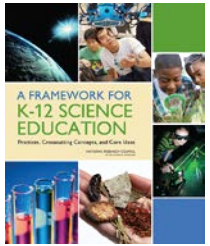


The “Content” Dimension

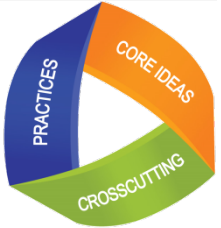
The framework focuses on a limited number of core ideas in science and engineering both within and across the disciplines. …

Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.

- NRC *Framework,* 2012



The “DCI” of NGSS



4 Disciplinary Core Ideas Categories

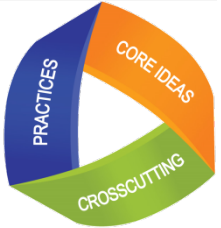
PS: Physical Sciences

LS: Life Sciences

ESS: Earth and Space Science

ETS: Engineering, Technology and the Applications of Science

The “PS” of NGSS



Disciplinary Core Ideas

Physical Sciences

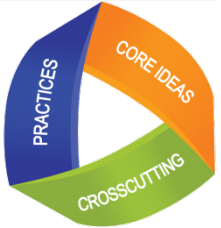
PS1: Matter and its interactions

PS2: Motions and stability: Forces and interactions

PS3: Energy

PS4: Waves and their applications in technologies for information transfer

The “LS” of NGSS



Disciplinary Core Ideas

Life Sciences

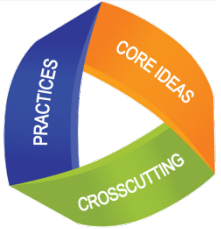
LS1: From molecules to organisms: Structures and processes
(Parts of a plant, plant structures, life cycles)

LS2: Ecosystems: Interactions, energy, and dynamics
(Reproduction, pollination, seed dispersal, photosynthesis, interrelationships)

LS3: Heredity: Inheritance and variation of traits
(Growth and development of individual plants)

LS4: Biological evolution: Unity and diversity
(Adaptation, plants in different places look different, biomes)

The “ESS” of NGSS



Disciplinary Core Ideas

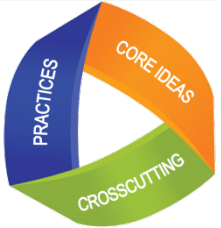
Earth and Space Sciences

ESS1: Earth’s place in the universe

ESS2: Earth’s systems
(Weather and climate, carbon cycling)

ESS3: Earth and human activity

The “ETS” of NGSS



Disciplinary Core Ideas

Engineering, Technology, and the Applications of Science

ETS1: Engineering design

ETS 2: Links among engineering, technology, science and society

Fitting an Activity to a DCI

Melting Ice Activity

- Participate like a student, try to answer the question and explain the answer.
- Be aware of your own thinking process and how you learn.
- Select a DCI for this activity.

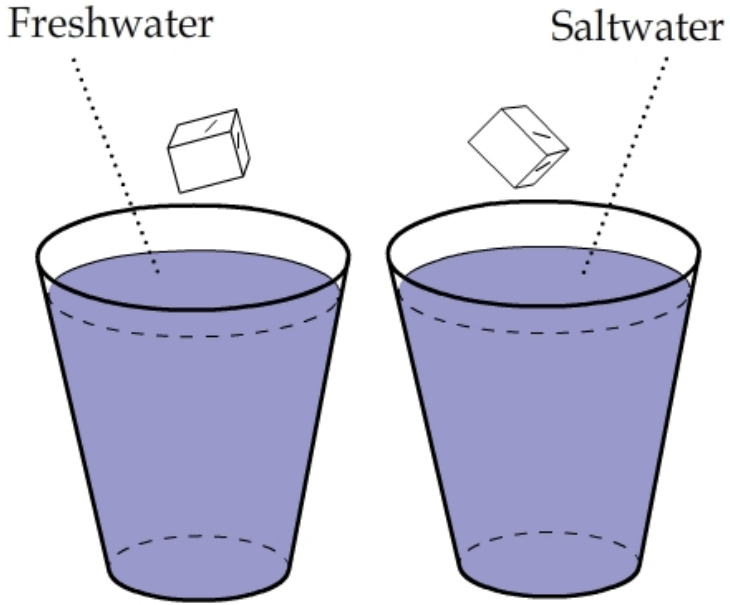
DCI Activity: Melting Ice

Will an ice cube melt faster in plain water or salt water?

- What could you do to find the answer?
- How can you be sure to get the right answer?

Melting Ice

Let’s try it!



Working Backwards: Melting Ice

Which DCI applies?

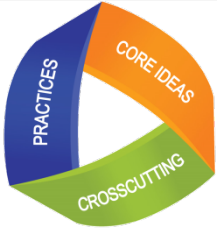
PS: Physical Sciences

LS: Life Sciences

ESS: Earth and Space Science

ETS: Engineering, Technology and the Applications of Science

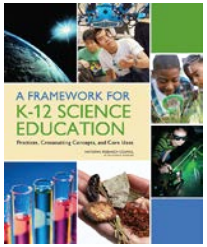
The Science and Engineering Practices



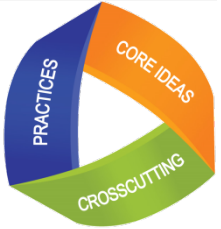
“Practices” not Skills

… students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the discourses by which such ideas are developed and refined. At the same time, they cannot learn or show competence in practices except in the context of specific content.

- NRC *Framework,* 2012

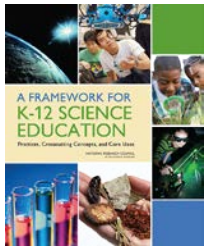


The Science and Engineering Practices

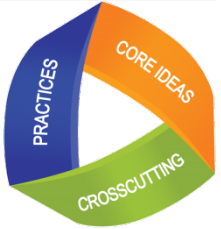


Any education that focuses predominantly on the detailed products of scientific labor— the facts of science—without developing an understanding of how those facts were established or that ignores the many important applications of science in the world misrepresents science and marginalizes the importance of engineering.

