Updating Earth and Space Science for Middle and High School in the New World of NGSS

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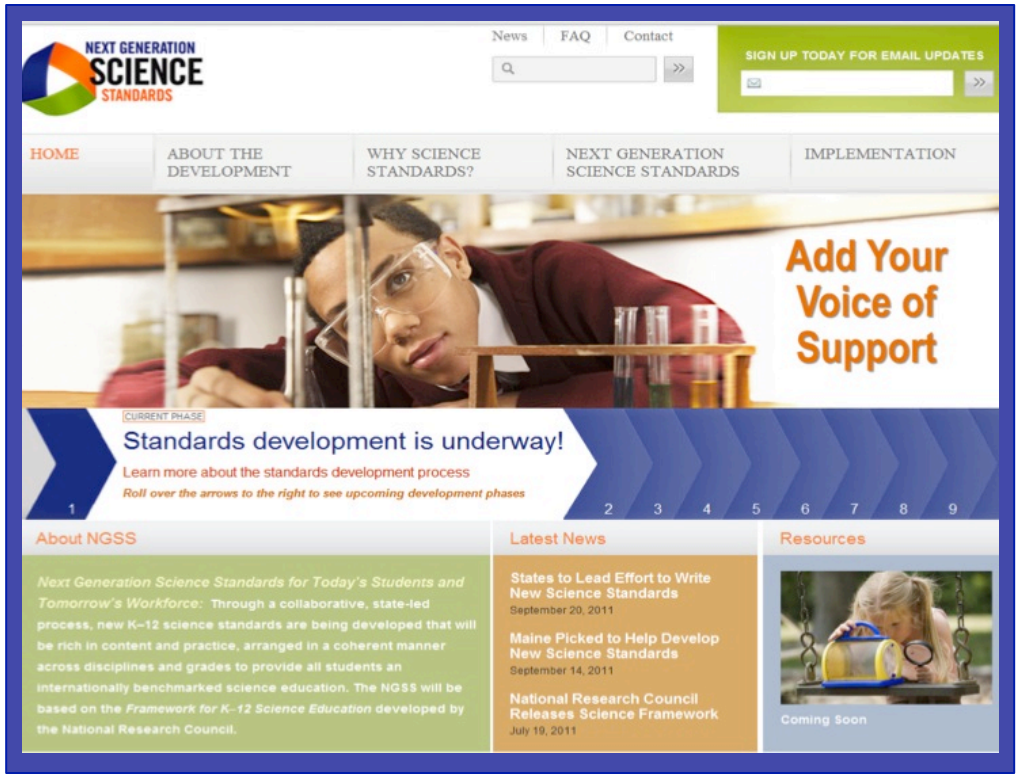
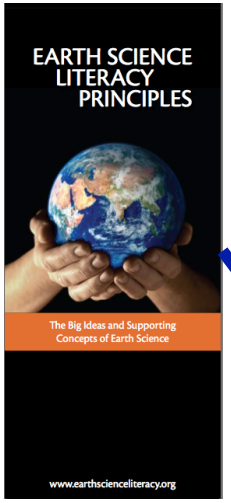
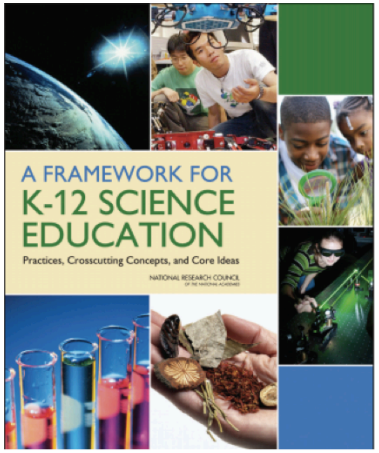
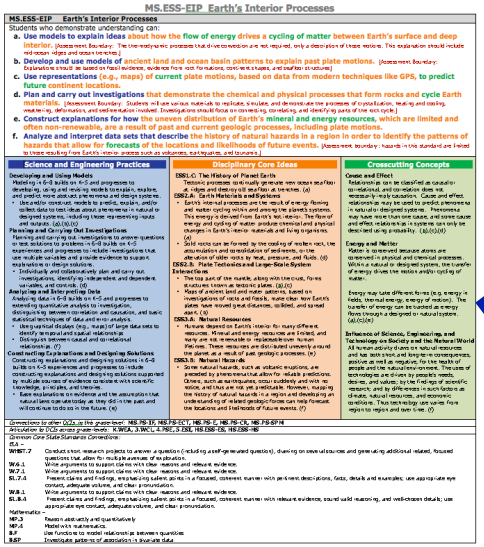


NEXT GENERATION SCIENCE STANDARDS

The NGSS are the result of a multi-step process







- Teacher Development
- Curricula
- Instructional Materials
- Instruction
- Assessment

NEXT GENERATION SCIENCE STANDARDS

The NGSS are *NOT* a Curriculum

The NRC Framework is the Skeleton
The NGSS are the fleshed-out organs
Curricula will be the clothes.

