Challenges in Developing K-8 Science Programs Aligned with the Next Generation Science Standards

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Seattle, WA, Oct 24, 2017

PEEC for NGSS Instructional Materials Design

Overview of PEEC

PEEC is an acronym for the **Primary Evaluation of Essential Criteria for NGSS Instructional Materials Design.**

PEEC takes the compelling vision for science education as described in *A Framework for K–12 Science Education* and embodied in the Next Generation Science Standards (NGSS) and operationalizes it for two purposes:

1. to help educators determine how well instructional materials under consideration have been designed for the *Framework* and NGSS, and
2. to help curriculum developers construct and write science instructional materials that are designed for the *Framework* and NGSS.

The resource seeks to focus educators and curriculum developers on the critical innovations within the NGSS and dig deeply into materials to (1) evaluate the presence of those innovations and (2) answer the question "*How thoroughly are these science instructional materials designed for the NGSS?* PEEC can be used by educators to evaluate the NGSS design of textbooks as well as comprehensive science instructional materials programs designed to include different units, kits, modules, textbooks, textbook series, or web-based instructional materials, including open educational resources. PEEC enables curriculum developers to more easily create and refine instructional materials, and do so knowing that their efforts are focused on the same NGSS innovations that schools, districts, and states will be using to select their instructional materials.

Throughout PEEC, the word "**designed**" is intentionally used rather than "aligned." The word "designed" was chosen because it reflects the degree to which the materials were consciously planned and organized to support the NGSS. For curriculum developers, this might mean starting from scratch and building new materials, or it might mean starting with existing materials and significantly reworking them. The focus either way is ensuring that the NGSS innovations are a foundational aspect of, and clearly visible within, instructional materials.

Download PEEC for more information. Click here for FAQs about PEEC.

RECENT NEWS

- July 2017 NGSS NOW Newsletter
- Primary Evaluation of Essential Criteria for NGSS Instructional Materials Design
- June 2017 NGSS NOW Newsletter
- EQuIP Peer Review Panel for Science: New Category, New Badge, New Pathway
- NGSS District Implementation Workbook

Any NGSS-designed Curricular Materials Should Incorporate the "Five NGSS Innovations"

1. *Three-Dimensional Learning*

NRC Framework
Three Dimensions:

(1) Disciplinary Core Ideas (DCIs)

(2) *Science* and *Engineering* Practices (SEPs)

(3) Crosscutting Concepts (CCCs)

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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.]

PRACTICES	*BIG IDEAS*	*X-CUTTING CONCEPTS*
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)*

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Any NGSS-designed Curricular Materials Should Incorporate the "Five NGSS Innovations"

1. Three-Dimensional Learning
2. ***Building K-12 Progressions***

Example of K-12 Progres- sions:

Developing and Using Models

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Developing and Using Models A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.	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.	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.	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.	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
	• Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences.	• Identify limitations of models.	• Evaluate limitations of a model for a proposed object or tool.	• Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. • Design a test of a model to ascertain its reliability.
	• Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	• Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. • Develop and/or use models to describe and/or predict phenomena.	• Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. • Use and/or develop a model of simple systems with uncertain and less predictable factors. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms.	• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
	• Develop a simple model based on evidence to represent a proposed object or tool.	• Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. • Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	• Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	• Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

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	• Develop a simple model based on evidence to represent a proposed object or tool.	• Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. • Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	• Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	• Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Example of K-12 Progres-sions:

Developing and Using Models

Science and Engineering Practices	K–2 Condensed Practices	3–5 Condensed Practices	6–8 Condensed Practices	9–12 Condensed Practices
Developing and Using Models A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Me... ob... re...	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.	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.	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.	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).
	• Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences.	• Identify limitations of models.	• Evaluate limitations of a model for a proposed object or tool.	• Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. • Design a test of a model to ascertain its reliability.
	• Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	• Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. • Develop a model using an analogy, example, or abstract representation to describe a ...	• Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. • Use and/or develop a model of simple systems with uncertain and less predictable factors ...	• Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict ...
		... effect relationships or interactions concerning the functioning of a natural or designed system.	... representing inputs and outputs, and those at unobservable scales.	... (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Also Grade-Banded Progressions for *Disciplinary Core Ideas, Crosscutting Concepts, Engineering/Technology/Applications of Science,* and *Nature of Science*

Any NGSS-designed Curricular Materials Should Incorporate the "Five NGSS Innovations"

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. ***Alignment with Common Core English Language Arts and Mathematics***

Connections to Common Core Math and ELA:

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.]

PRACTICES	*BIG IDEAS*	*X-CUTTING CONCEPTS*
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)*

Connections to Common Core Math and ELA:

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.]

PRACTICES

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.

BIG IDEAS

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.

X-CUTTING CONCEPTS

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 -

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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)*

Connections to Common Core Math and ELA:

The Practices of Science and Engineering (SEPs)

Strong English Connections

Strong Math Connections

1. Asking questions (*for science*) and defining problems (*for engineering*)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (*for science*) and designing solutions (*for engineering*)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Any NGSS-designed Curricular Materials Should Incorporate the “Five NGSS Innovations”

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. Alignment with Common Core English Language Arts and Mathematics
4. ***Making Sense of Phenomena and Designing Solutions to Problems***

NGSS: → Problem-Based Learning

- Creates a more student-centric environment
- Moves the focus away from the teacher's instruction toward the student's active learning process

Phenomenon-Based Learning

- Phenomena are defined through broad big-picture questions
- Issues are usually of human relevance
- Challenges are approached holistically, viewed from a variety of perspectives

Phenomenon-Based Learning

- *Student sense-making and solution-designing should be the context for student learning and a window into student understanding of all three dimensions of the standards*

Three-Dimensional Learning

Three-Dimensional Learning

1. Just DCIs = Encyclopedia

Three-Dimensional Learning

1. Just DCIs = Encyclopedia
2. Just SEPs = Random activities

Three-Dimensional Learning

1. Just DCIs = Encyclopedia
2. Just SEPs = Random activities
3. Just CCCs = Random science phenomena

Three-Dimensional Learning

1. Just DCIs = Encyclopedia
2. Just SEPs = Random activities
3. Just CCCs = Random science phenomena
4. DCIs + CCCs = Old-Fashioned Textbook

Three-Dimensional Learning

1. Just DCIs = Encyclopedia
2. Just SEPs = Random activities
3. Just CCCs = Random science phenomena
4. DCIs + CCCs = Old-Fashioned Textbook
5. SEPs + DCIs = List of science labs

Three-Dimensional Learning

1. Just DCIs = Encyclopedia
2. Just SEPs = Random activities
3. Just CCCs = Random science phenomena
4. DCIs + CCCs = Old-Fashioned Textbook
5. SEPs + DCIs = List of science labs
6. SEPs + CCCs = Telling stories of science phenomena

Three-Dimensional Learning

1. Just DCIs = Encyclopedia
2. Just SEPs = Random activities
3. Just CCCs = Random science phenomena
4. DCIs + CCCs = Old-Fashioned Textbook
5. SEPs + DCIs = List of science labs
6. SEPs + CCCs = Telling stories of science phenomena
7. SEPs + DCIs + CCCs = Coherent curriculum of **science and engineering practices**, connected to **disciplinary core ideas**, organized around **storylines of understanding** that build and apply ideas across time

Any NGSS-designed Curricular Materials Should Incorporate the Five “NGSS Innovations”