- NRC *Framework,* 2012



The “SEP” of NGSS



8 Science and Engineering Practices

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

Fitting an Activity to a SEP

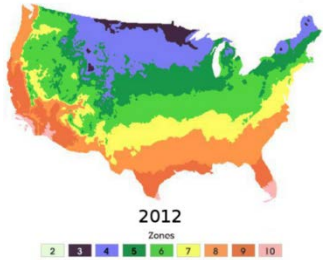
USDA Map Activity

- Participate like a student, try to answer the question and explain the answer.
- Be aware of your own thinking process and how you learn.
- Select a SEP for this activity.

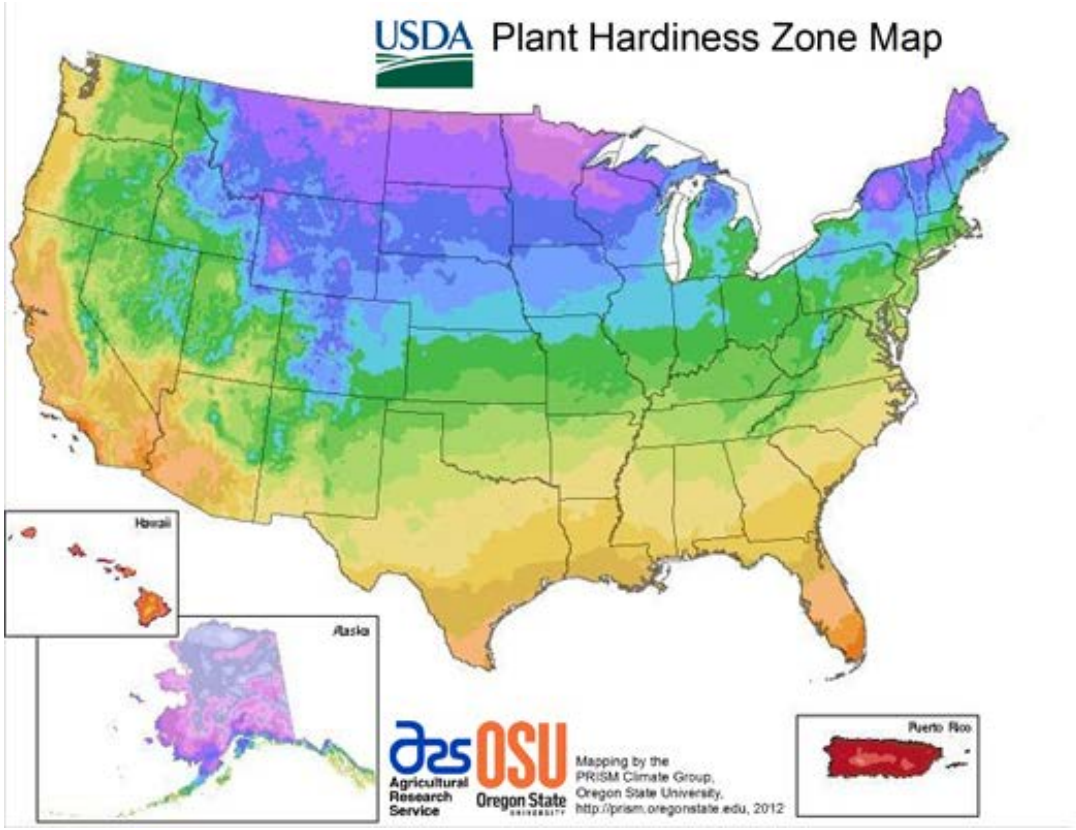
SEP Activity: Plant Hardiness Zones

Do these maps provide evidence of climate change?

1. Compare the hardiness zone maps from four different years.
2. Work as a group to answer these questions:
   - What do the colors on the map indicate?
   - What trends can you identify?
   - Can you make a claim about global climate change based on this evidence?
   - What additional information would help you make or support a claim about the climate?



Zone	Avg. Annual Low
2	-40° through -50°
3	-30° through -40°
4	-20° through -30°
5	-10° through - 20°
6	0° through -10°
7	10° through 0°
8	20° through 10°
9	30° through 20°
10	40° through 30°



Average Annual Extreme Minimum Temperature 1976-2005

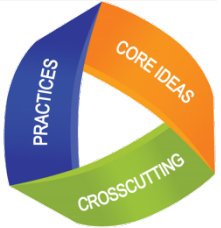
Temp (F)	Zone	Temp (C)
-60 to -55	1a	-51.1 to -48.3
-55 to -50	1b	-48.3 to -45.6
-50 to -45	2a	-45.6 to -42.8
-45 to -40	2b	-42.8 to -40
-40 to -35	3a	-40 to -37.2
-35 to -30	3b	-37.2 to -34.4
-30 to -25	4a	-34.4 to -31.7
-25 to -20	4b	-31.7 to -28.9
-20 to -15	5a	-28.9 to -26.1
-15 to -10	5b	-26.1 to -23.3
-10 to -5	6a	-23.3 to -20.6
-5 to 0	6b	-20.6 to -17.8
0 to 5	7a	-17.8 to -15
5 to 10	7b	-15 to -12.2
10 to 15	8a	-12.2 to -9.4
15 to 20	8b	-9.4 to -6.7
20 to 25	9a	-6.7 to -3.9
25 to 30	9b	-3.9 to -1.1
30 to 35	10a	-1.1 to 1.7
35 to 40	10b	1.7 to 4.4
40 to 45	11a	4.4 to 7.2
45 to 50	11b	7.2 to 10
50 to 55	12a	10 to 12.8
55 to 60	12b	12.8 to 15.6
60 to 65	13a	15.6 to 18.3
65 to 70	13b	18.3 to 21.1

Working Backwards: USDA Plant Zone Map Activity

Which science and engineering practices apply?