NEXT GENERATION SCIENCE STANDARDS

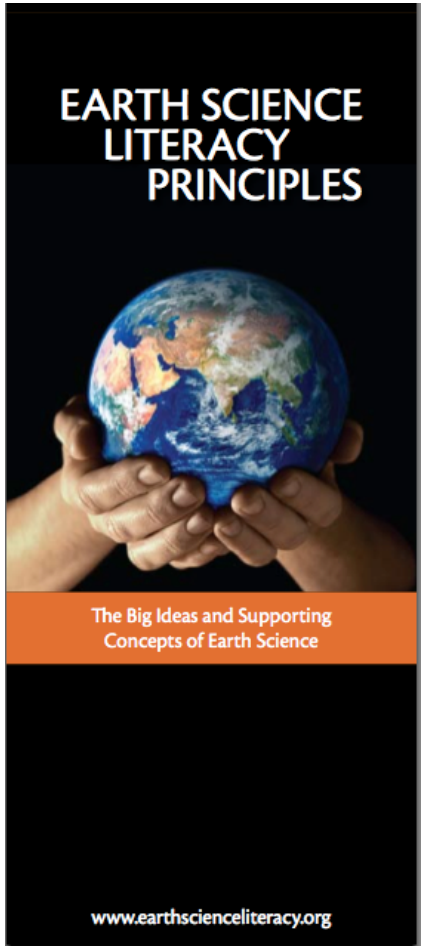
The NGSS are *NOT* a Curriculum

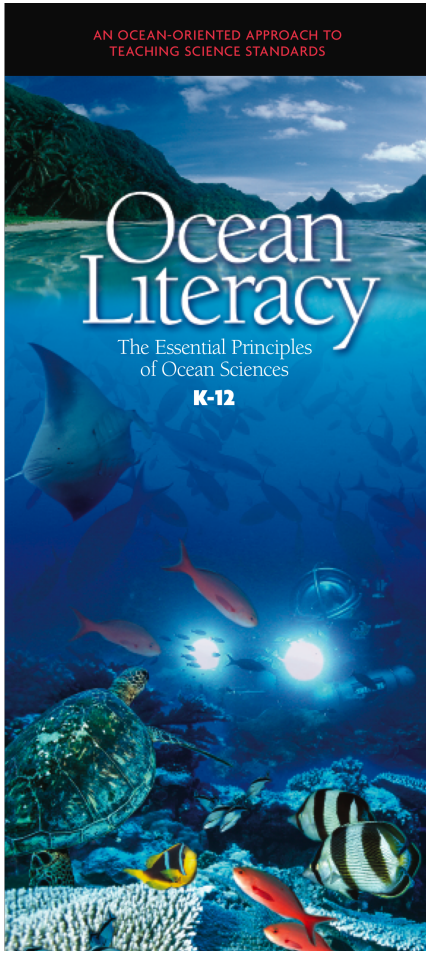
The NRC Framework is the Skeleton
The NGSS are the fleshed-out organs
Curricula will be the clothes.

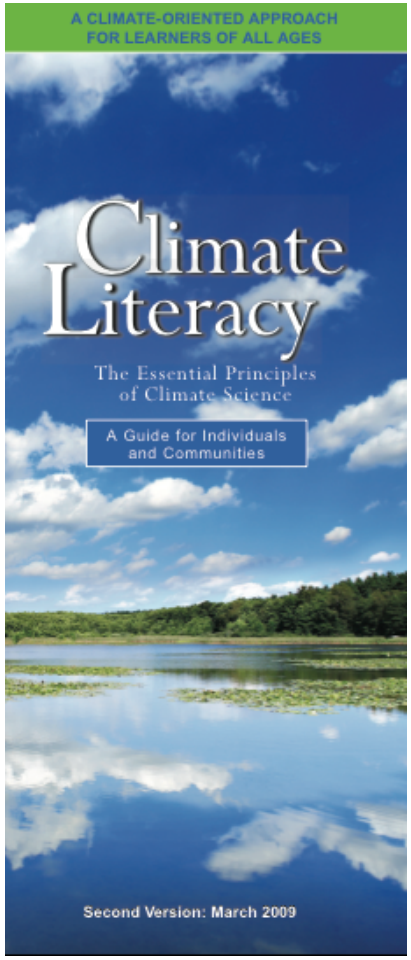
You can dress up the NGSS any way that you want!