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. Alignment with Common Core English Language Arts and Mathematics
4. Making Sense of Phenomena and Designing Solutions to Problems
5. ***All Standards, All Students***

Any NGSS-designed Curricul
Incorporate the Five “NGSS I

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. Alignment with Common Core
   Arts and Mathematics
4. Making Sense of Phenomena
   Solutions to Problems
5. ***All Standards, All Students***

Accelerated Model Course Pathway:

5-Year Model

(For Gifted Students)

Course 1

- MS.PS.1 Matter and its Interactions
- MS.PS.2 Motion and Stability: Forces and
- MS.PS.3 Energy
- MS.PS.4 Waves
- MS.ESS1 Earth's Place in the Universe
- MS.ESS.2 Earth Systems
- MS.ESS.3 Earth and Human Activity

Course 2

- MS.PS.4 HS.PS.4 Waves
- MS.LS.1 Structure and Processes
- MS.LS.2 Ecosystems
- MS.LS.3 Heredity
- MS.LS.4 Evolution
- MS.ESS1 Earth's Place in the Universe
- MS.ESS.2 Earth Systems
- MS.ESS.3 Earth and Human Activity

Course 3

- HS.PS.1 Matter
- MS.LS.4 Evolution
- HS.LS.1 Structure and Processes
- HS.LS.2 Ecosystems
- HS.ESS.2 Earth Systems
- HS.ESS.3 Earth and Human Activity

Course 4

- HS.PS.2 Motion and Forces
- HS.PS.3 Energy
- HS.PS.4 Waves
- HS.LS.1 Structure and Processes
- HS.LS.2 Ecosystems
- HS.ESS1 Earth's Place in the Universe
- HS.ESS.2 Earth Systems

Course 5

- HS.PS.1 Matter
- HS.LS.2 Ecosystems
- HS.LS.3 Heredity
- HS.LS.4 Evolution
- HS.ESS1 Earth's Place in the Universe
- HS.ESS.2 Earth Systems
- HS.ESS.3 Earth and Human Activity

Accelerated Model Course Pathway:

4-Year Model

(For *Very* Gifted Students)

Course 1
- MS.PS.1 Matter
- MS.PS.2 Motion and Forces
- MS.PS.3 Energy
- MS.PS.4 Waves
- MS.ESS1 Earth's Place in the Universe
- MS.ESS.2 Earth Systems
- MS.ESS.3 Earth and Human Activity

Course 2
- MS.PS.4 HS.PS.4 Waves
- MS.LS.1 Structure and Processes
- MS.LS.2 HS.LS.2 Ecosystems
- HS.ESS1 Earth's Place in the Universe
- HS.ESS.2 Earth Systems
- HS.ESS.3 Earth and Human Activity

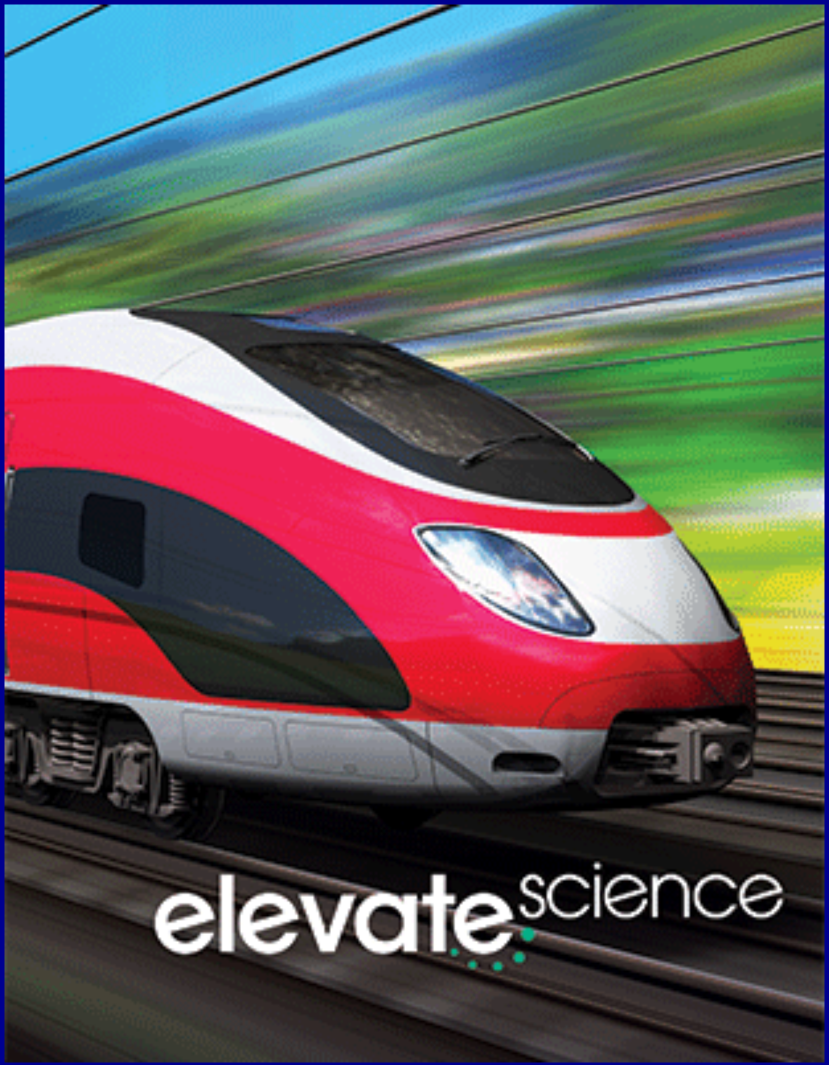
Course 3
- HS.PS.1 Matter
- HS.PS.2 Motion and Forces
- HS.PS.3 Energy
- HS.PS.4 Waves
- HS.LS.1 Structure and Processes
- HS.LS.2 Ecosystems
- HS.ESS1 Earth's Place in the Universe
- HS.ESS.2 Earth Systems

Course 4
- HS.PS.1 Matter
- HS.LS.1 Structure and Processes
- HS.LS.2 Ecosystems
- MS.LS.3 HS.LS.3 Heredity
- MS.LS.4 HS.LS.4 Evolution
- HS.ESS1 Earth's Place in the Universe
- HS.ESS.2 Earth Systems
- HS.ESS.3 Earth and Human Activity

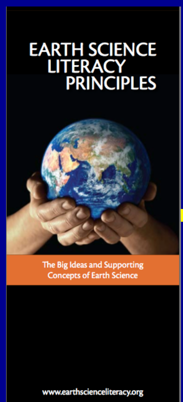
Elevate Science

(Michael Padilla, Zipporah Miller, Michael Wysession)

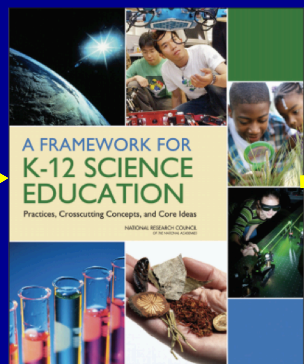
An NGSS-designed K-8 science program combining print workbooks with interactive online materials