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

The Crosscutting Concepts

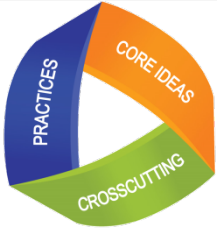


Crosscutting Concepts bridge disciplinary boundaries

Their purpose is to help students:

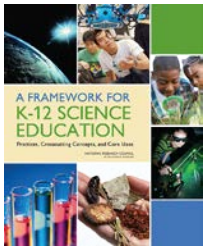
- Deepen understanding of the disciplinary core ideas
- Develop a coherent and scientifically based view of the world
- Make connections between knowledge and the practices of science

Crosscutting Concepts

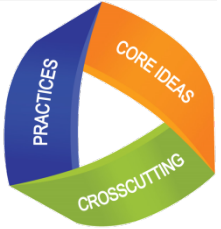


Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas.

—NRC *Framework,* 2012



The “CC” of NGSS



7 Crosscutting Concepts

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

Activity: Flower Sorting, Part 1

How are flowers alike and different?

1. Sort the flower cards by any observable characteristics you like. Be prepared to describe how your sorted them.
2. Reshuffle the cards. Pick **one** characteristic (example: black petals) and sort the flowers into two piles: flowers that have this characteristic and flowers that do not.

Activity: Flower Sorting, Part 2

Focus on the Odds: What do they have in common?

1. Sort cards into two piles: odd numbers and even numbers.
2. How are all the even numbered flowers alike?
3. How are all the odd numbered flowers alike?
4. Based on your descriptions, could you put the Odd flowers in the Even pile? Could you put the Even flowers in the Odd pile?
5. What do you think are the defining characteristics of flowers in the Odd pile?

Working Backwards: Flower Sorting

Which Crosscutting Concepts apply?

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

Small Group Discussion

Describe a program or activity you offer at your garden that you feel aligns well with the NGSS.

1. What **Science & Engineering Practices** are students performing?
2. What **Crosscutting Concepts** are student applying?
3. How are you talking about the **Nature of Science**?

NGSS Storylines

We have covered:

1. The range of science topics, DCI
2. The things students should do, SEP
3. The ways students should think, CC

Now, what about applying this to different grade levels?

Storylines: Take-Home Activity

What role does your garden play in the story?

Read the storylines for the different grade levels.

Mark the parts of the storylines that your program already supports or has potential to support.

Use the storyline narratives to gauge the topics and learning activities for your programs.

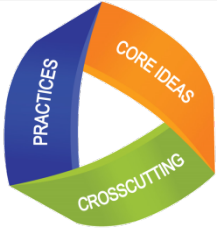
Grade Level Progressions

Life Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
LS1.A Structure and function	All organisms have external parts that they use to perform daily functions.	Organisms have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.	All living things are made up of cells. In organisms, cells work together to form tissues and organs that are specialized for particular body functions.	Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors.
LS1.B Growth and development of organisms	Parents and offspring often engage in behaviors that help the offspring survive	Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles.	Animals engage in behaviors that increase the odds of reproduction. An organism's growth is affected by both genetic and environmental factors.	Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types.
LS1.C Organization for matter and energy flow in organisms	Animals obtain food they need from plants or other animals. Plants need water and light.	Food provides animals with the materials and energy they need for body repair, growth, warmth, and motion. Plants acquire material for growth chiefly from air, water, and process matter and obtain energy from sunlight, which is used to maintain conditions necessary for survival.	Plants use the energy from light to make sugars through photosynthesis. Within individual organisms, food is broken down through a series of chemical reactions that rearrange molecules and release energy.	The hydrocarbon backbones of sugars produced through photosynthesis are used to make amino acids and other molecules that can be assembled into proteins or DNA. Through cellular respiration, matter and energy flow through different organizational levels of an organism as elements are recombined to form different products and transfer energy.
LS1.D Information Processing	Animals sense and communicate information and respond to inputs with behaviors that help them grow and survive.	Different sense receptors are specialized for particular kinds of information; Animals use their perceptions and memories to guide their actions.	Each sense receptor responds to different inputs, transmitting them as signals that travel along nerve cells to the brain; The signals are then processed in the brain, resulting in immediate behavior or memories.	N/A

Performance Expectations



“Best Fit” PE’s for Public Gardens

1. The “Best Fit” list is for convenience only; other standards may apply to your programs.
2. You don’t have to do it all! Select standards that fit your mission, your audience, your site, and your resources.
3. Focus on the SEP, DCI, and CC for each standard, providing the **experiences** that enable students to meet the standards.
4. Remember that Performance Expectations define what students should achieve by the end of the grade; you don’t have to meet expectations in one program.
5. When promoting your programs use the PE codes (2-LS4-1, 3-LS1-1, etc.); quote the language used in the NGSS standards.

Sample Standard

Students who demonstrate understanding can:

K-ESS2-1. **Use and share observations of local weather conditions to describe patterns over time.** [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [*Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.*]

K-ESS2-2. **Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.** [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

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

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions. (K-ESS2-1)

Engaging in Argument from Evidence
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
- Construct an argument with evidence to support a claim. (K-ESS2-2)

Connections to Nature of Science

Science Knowledge is Based on Empirical Evidence
- Scientists look for patterns and order when making observations about the world. (K-ESS2-1)

Disciplinary Core Ideas

ESS2.D: Weather and Climate
- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1)

ESS2.E: Biogeology
- Plants and animals can change their environment. (K-ESS2-2)

ESS3.C: Human Impacts on Earth Systems
- Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. *(secondary to K-ESS2-2)*

Crosscutting Concepts

Patterns
- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence. (K-ESS2-1)

Systems and System Models
- Systems in the natural and designed world have parts that work together. (K-ESS2-2)

Connections to other DCIs in kindergarten: N/A

Articulation of DCIs across grade-levels:
2.ESS2.A (K-ESS2-1); **3.ESS2.D** (K-ESS2-1); **4.ESS2.A** (K-ESS2-1); **4.ESS2.E** (K-ESS2-2); **5.ESS2.A** (K-ESS2-2)

Common Core State Standards Connections:

ELA/Literacy -

R.K.1	With prompting and support, ask and answer questions about key details in a text. (K-ESS2-2)
W.K.1	Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)
W.K.2	Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. *(K-ESS2-2)*
W.K.7	Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-ESS2-1)