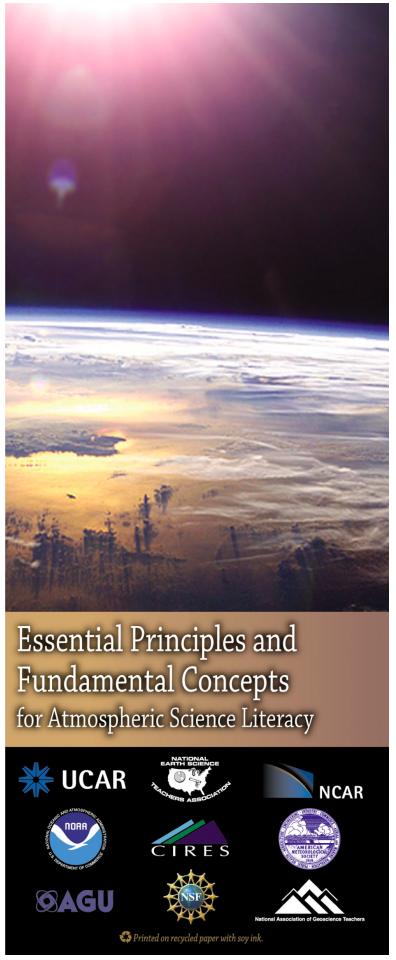
NEXT GENERATION SCIENCE STANDARDS

Geoscience content informed by recent community-based literacy efforts



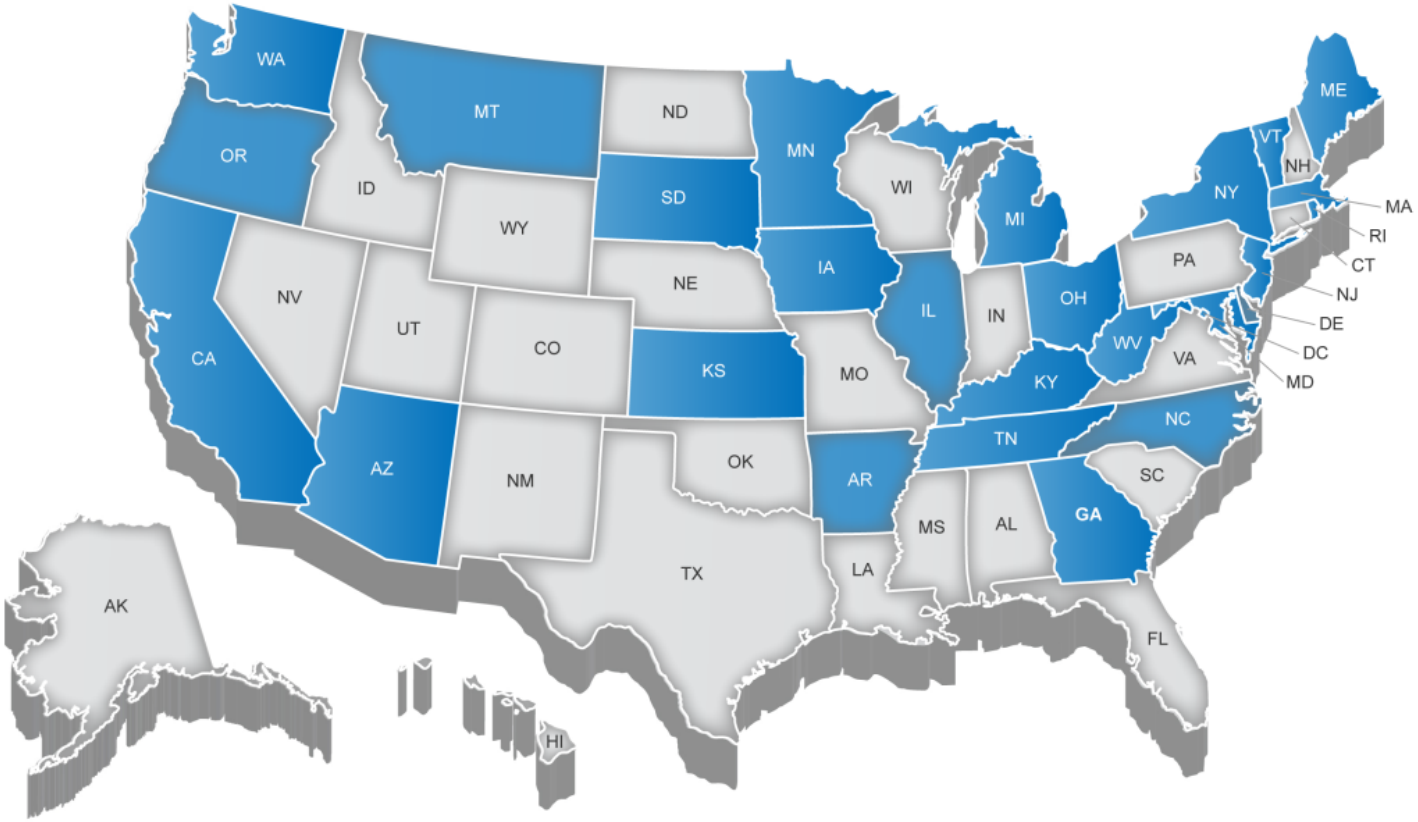






NEXT GENERATION SCIENCE STANDARDS

The NGSS were the result of a "states-led" process



States that have already adopted the NGSS:

California, Delaware, Kansas, Kentucky, Maryland, Rhode Island, Vermont, Washington State

The NGSS were a collaborative effort

NGSS Earth and Space Science Writing Team Members:

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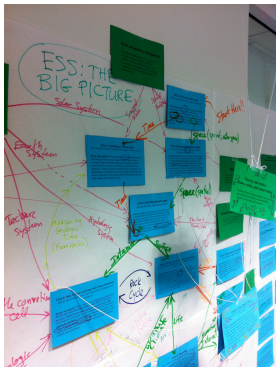
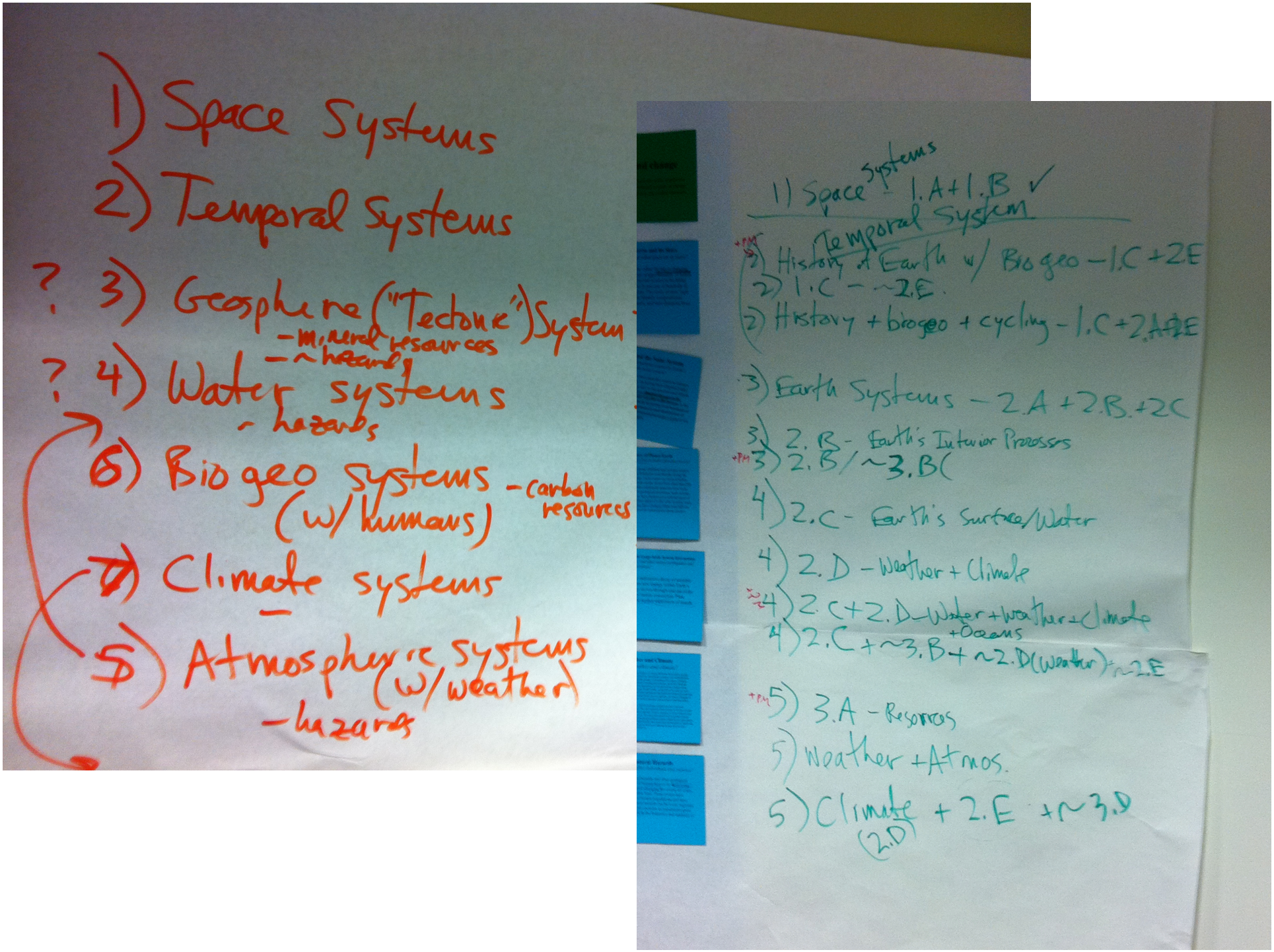
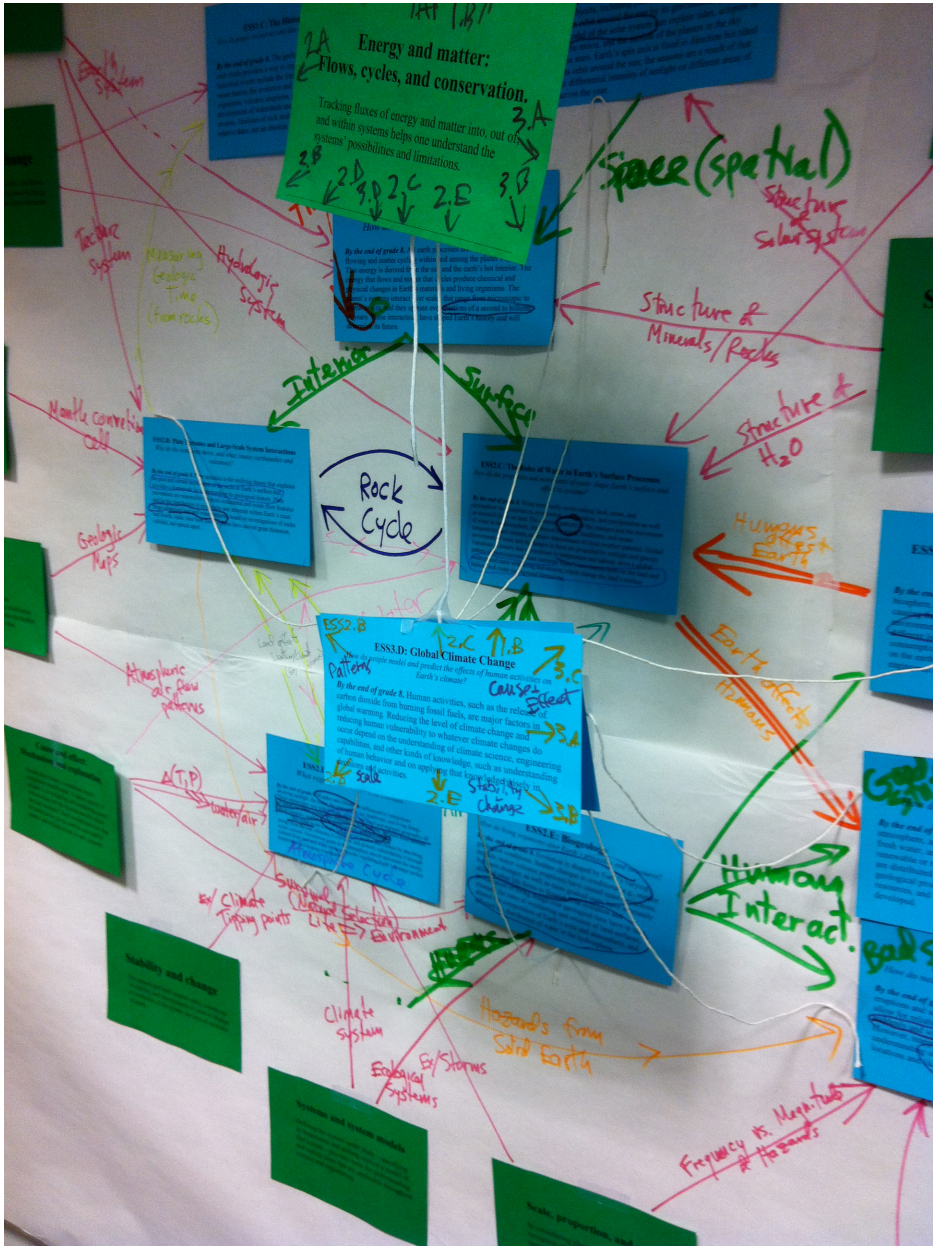