Timeline for the NGSS & ***Elevate Science***



2009



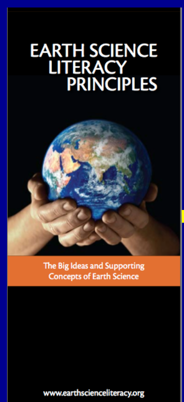
2011

2013

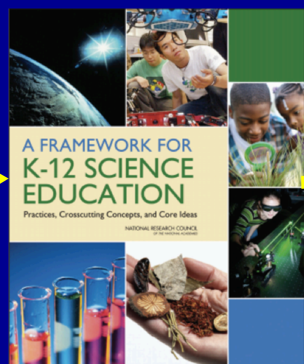
- Teacher Development
- Curricula
- Instructional Materials
- Instruction
- Assessment

2017

Timeline for the NGSS & ***Elevate Science***



2009



2011

2013

- Teacher Development
- Curricula
- Instructional Materials
- Instruction
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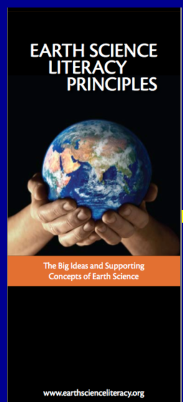
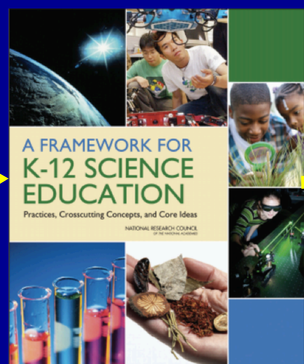
2017

Timeline for the NGSS & ***Elevate Science***



2009



2011

2013

- Teacher Development
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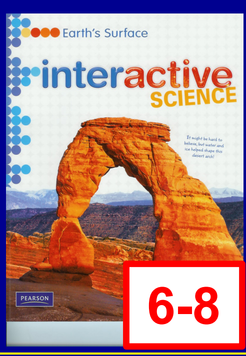
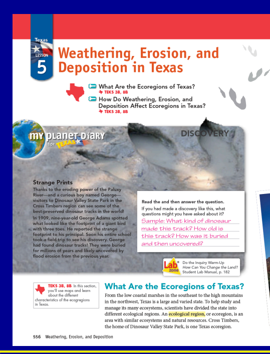
- Instructional Materials
- Instruction
- Assessment

2017

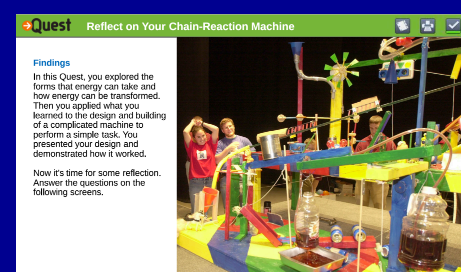


2008-2011

2009-2012



2012-2013



2013-2014

2013-2017

Publisher Challenges

EDWEEK Market Brief | MARKET TRENDS | EXCLUSIVE DATA | WEBINARS | TOPICS | MORE

Marketplace K-12 *May 5, 2017*

Pearson Explores Sale of Its U.S. K-12 Curriculum Business

Michele Molnar
Associate Editor

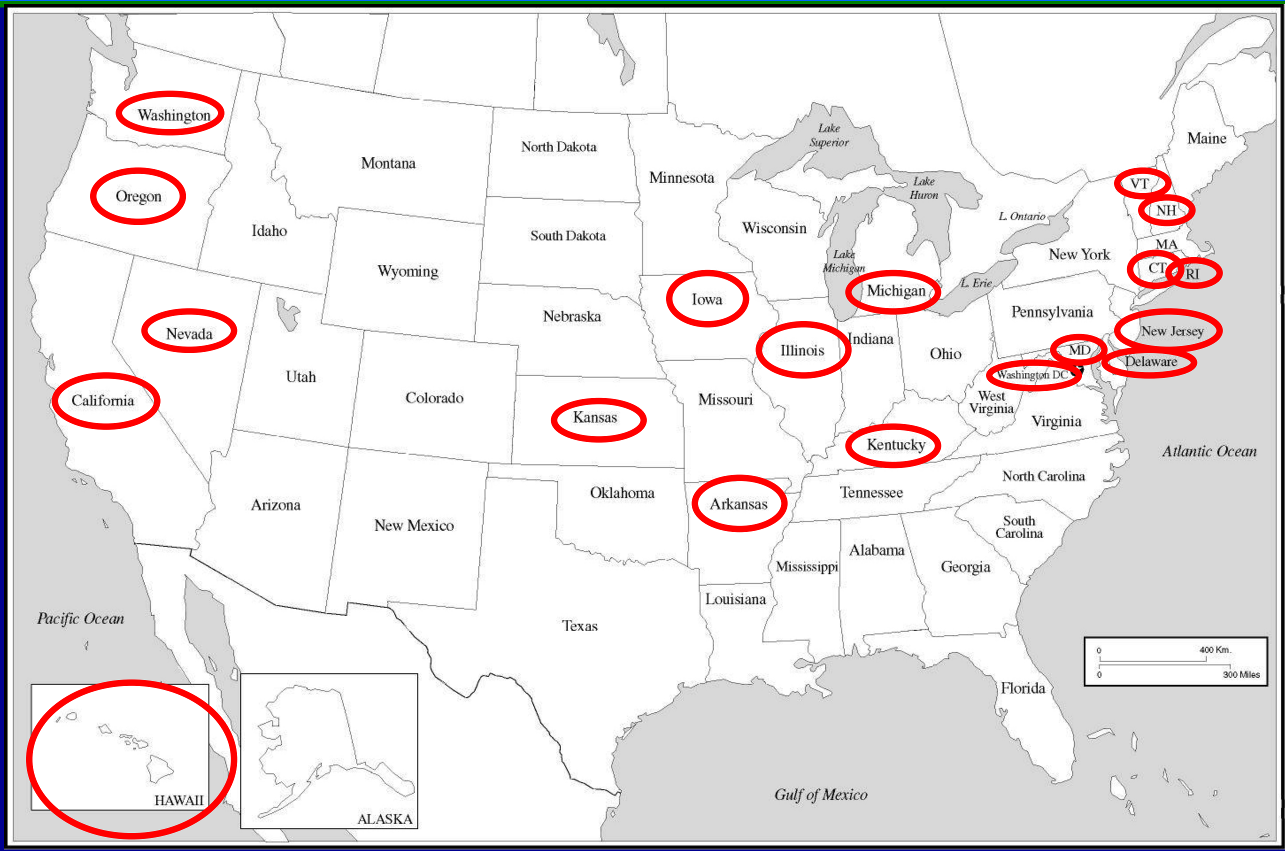
Pearson, the largest education company in the world, announced today that it's considering selling off its U.S. K-12 digital and print curriculum business, citing the "slow pace of digital adoption" in schools.

Besides that issue, the company cited a "challenging competitive and market environment" and the high capital needs of the digital curriculum market as reasons for its announcement of a strategic review of that portion of the business.