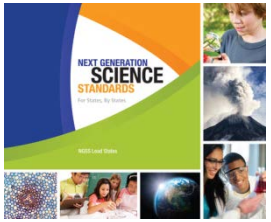
Mathematics -

MP.2	Reason abstractly and quantitatively. (K-ESS2-1)
MP.4	Model with mathematics. (K-ESS2-1)
K.CC.A	Know number names and the count sequence. (K-ESS2-1)
K.MD.A.1	Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-ESS2-1)
K.MD.B.3	Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

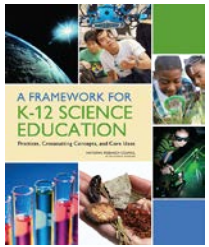
* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

NGSS Resources

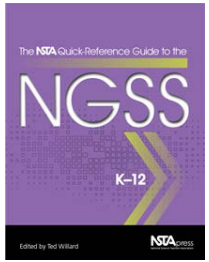
Books



Next Generation Science Standards, For States, By States
NGSS Lead States



A Framework for K-12 Science Education:
Practices, Crosscutting Concepts, and Core Ideas
National Research Council



The NSTA Quick Reference Guide to the NGSS, K-12
Edited by Ted Willard

NGSS Resources

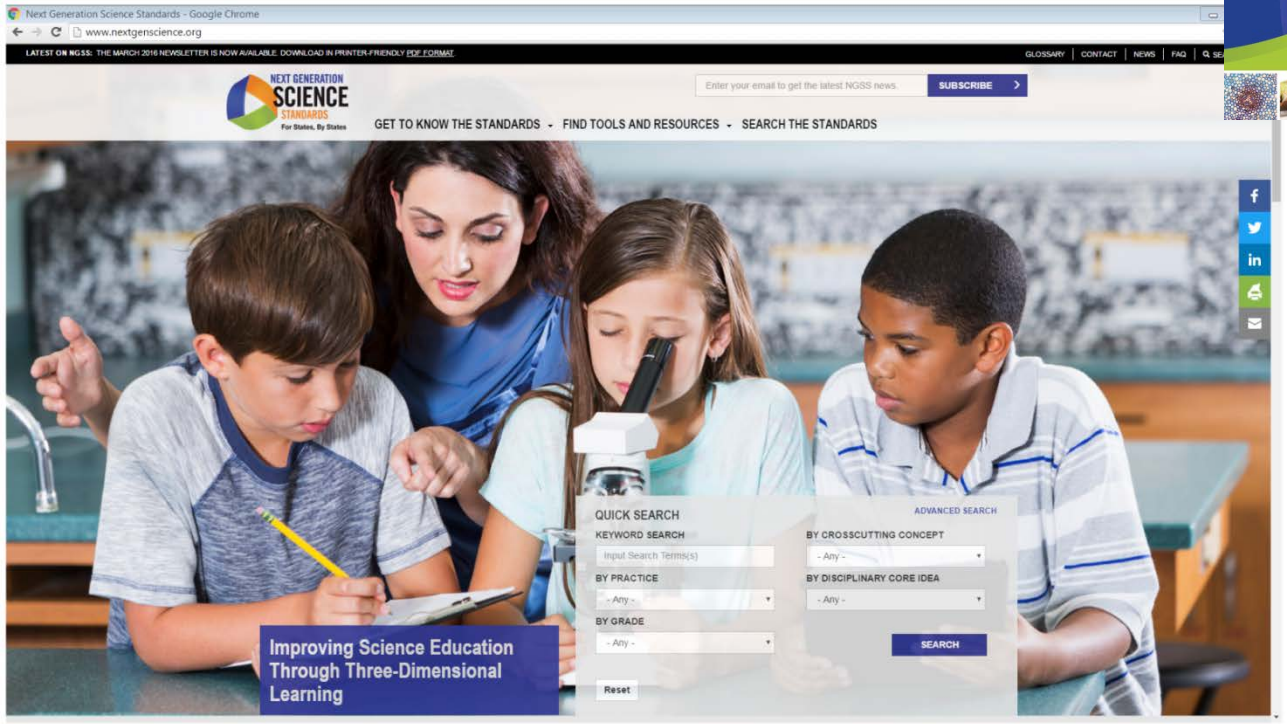
Essential Websites

Next Generations Science Standards
http://www.nextgenscience.org/

National Science Teachers Association
http://ngss.nsta.org/Default.aspx

National Academies Press, online version of *A Framework for K-12 Science Education,* National Research Council
http://www.nap.edu/read/13165/chapter/1