NEXT GENERATION SCIENCE STANDARDS


1) Space Systems
2) Temporal Systems
? 3) Geosphere ("Tectonic") System
- Mineral resources
- ~ hazards
? 4) Water systems
- hazards
6) Biogeo systems (w/ humans) - carbon resources
7) Climate systems
5) Atmospheric systems (w/ weather)
- hazards
1) Space Systems - 1.A + 1.B ✓
Temporal System
+PM 2) History of Earth w/ Biogeo - 1.C + 2.E
2) 1.C - ~2.E
2) History + biogeo + cycling - 1.C + 2.A + 2.E
3) Earth Systems - 2.A + 2.B + 2.C
3) 2.B - Earth's Interior Processes
+PM 3) 2.B / ~3.B(
4) 2.C - Earth's Surface/Water
4) 2.D - Weather + Climate
~4) 2.C + 2.D - Water + weather + Climate + Oceans
4) 2.C + ~3.B + ~2.D (Weather) = ~2.E
+PM 5) 3.A - Resources
5) Weather + Atmos.
5) Climate (2.D) + 2.E + ~3.D


Structure and function
Patterns
1
2
5
ESS1.A: The Universe and Its Stars
What is the universe, and what goes on in stars?
ESS2.A: Earth Materials and Systems
How do the major earth systems interact?
ESS2.D: Weather and Climate
What regulates weather and climate?
ESS1.B: Earth and the Solar System
What are the predictable patterns caused by Earth's movement in the solar system?
ESS3.A: Natural Resources
How do humans depend on Earth's resources?
ESS3.B: Natural Hazards
How do humans affect—or be affected—by natural hazards?
ESS3.C: Human Impacts on Earth Systems
How do humans change the planet?
ESS2.E: Biogeology
ESS1.C: The History of Planet Earth


ETS2.B: Influence of Engineering, Technology and Science on Society and the Natural World
ESS2.E: Biogeology
ESS3.A: Natural Resources
LS1.A: Structure and Function
PS1.A: Structure and Properties of Matter
EX/ ESS2.C: This is an example for one grade band endpoint
Resources for Life/Humans
phases of matter
EX/ Water Cycle
Gravitational potential energy
Ocean
Water
Materials
Resources
Life
water cycles
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
cycles
forces
Energy
Sunlight driving water cycle
weather climate
Modeling systems
ETS1.B: Developing Possible Solutions
ESS2.A: Earth Materials and Systems
Land Surfaces
Ice
Historical


Energy and matter:
Flows, cycles, and conservation.
Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
Space (spatial)
Structure of Solar System
Tectonic System
Measuring Geologic Time (from rocks)
Hydrologic System
Structure of Minerals/Rocks
Interior
Surface
Mantle convection cell
Rock Cycle
Structure of H2O
Geologic Maps
Humans affect Earth
Earth affects Humans
ESS3.D: Global Climate Change
Cause & Effect
Patterns
Scale
Stability/Change
Atmospheric Cycle
Water/air
Ex/ Climate Tipping points
Survival (Natural Selection) Life
Environment
Human Interact.
Climate system
Ecological Systems
Ex/ Storms
Hazards from Solid Earth
Frequency vs. Magnitude of Hazards


ESS: THE BIG PICTURE
Scale, proportion, and quantity
Solar System
Temporal Scales
Time
Start Here!!
Space (special; outer space)
Earth System
ESS1.C: The History of Planet Earth
ESS1.A: The Universe and Its Stars
ESS1.B: Earth and the Solar System
ESS2.A: Earth Materials and Systems
Space (spatial)
Tectonic System
Measuring Geologic Time (from rocks)
Hydrologic System
Structure of Minerals/Rocks
Interior
Surface
Energy and matter:
Flows, cycles, and conservation
ESS2.B: Plate Tectonics and Large-Scale System Interactions
Rock Cycle
Life
Air
Human Interact.

HS-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

HS-ESS3-1. **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

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

Constructing Explanations and Designing Solutions

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 student-generated sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

ESS3.A: Natural Resources

- Resource availability has guided the development of human society.

ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Modern civilization depends on major technological systems.

Connections to other DCIs in this grade-band: N/A

Articulation of DCIs across grade-bands:

MS.LS2.A ; **MS.LS4.D** ; **MS.ESS2.A** ; **MS.ESS3.A** ; **MS.ESS3.B**

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS3-1)*

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. *(HS-ESS3-1)*

HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-ESS3-1)*

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. *(HS-ESS3-1)*

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-ESS3-1)*

How do schools Teach Earth and Space Science with the NGSS?