NGSS State-wise Adoption

Adopting States:

- Arkansas
- California
- Connecticut
- Delaware
- Hawaii
- Illinois
- Iowa
- Kansas
- Kentucky
- Maryland
- Michigan
- Nevada
- N. Hampshire
- New Jersey
- Oregon
- Rhode Isl.
- Vermont
- Washington
- (and DC)



NGSS State-wise Adoption

Adopting States:

Arkansas
California
Connecticut
Delaware
Hawaii
Illinois
Iowa
Kansas
Kentucky
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Michigan
Nevada
N. Hampshire
New Jersey
Oregon
Rhode Isl.
Vermont
Washington
(and DC)

NGSS State-wise Adoption

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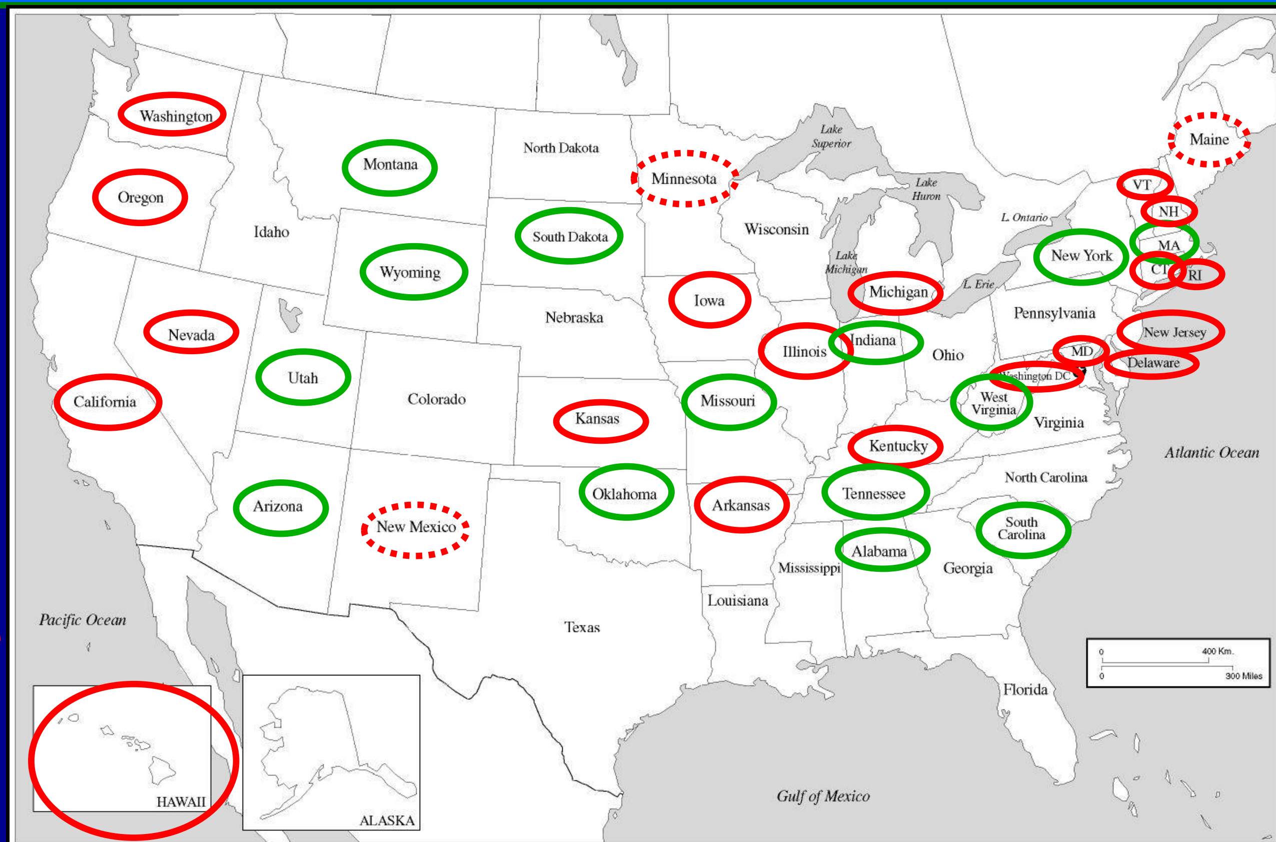
Vermont
Washington
(and DC)



Adapting: **Alabama, Arizona, Massachusetts, Missouri, Montana, New York, Oklahoma, S. Carolina, S. Dakota, Tennessee, Utah, West Virginia, Wyoming**

NGSS State-wise Adoption

Adopting States:

Arkansas
California
Connecticut
Delaware
Hawaii
Illinois
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Kansas
Kentucky
Maryland
Michigan
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New Jersey
Oregon
Rhode Isl.
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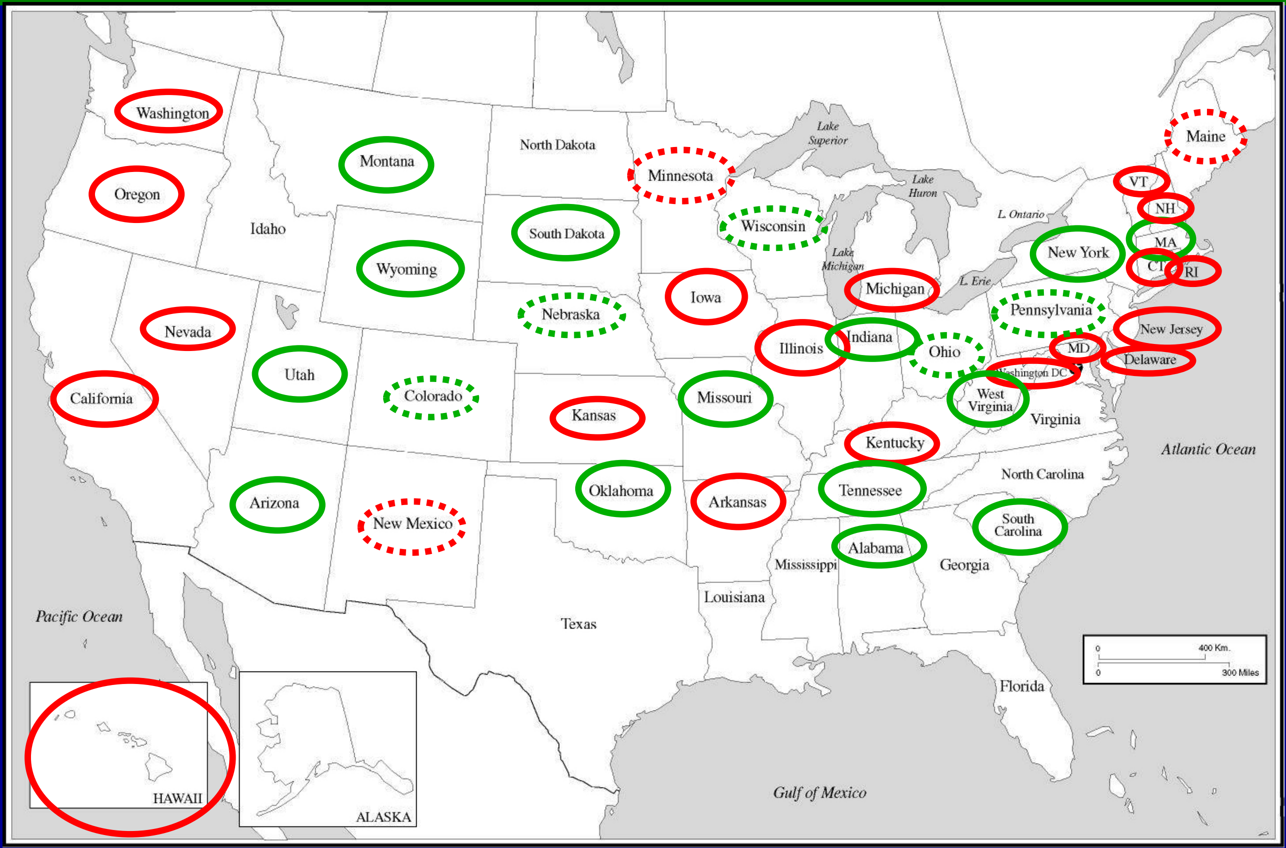