NGSS Online


Next Generation Science Standards - Google Chrome
www.nextgenscience.org
LATEST ON NGSS: THE MARCH 2016 NEWSLETTER IS NOW AVAILABLE. DOWNLOAD IN PRINTER-FRIENDLY PDF FORMAT
GLOSSARY
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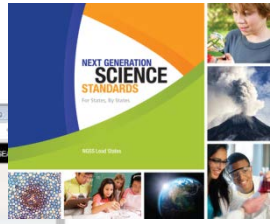
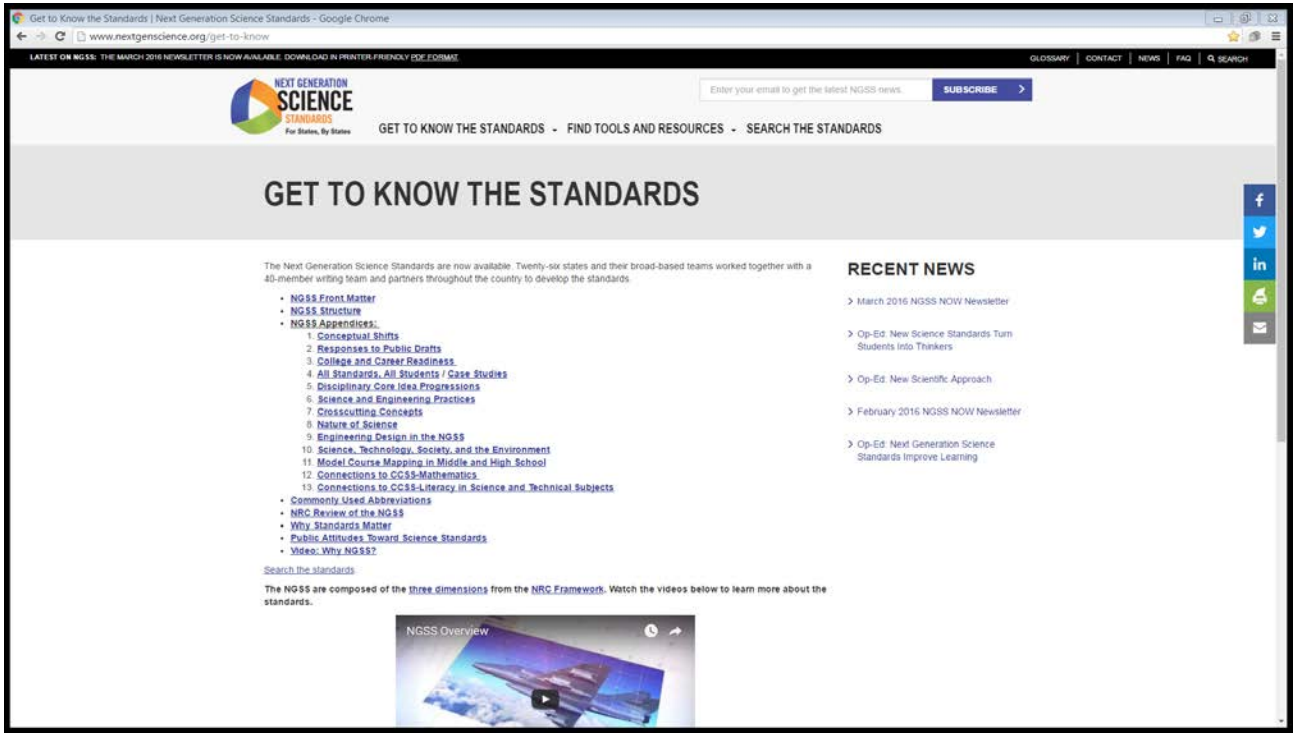
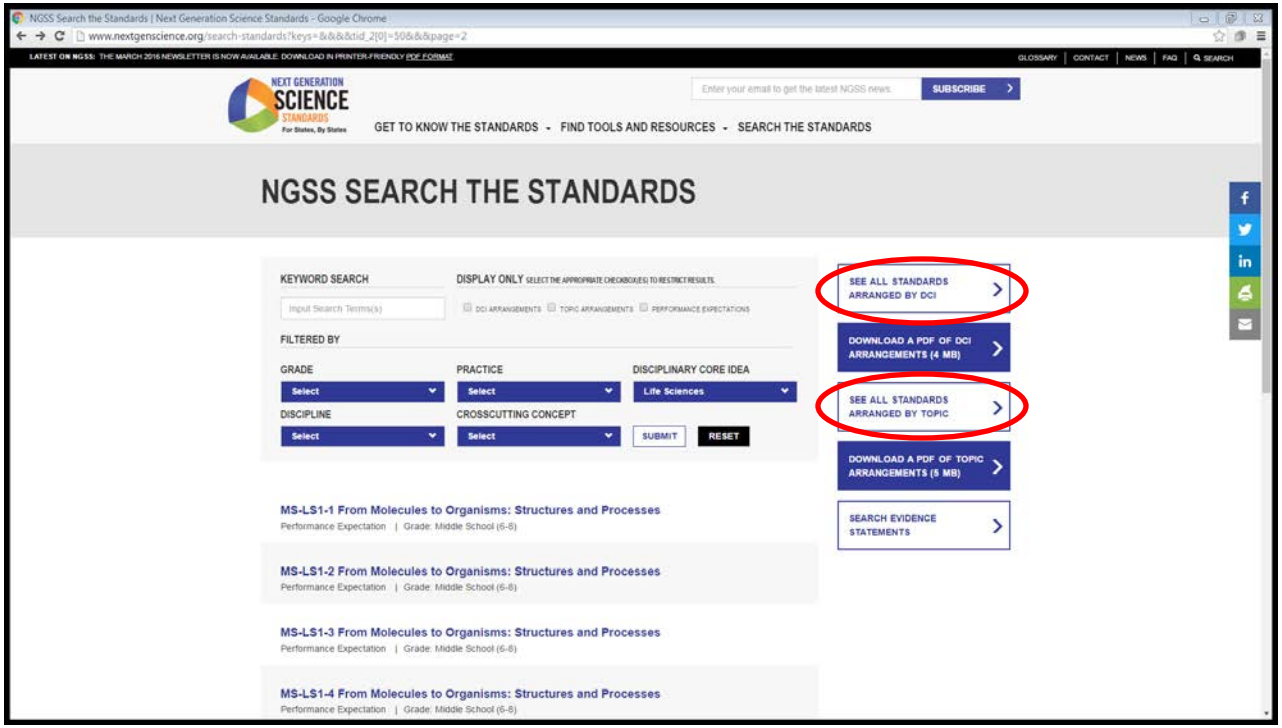
BY CROSSCUTTING CONCEPT
- Any -
BY PRACTICE
- Any -
BY DISCIPLINARY CORE IDEA
- Any -
BY GRADE
- Any -
SEARCH
Reset
Improving Science Education Through Three-Dimensional Learning


NEXT GENERATION
SCIENCE
STANDARDS

Get to Know the Standards



Search the Standards



DCI *vs.* Topic Arrangement

Which version is best for your purposes?

DCI Arrangement

5-LS2 Ecosystems: Interactions, Energy, and Dynamics

5-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

5-LS2-1. **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

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 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model to describe phenomena. (5-LS2-1) --- ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Science explanations describe the mechanisms for natural events. (5-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosyste** • Matter cycles between the air and soil and among plants, at and microbes as these organisms live and die. Organisms o gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-	**Systems and System Models** • A system can be described in terms of its components and their interactions. (5-LS2-1)

Topic Arrangement

5.Matter and Energy in Organisms and Ecosystems

5.Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

5-PS3-1. **Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.** [Clarification Statement: Examples of models could include diagrams, and flow charts.]