1. Start with the Performance Expectations.
   - 15 at Middle School; 19 at High School
   - Bundle where possible

NEXT GENERATION SCIENCE STANDARDS

MS-ESS2 Earth's Systems

MS-ESS2 Earth's Systems

Students who demonstrate understanding can:

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]

MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]

MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]

MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]

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

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS2-1),(MS-ESS2-6)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Planning and Carrying Out Investigations

Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. *(HS.ESS1.C GBE) (secondary to MS-ESS2-3)*

ESS2.A: Earth's Materials and Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)
- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of

Crosscutting Concepts

Patterns

- Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. (MS-ESS2-3)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Scale Proportion and Quantity

How do schools Teach Earth and Space Science with the NGSS?

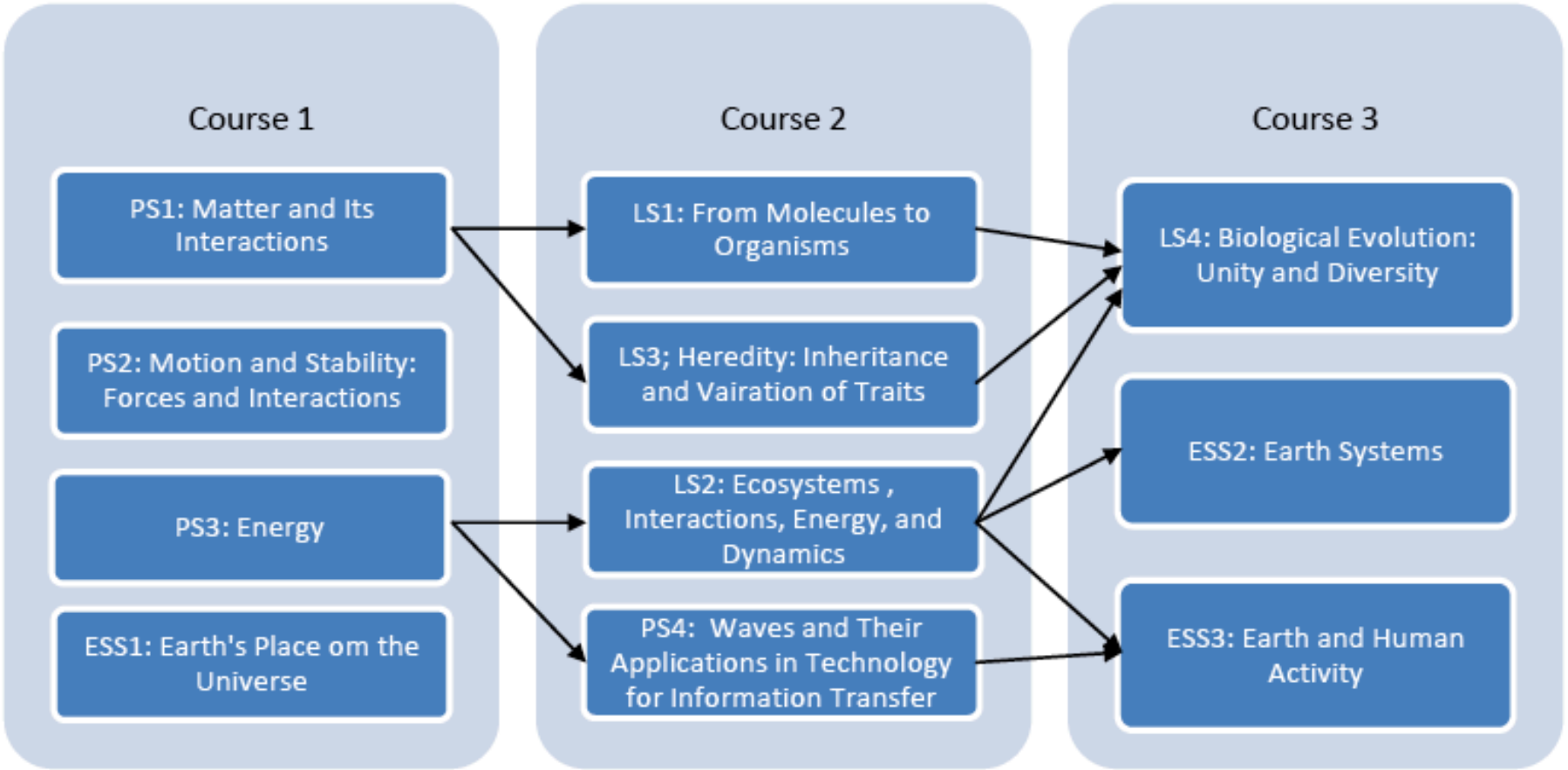
1. Start with the Performance Expectations.
   - 15 at Middle School; 19 at High School
2. Determine how you will be organizing them
   - Use the *Appendix K* **Course Maps** as a guide

NEXT GENERATION SCIENCE STANDARDS

How would you construct a 6-12 curriculum around the NGSS, given the amount and complexity of the Earth and Space Science?

Course Map #1: Conceptual Understanding Model

Figure 2: Organization of Disciplinary Core Ideas in Course Map 1



How would you construct a 6-12 curriculum around the NGSS, given the amount and complexity of the Earth and Space Science?