Adapting: Alabama, Arizona, Massachusetts, Missouri, Montana, New York, Oklahoma, S. Carolina, S. Dakota, Tennessee, Utah, West Virginia, Wyoming

NGSS State-wise Adoption

Adopting States:

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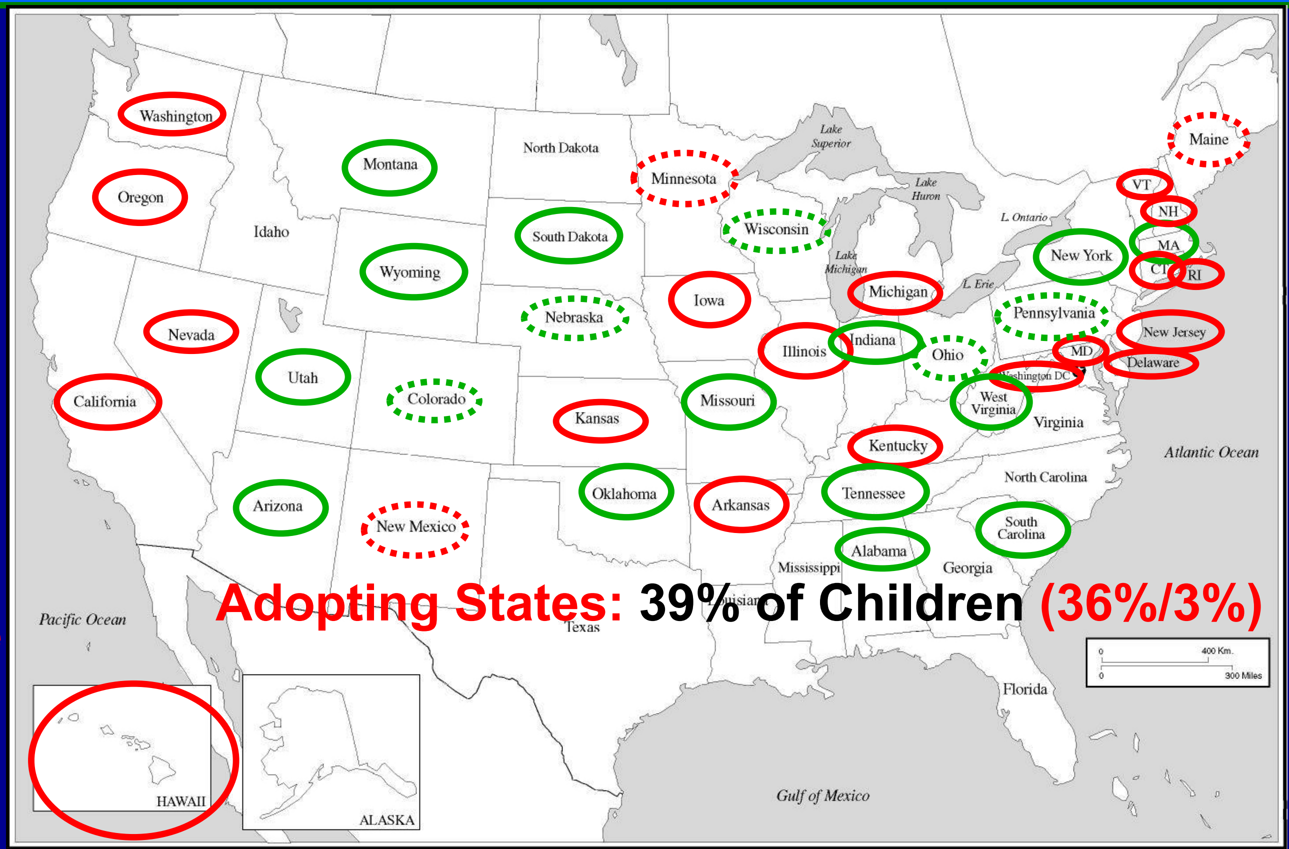
- Kentucky
- Maryland
- Michigan
- Nevada
- N. Hampshire
- New Jersey
- Oregon
- Rhode Isl.
- Vermont
- Washington
- (and DC)



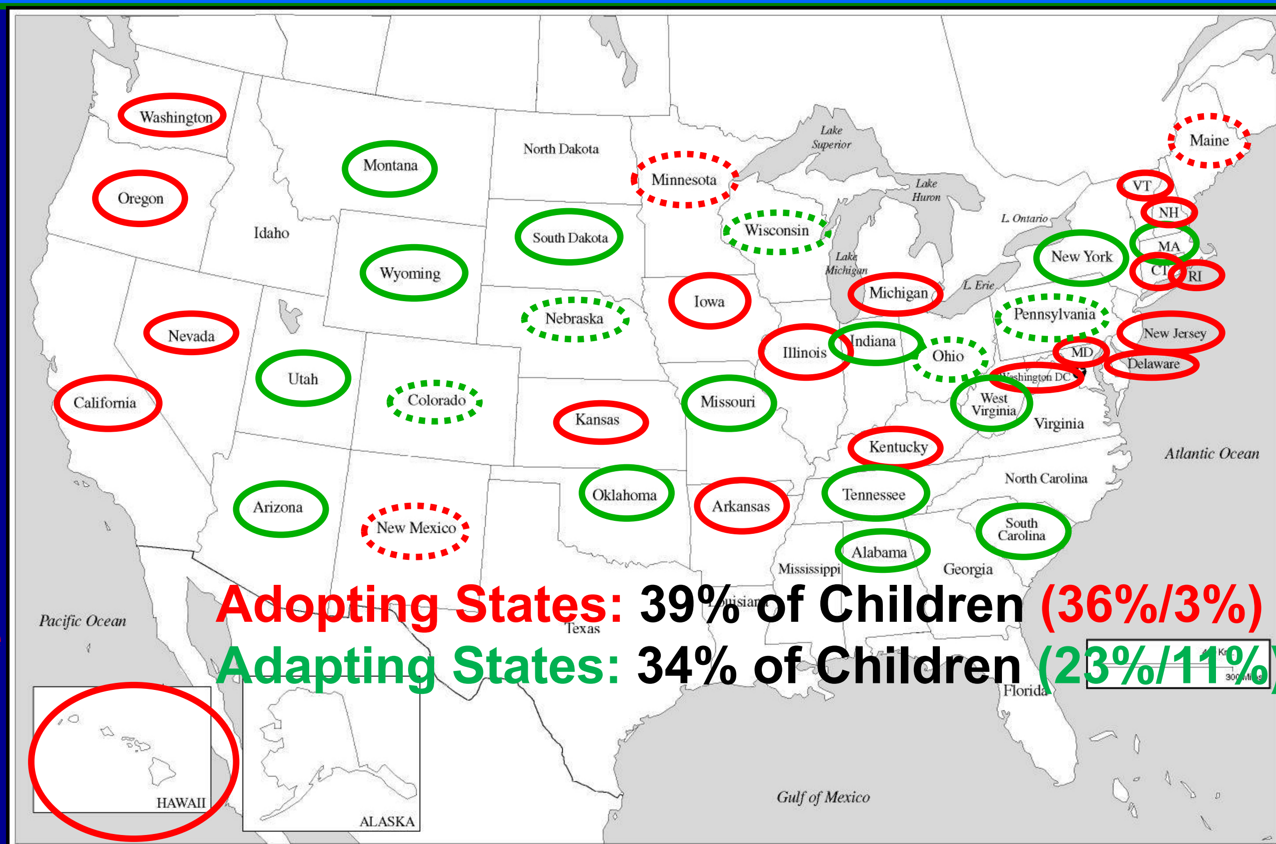
Adopting States: 39% of Children (36%/3%)