5-LS1-1. **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

5-LS2-1. **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

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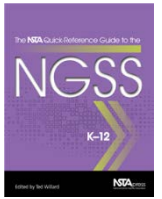
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena. (5-PS3-1) • Develop a model to describe phenomena. (5-LS2-1) **n Evidence** vidence in 3–5 builds on K– to critiquing the scientific osed by peers by citing atural and designed evidence, data, or a --- *ature of Science* chanisms, and Theories ribe the mechanisms for	**PS3.D: Energy in Chemical Processes and Everyday Life** • The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1) **LS1.C: Organization for Matter and Energy Flow in Organisms** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary to 5-PS3-1)* • Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: Interdependent Relationships in Ecosystems** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	**Systems and System Models** • A system can be described in terms of its components and their interactions. (5-LS2-1) **Energy and Matter** • Matter is transported into, out of, and within systems. (5-LS1-1) • Energy can be transferred in various ways and between objects. (5-PS3-1)

DCI *vs.* Topic Arrangement



How is the school district organizing science curriculum?

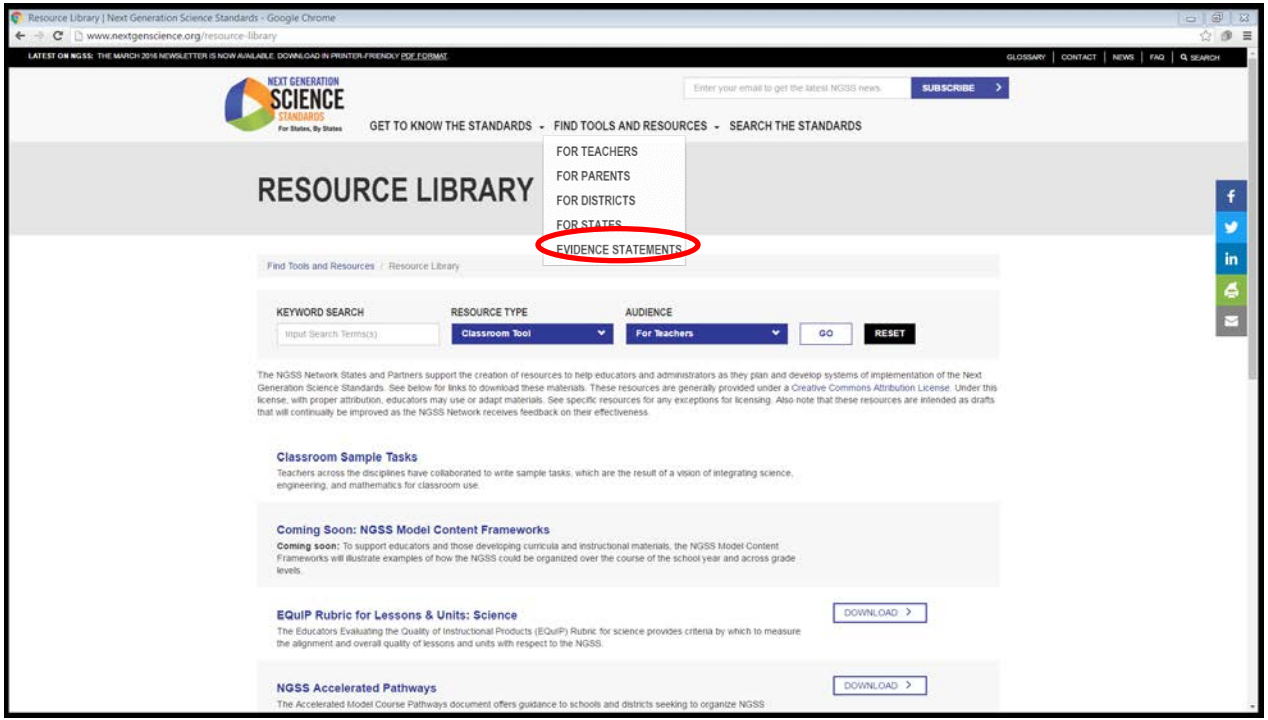
DCI Arrangement

Level		Life Science	Earth and Space Science	Physical Science	Engineering
Elementary School	K	K-LS-1 From Molecules to Organisms: Structures and Processes	K-ESS-2 Earth's Systems K-ESS-3 Earth and Human Activity	K-PS-2 Motion and Stability: Forces and Interactions K-PS-3 Energy	K–2-ETS-1 Engineering Design
	1	1-LS-1 From Molecules to Organisms: Structures and Processes 1-LS-3 Heredity: Inheritance and Variation of Traits	1-ESS-1 Earth's Place in the Universe	1-PS-4 Waves and Their Applications in Technologies for Information Transfer	
	2	2-LS-2 Ecosystems: Interactions, Energy, and Dynamics 2-LS-4 Biological Evolution: Unity and Diversity	2-ESS-1 Earth's Place in the Universe 2-ESS-2 Earth's Systems	2-PS-1 Matter and Its Interactions	
	3	3-LS-1 From Molecules to Organisms: Structures and Processes 3-LS-2 Ecosystems: Interactions, Energy, and Dynamics 3-LS-3 Heredity: Inheritance and Variation of Traits 3-LS-4 Biological Evolution: Unity and Diversity	3-ESS-2 Earth's Systems 3-ESS-3 Earth and Human Activity	3-PS-2 Motion and Stability: Forces and Interactions	3–5-ETS-1 Engineering Design
	4	4-LS-1 From Molecules to Organisms: Structures and Processes	4-ESS-1 Earth's Place in the Universe 4-ESS-2 Earth's Systems 4-ESS-3 Earth and Human Activity	4-PS-3 Energy 4-PS-4 Waves and Their Applications in Technologies for Information Transfer	
	5	5-LS-1 From Molecules to Organisms: Structures and Processes 5-LS-2 Ecosystems: Interactions, Energy, and Dynamics	5-ESS-1 Earth's Place in the Universe 5-ESS-2 Earth's Systems 5-ESS-3 Earth and Human Activity	5-PS-1 Matter and Its Interactions 5-PS-2 Motion and Stability: Forces and Interactions 5-PS-3 Energy	
Middle School		MS-LS-1 From Molecules to Organisms: Structures and Processes MS-LS-2 Ecosystems: Interactions, Energy, and Dynamics MS-LS-3 Heredity: Inheritance and Variation of Traits MS-LS-4 Biological Evolution: Unity and Diversity	MS-ESS-1 Earth's Place in the Universe MS-ESS-2 Earth's Systems MS-ESS-3 Earth and Human Activity	MS-PS-1 Matter and Its Interactions MS-PS-2 Motion and Stability: Forces and Interactions MS-PS-3 Energy MS-PS-4 Waves and Their Applications in Technologies for Information Transfer	MS-ETS-1 Engineering Design
High School		HS-LS-1 From Molecules to Organisms: Structures and Processes HS-LS-2 Ecosystems: Interactions, Energy, and Dynamics HS-LS-3 Heredity: Inheritance and Variation of Traits HS-LS-4 Biological Evolution: Unity and Diversity	HS-ESS-1 Earth's Place in the Universe HS-ESS-2 Earth's Systems HS-ESS-3 Earth and Human Activity	HS-PS-1 Matter and Its Interactions HS-PS-2 Motion and Stability: Forces and Interactions HS-PS-3 Energy HS-PS-4 Waves and Their Applications in Technologies for Information Transfer	HS-ETS-1 Engineering Design