Course Map #1: Conceptual Understanding Model:

Courses constructed based on the most efficient and logical progression of concepts

Table 1: Listing of all Component Ideas in Course Map 1

	Course 1: **DCI component ideas**	Course 2: **DCI component ideas**	Course 3: **DCI component ideas**
Physical Science DCI	PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS2.A: Forces and Motion PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS4.A: Wave Properties	PS2.B: Types of Interactions PS3.D: Energy in Chemical Processes and Everyday Life PS4.B: Electromagnetic PS4.C: Information Technologies and Instrumentation	PS1.C: Nuclear Processes PS2.B: Types of Interactions
Life Science DCI	LS2.A: Interdependent Relationships in Ecosystems	LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS1.C: Organization for Matter and Energy Flow in Organisms LS2.B: Cycles of Matter and Energy Transfer in Ecosystems LS3.A: Inheritance of Traits LS3.B: Variation of Traits	LS1.D: Information Processing LS2.C: Ecosystems Dynamics, Functioning, and Resilience LS2.D: Social Interactions and Group Behavior LS4.A: Evidence of Common Ancestry and Diversity LS4.B: Natural Selection LS4.C: Adaptation LS4.D: Biodiversity and Humans
Earth Science DCI	ESS1.B: Earth and the Solar System ESS2.A: Earth Materials and Systems ESS2.C: The Roles of Water in Earth's Surface Processes	ESS1.A: The Universe and Its Stars ESS2.B: Plate Tectonics and Large-Scale System Interactions	ESS1.C: The History of Planet Earth ESS2.C: The Roles of Water in Earth's Surface Processes ESS2.D: Weather and Climate ESS3.A: Natural Resources ESS3.B: Natural Hazards ESS3.C: Human Impacts on Earth Systems ESS3.D: Global Climate Change

NEXT GENERATION SCIENCE STANDARDS

How would you construct a 6-12 curriculum around the NGSS, given the amount and complexity of the Earth and Space Science?

Course Map #2: Science Domains Model:

The 3 courses are Physical Science, Life Science, and Earth and Space Science
(for both middle and high school)

Science Domains Model (9-12)

Physical Science	
PS1.A	HS-PS1-a
	HS-PS1-b
	HS-PS1-c
	HS-PS2-f
PS1.B	HS-PS1-e
	HS-PS1-f
	HS-PS1-g
	HS-PS1-h
	HS-PS1-i
PS1.C	HS-PS1-j
PS2.A	HS-PS2-a
	HS-PS2-b
	HS-PS2-c
PS2.B	HS-PS2-d
	HS-PS2-e
PS2.C	HS-PS1-g
	HS-PS2-b
	HS-PS2-c
PS3.A	HS-PS3-a
	HS-PS3-b
	HS-PS3-c
PS3.B	HS-PS3-a
	HS-PS3-b
	HS-PS3-d
PS3.D	HS-PS3-b
	HS-PS3-d
	HS-PS3-f
	HS-PS3-g
	HS-PS4-h
	HS-ESS1-a
PS4.A	HS-PS4-a
	HS-PS4-b
	HS-PS4-c
	HS-PS4-d
PS4-B	HS-PS4-a
	HS-PS4-e
	HS-PS4-f
	HS-PS4-g
	HS-PS4-h
	HS-ESS1-a
PS4-C	HS-PS4-f

Life Science	
LS1.A	HS-LS1-a
	HS-LS1-b
	HS-LS1-c
	HS-LS1-d
LS1.B	HS-LS1-e
	HS-LS1-f
	HS-LS1-g
	HS-LS1-c
LS1.C	HS-LS1-h
	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
	HS-LS2-f
LS1.D	HS-LS1-k
	HS-LS1-l
LS2.A	HS-LS2-a
	HS-LS2-b
LS2.B	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-e
	HS-LS2-c
LS2.C	HS-LS2-h
	HS-LS2-i
	HS-LS2-j
	HS-LS2-b
LS2.D	HS-LS2-k
LS3.A	HS-LS3-a
	HS-LS3-f
	HS-LS3-d
LS3.B	HS-LS3-a
	HS-LS3-b
LS4.A	HS-LS4-f
LS4.B	HS-LS4-b
	HS-LS4-d
	HS-LS4-c
	HS-LS4-e
LS4.C	HS-LS4-b
	HS-LS4-d
	HS-LS4-c
	HS-LS4-e
	HS-LS4-a
LS4.D	HS-LS2-l
	HS-LS2-j

Earth and Space Science	
ESS1.A	HS-ESS1-b
	HS-ESS1-c
	HS-ESS1-a
	HS-ESS1-d
ESS1.B	HS-ESS1-e
	HS-ESS1-f
ESS1.C	HS-ESS1-g
	HS-ESS1-i
	HS-ESS1-j
	HS-ESS1-h
ESS2.A	HS-ESS2-c
	HS-ESS2-d
	HS-ESS2-a
	HS-ESS2-b
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS2-g
	HS-ESS2-h
ESS2.B	HS-ESS2-d
	HS-ESS2-a
	HS-ESS1-h
ESS2.C	HS-ESS2-i
ESS2.D	HS-ESS2-j
	HS-ESS2-k
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS3-g
	HS-ESS3-h
ESS2.E	HS-ESS1-l
ESS3.A	HS-ESS3-a
	HS-ESS3-b
ESS3.B	HS-ESS3-c
	HS-ESS3-d
ESS3.C	HS-ESS3-e
	HS-ESS3-f
ESS3.D	HS-ESS3-i
	HS-ESS3-g
	HS-ESS3-h

KEY

	PE appears in more than one DCI in the same course.
	PE shared across more than one course because a component idea is divided between courses.
	PE appears in more than one course and it is connected to more than one DCI component idea in the same course.