Adapting: Alabama, Arizona, Massachusetts, Missouri, Montana, New York, Oklahoma, S. Carolina, S. Dakota, Tennessee, Utah, West Virginia, Wyoming

NGSS State-wise Adoption

Adopting States:

Arkansas
California
Connecticut
Delaware
Hawaii
Illinois
Iowa
Kansas
Kentucky
Maryland
Michigan
Nevada
N. Hampshire
New Jersey
Oregon
Rhode Isl.
Vermont
Washington
(and DC)



Adopting States: 39% of Children (36%/3%)

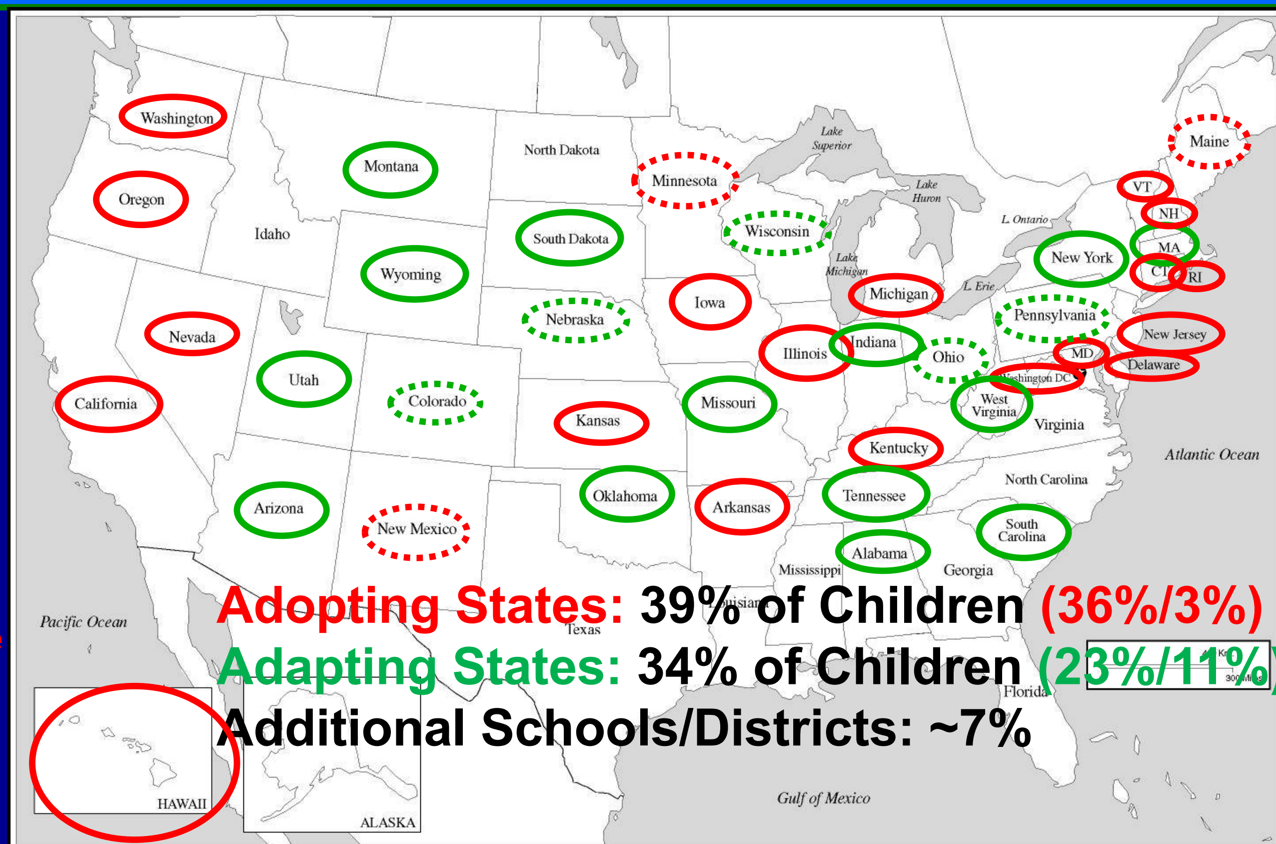
Adapting States: 34% of Children (23%/11%)

Adapting: **Alabama, Arizona, Massachusetts, Missouri, Montana, New York, Oklahoma, S. Carolina, S. Dakota, Tennessee, Utah, West Virginia, Wyoming**

NGSS State-wise Adoption

Adopting States:

Arkansas
California
Connecticut
Delaware
Hawaii
Illinois
Iowa
Kansas
Kentucky
Maryland
Michigan
Nevada
N. Hampshire
New Jersey
Oregon
Rhode Isl.
Vermont
Washington
(and DC)



Adopting States: 39% of Children (36%/3%)
Adapting States: 34% of Children (23%/11%)
Additional Schools/Districts: ~7%

Adapting: Alabama, Arizona, Massachusetts, Missouri, Montana, New York, Oklahoma, S. Carolina, S. Dakota, Tennessee, Utah, West Virginia, Wyoming

NGSS State-wise Adoption

Adopting States:

- Arkansas
- California
- Connecticut
- Delaware
- Hawaii
- Illinois
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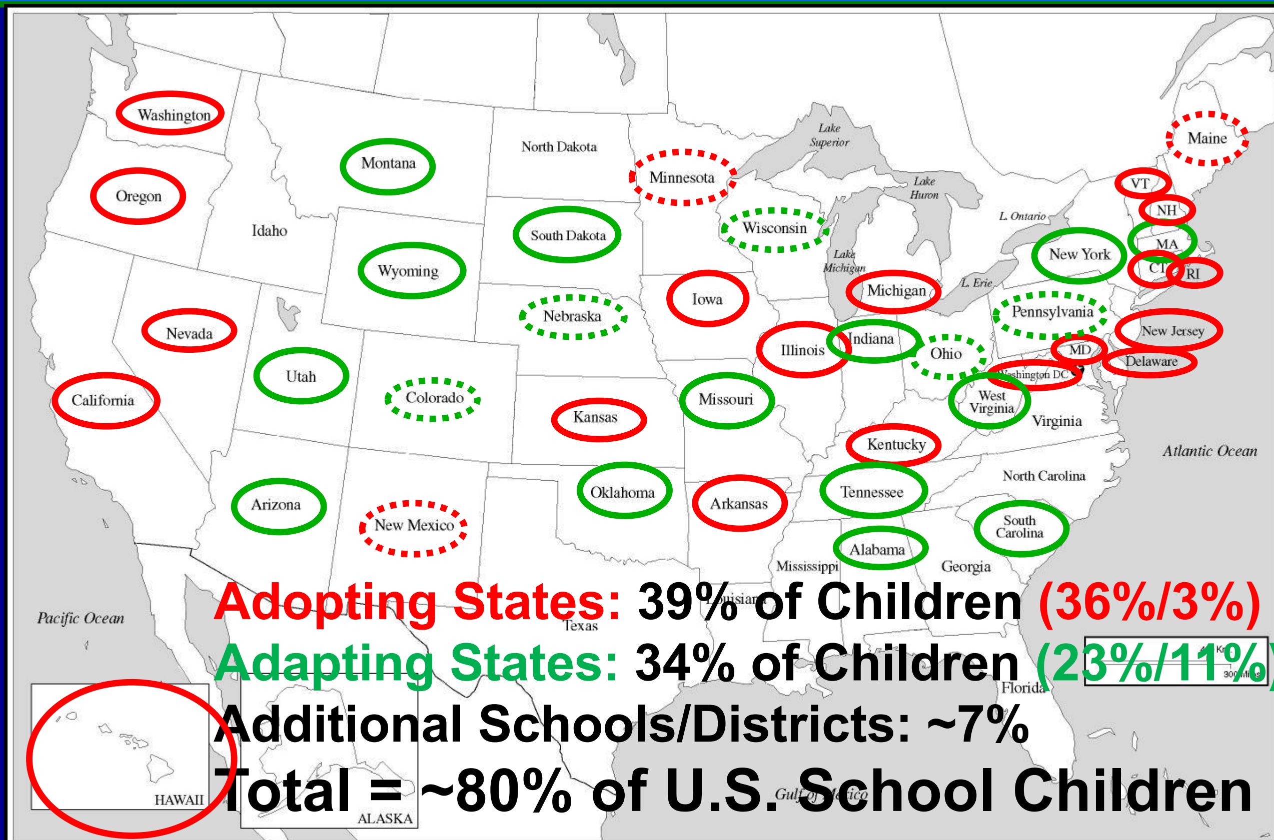
- Kansas
- Kentucky
- Maryland
- Michigan
- Nevada
- N. Hampshire
- New Jersey
- Oregon
- Rhode Isl.
- Vermont
- Washington
- (and DC)



Adopting States: 39% of Children (36%/3%)

Adapting States: 34% of Children (23%/11%)

Additional Schools/Districts: ~7%

Total = ~80% of U.S. School Children

Adapting: **Alabama, Arizona, Massachusetts, Missouri, Montana, New York, Oklahoma, S. Carolina, S. Dakota, Tennessee, Utah, West Virginia, Wyoming**

Every state (and maybe district!) will teach their NGSS-adopted or adapted curriculum differently

What content should Instructional Materials include?

Every state (and maybe district!) will teach their NGSS-adopted or adapted curriculum differently

What content should Instructional Materials include?

K-5 (easier): NGSS is grade-leveled

Every state (and maybe district!) will teach their NGSS-adopted or adapted curriculum differently

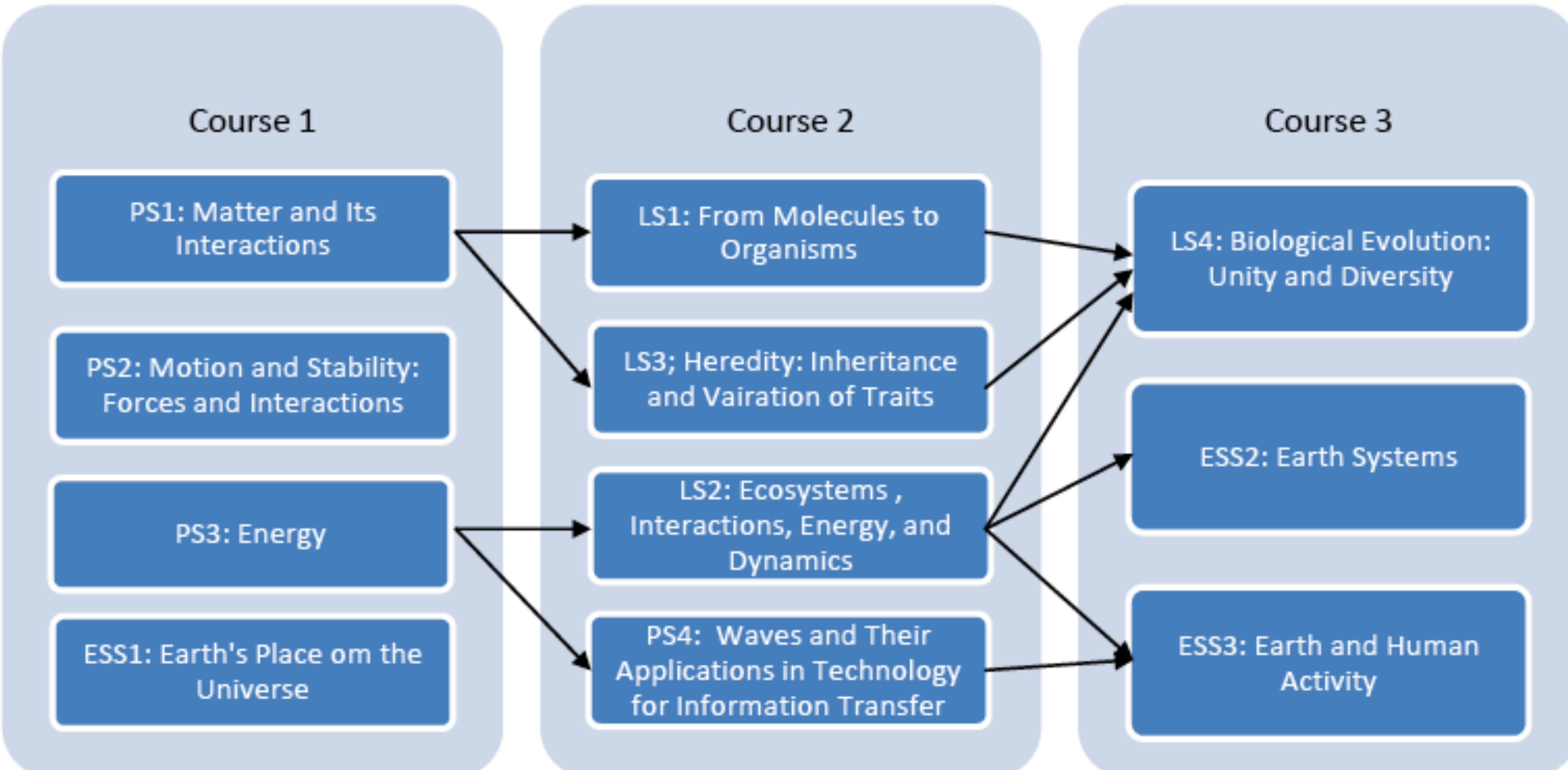
What content should Instructional Materials include?

K-5 (easier): NGSS is grade-leveled

6-8 (harder): NGSS is grade-banded

Constructing NGSS-designed Instructional Materials

Appendix K -- Course Map #1: Conceptual Understanding Model



Course Map #2: Science Domains Model

The 3 courses are Physical Science, Life Science, and Earth and Space Science (for either middle or 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.