Topic Arrangement

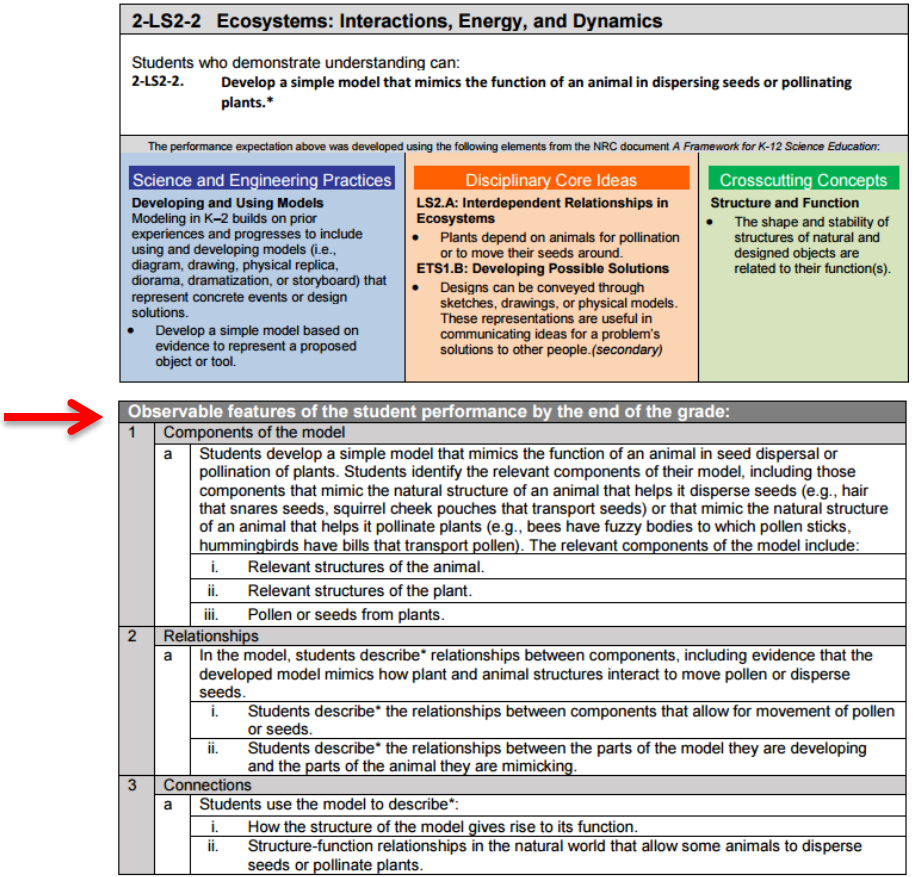
Level		Life Science	Earth and Space Science	Physical Science	Engineering
Elementary School	K	K. Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment	K. Weather and Climate	K. Forces and Interactions: Pushes and Pulls	K–2. Engineering Design
	1	1. Structure, Function, and Information Processing	1. Space Systems: Patterns and Cycles	1. Waves: Light and Sound	
	2	2. Interdependent Relationships in Ecosystems	2. Earth's Systems: Processes That Shape the Earth	2. Structure and Properties of Matter	
	3	3. Interdependent Relationships in Ecosystems 3. Inheritance and Variation of Traits: Life Cycles and Traits	3. Weather and Climate	3. Forces and Interactions	3–5. Engineering Design
	4	4. Structure, Function, and Information Processing	4. Earth's Systems: Processes that Shape the Earth	4. Energy 4. Waves: Waves and Information	
	5	5. Matter and Energy in Organisms and Ecosystems	5. Earth's Systems 5. Space Systems: Stars and the Solar System	5. Structure and Properties of Matter	
Middle School		MS. Structure, Function, and Information Processing MS. Matter and Energy in Organisms and Ecosystems MS. Interdependent Relationships in Ecosystems MS. Natural Selection and Adaptations MS. Growth, Development, and Reproduction of Organisms	MS. Space Systems MS. History of Earth MS. Earth's Systems MS. Weather and Climate MS. Human Impacts	MS. Structure and Properties of Matter MS. Chemical Reactions MS. Forces and Interactions MS. Energy MS. Waves and Electromagnetic Radiation	MS. Engineering Design
High School		HS. Structure and Function HS. Inheritance and Variation of Traits HS. Matter and Energy in Organisms and Ecosystems HS. Interdependent Relationships in Ecosystems HS. Natural Selection and Evolution	HS. Space Systems HS. History of Earth HS. Earth's Systems HS. Weather and Climate HS. Human Sustainability	HS. Structure and Properties of Matter HS. Chemical Reactions HS. Forces and Interactions HS. Energy HS. Waves and Electromagnetic Radiation	HS. Engineering Design

Resource Library



Evidence Statement

Provides more information for student assessment



2-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

2-LS2-2. **Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.***

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

Science and Engineering Practices

Developing and Using Models

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.

- Develop a simple model based on evidence to represent a proposed object or tool.

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Plants depend on animals for pollination or to move their seeds around.

ETS1.B: Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.*(secondary)*

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s).