NEXT GENERATION SCIENCE STANDARDS

How would you construct a 6-12 curriculum around the NGSS, given the amount and complexity of the Earth and Space Science?

Course Map #3: Modified Science Domains Model (for high school):

Incorporate the Earth and Space Science into existing biology, chemistry, and physics courses.

→ Least efficient in terms of instruction time; concepts taught out of order (without adequate prerequisites)

NEXT GENERATION SCIENCE STANDARDS

Modified Science Domains Model (9-12)

Biology

LS1.A	HS-LS1-a
	HS-LS1-b
	HS-LS1-c
	HS-LS1-d
LS1.B	HS-LS1-e
	HS-LS1-f
	HS-LS1-g
	HS-LS3-c
LS1.C	HS-LS1-h
	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
	HS-LS2-c
LS1.D	HS-LS1-k
	HS-LS1-l
LS2.A	HS-LS2-a
	HS-LS2-b
LS2.B	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
	HS-LS2-f
LS2.C	HS-LS2-h
	HS-LS2-i
	HS-LS2-j
	HS-LS2-b
LS2.D	HS-LS2-k
LS3.A	HS-LS3-a
	HS-LS3-b
	HS-LS3-d
LS4.A	HS-LS4-f
LS4.B	HS-LS4-b
	HS-LS4-d
	HS-LS4-c
	HS-LS4-e
LS4.C	HS-LS4-b
	HS-LS4-d
	HS-LS4-c
	HS-LS4-e
	HS-LS4-a
LS4.D	HS-LS2-l
	HS-LS2-j
ESS1.C	HS-ESS1-g
	HS-ESS1-i
	HS-ESS1-j
	HS-ESS1-h
ESS2.E	HS-ESS1-l
ESS3.B	HS-ESS3-c
	HS-ESS3-d
ESS3.C	HS-ESS3-e
	HS-ESS3-f

Chemistry

PS1.A	HS-PS1-a
	HS-PS1-b
	HS-PS1-c
	HS-PS2-f
	HS-PS1-d
	HS-PS1-j
	HS-PS3-g
PS1.B	HS-PS1-e
	HS-PS1-f
	HS-PS1-g
	HS-PS1-h
	HS-PS1-i
PS2.C	HS-PS1-g
PS3.B	HS-PS3-d
PS3.D	HS-PS3-d
ESS2.C	HS-ESS2-i
ESS2.D	HS-ESS2-j
	HS-ESS2-k
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS3-g
	HS-ESS3-h
ESS3.A	HS-ESS3-a
	HS-ESS3-b
ESS3.D	HS-ESS3-i
	HS-ESS3-g
	HS-ESS3-h

Physics

PS2.A	HS-PS2-a
	HS-PS2-b
	HS-PS2-c
PS2.B	HS-PS2-d
	HS-PS2-e
PS2.C	HS-PS1-g
	HS-PS2-b
	HS-PS2-c
PS3.A	HS-PS3-a
	HS-PS3-b
	HS-PS3-c
PS3.B	HS-PS3-a
	HS-PS3-b
	HS-PS3-d
	HS-PS3-f
PS3.C	HS-PS3-e
PS4.A	HS-PS4-a
	HS-PS4-b
	HS-PS4-c
	HS-PS4-d
PS4.B	HS-PS4-a
	HS-PS4-e
	HS-PS4-f
	HS-PS4-g
	HS-PS4-h
ESS1.A	HS-ESS1-b
	HS-ESS1-c
	HS-ESS1-a
	HS-ESS1-d
ESS1.B	HS-ESS1-e
	HS-ESS1-f
ESS2.A	HS-ESS2-c
	HS-ESS2-d
	HS-ESS2-a
	HS-ESS2-b
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS2-g
	HS-ESS2-h
ESS2.B	HS-ESS2-d
	HS-ESS2-a
	HS-ESS1-h

KEY

	PE appears in more than one DCI in the same course.
	PE shared across more than one course because a component idea is divided between courses.
	PE appears in more than one course and it is connected to more than one DCI component idea in the same course.

How do schools Teach Earth and Space Science with the NGSS?

1. Start with the Performance Expectations.
   - ➢ 15 at Middle School; 19 at High School
2. Determine how you will be organizing them
   - ➢ Use the *Appendix K* **Course Maps** as a guide
3. Determine what you will teach to support the PE's
   - ➢ Use the *Clarification Statements* and *Assessment Boundaries as a guide*

NEXT GENERATION SCIENCE STANDARDS

HS-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

HS-ESS3-1. **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

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

Constructing Explanations and Designing Solutions

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 student-generated sources of evidence consistent with scientific knowledge, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

ESS3.A: Natural Resources

- Resource availability has guided the development of human society.

ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Modern civilization depends on major technological systems.

Connections to other DCIs in this grade-band: N/A

Articulation of DCIs across grade-bands:

MS.LS2.A ; **MS.LS4.D** ; **MS.ESS2.A** ; **MS.ESS3.A** ; **MS.ESS3.B**

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS3-1)*

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. *(HS-ESS3-1)*

HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. *(HS-ESS3-1)*

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. *(HS-ESS3-1)*

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-ESS3-1)*

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7. Professional Development

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6. Look for connections to Common Core for Math and ELA
7. Professional Development
8. Assessment