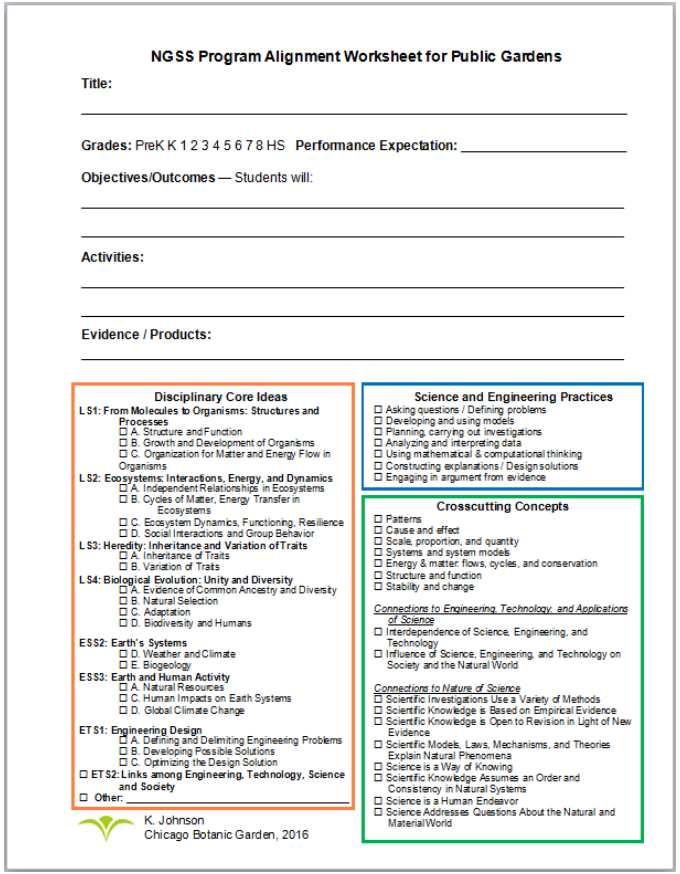
Observable features of the student performance by the end of the grade:

1	Components of the model	
	a	Students develop a simple model that mimics the function of an animal in seed dispersal or pollination of plants. Students identify the relevant components of their model, including those components that mimic the natural structure of an animal that helps it disperse seeds (e.g., hair that snares seeds, squirrel cheek pouches that transport seeds) or that mimic the natural structure of an animal that helps it pollinate plants (e.g., bees have fuzzy bodies to which pollen sticks, hummingbirds have bills that transport pollen). The relevant components of the model include:
		i. Relevant structures of the animal.
		ii. Relevant structures of the plant.
		iii. Pollen or seeds from plants.
2	Relationships	
	a	In the model, students describe* relationships between components, including evidence that the developed model mimics how plant and animal structures interact to move pollen or disperse seeds.
		i. Students describe* the relationships between components that allow for movement of pollen or seeds.
		ii. Students describe* the relationships between the parts of the model they are developing and the parts of the animal they are mimicking.
3	Connections	
	a	Students use the model to describe*:
		i. How the structure of the model gives rise to its function.
		ii. Structure-function relationships in the natural world that allow some animals to disperse seeds or pollinate plants.

NGSS Program Alignment

Use this worksheet to:

- Guide program development
- Communicate and promote the program's connection to NGSS
- Train program facilitators to do good science teaching
- Help your local school teachers improve their science teaching in the classroom



NGSS Program Alignment Worksheet for Public Gardens

Title: _____

Grades: PreK K 1 2 3 4 5 6 7 8 HS **Performance Expectation:** _____

Objectives/Outcomes — Students will:

_____

_____

Activities:

_____

_____

Evidence / Products:

_____

Disciplinary Core Ideas

LS1: From Molecules to Organisms: Structures and Processes
- ☐ A. Structure and Function
- ☐ B. Growth and Development of Organisms
- ☐ C. Organization for Matter and Energy Flow in Organisms

LS2: Ecosystems: Interactions, Energy, and Dynamics
- ☐ A. Independent Relationships in Ecosystems
- ☐ B. Cycles of Matter, Energy Transfer in Ecosystems
- ☐ C. Ecosystem Dynamics, Functioning, Resilience
- ☐ D. Social Interactions and Group Behavior

LS3: Heredity: Inheritance and Variation of Traits
- ☐ A. Inheritance of Traits
- ☐ B. Variation of Traits

LS4: Biological Evolution: Unity and Diversity
- ☐ A. Evidence of Common Ancestry and Diversity
- ☐ B. Natural Selection
- ☐ C. Adaptation
- ☐ D. Biodiversity and Humans

ESS2: Earth's Systems
- ☐ D. Weather and Climate
- ☐ E. Biogeology

ESS3: Earth and Human Activity
- ☐ A. Natural Resources
- ☐ C. Human Impacts on Earth Systems
- ☐ D. Global Climate Change

ETS1: Engineering Design
- ☐ A. Defining and Delimiting Engineering Problems
- ☐ B. Developing Possible Solutions
- ☐ C. Optimizing the Design Solution

☐ **ETS2: Links among Engineering, Technology, Science and Society**

☐ **Other:** _____

Science and Engineering Practices
- ☐ Asking questions / Defining problems
- ☐ Developing and using models
- ☐ Planning, carrying out investigations
- ☐ Analyzing and interpreting data
- ☐ Using mathematical & computational thinking
- ☐ Constructing explanations / Design solutions
- ☐ Engaging in argument from evidence

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

Connections to Engineering, Technology, and Applications of Science
- ☐ Interdependence of Science, Engineering, and Technology
- ☐ Influence of Science, Engineering, and Technology on Society and the Natural World

Connections to Nature of Science
- ☐ Scientific Investigations Use a Variety of Methods
- ☐ Scientific Knowledge is Based on Empirical Evidence
- ☐ Scientific Knowledge is Open to Revision in Light of New Evidence
- ☐ Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- ☐ Science is a Way of Knowing
- ☐ Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- ☐ Science is a Human Endeavor
- ☐ Science Addresses Questions About the Natural and Material World

K. Johnson
Chicago Botanic Garden, 2016

Happy STEMs to You!

Katherine Johnson
Youth Education Director

CHICAGO BOTANIC GARDEN