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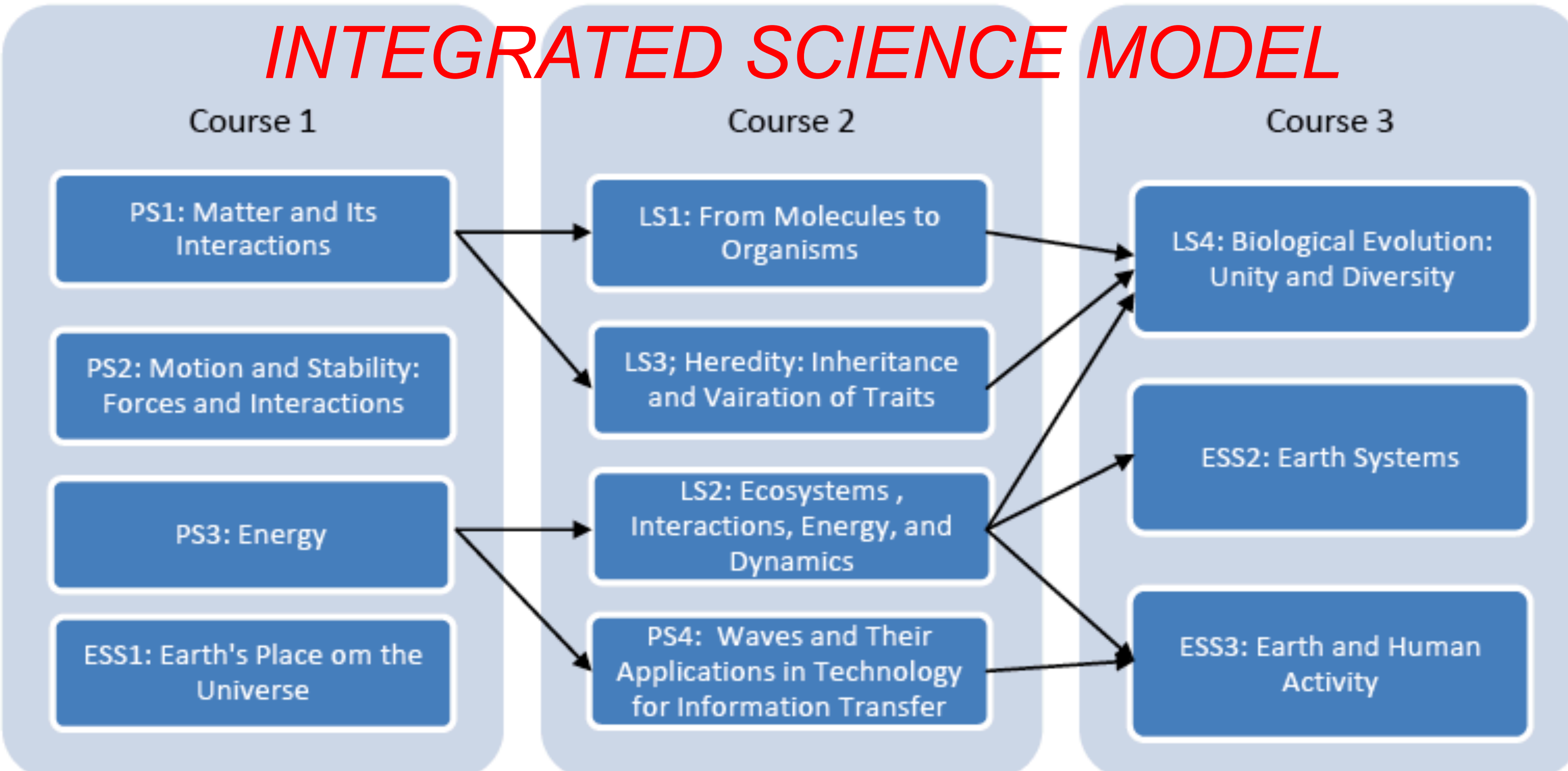

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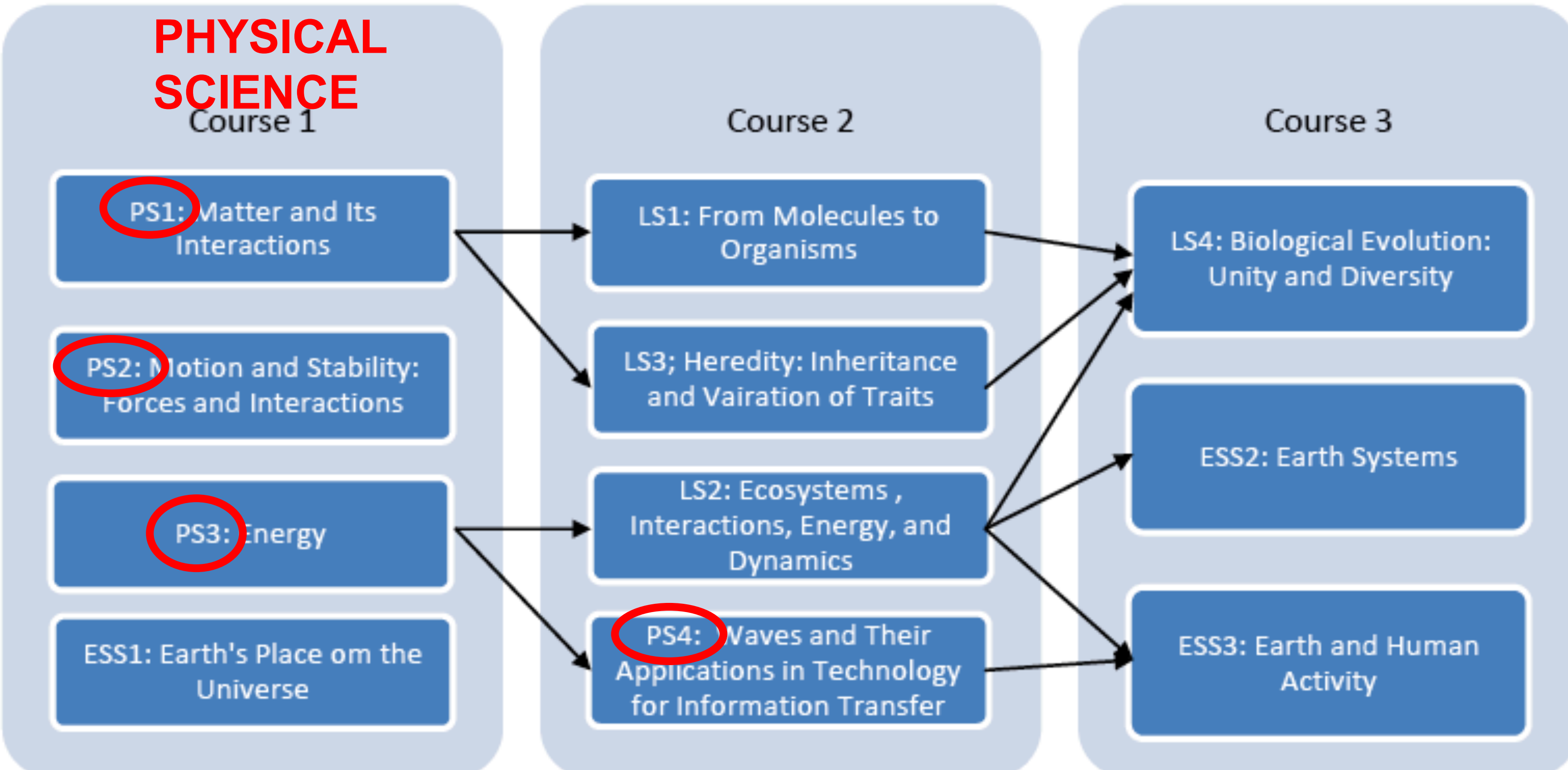

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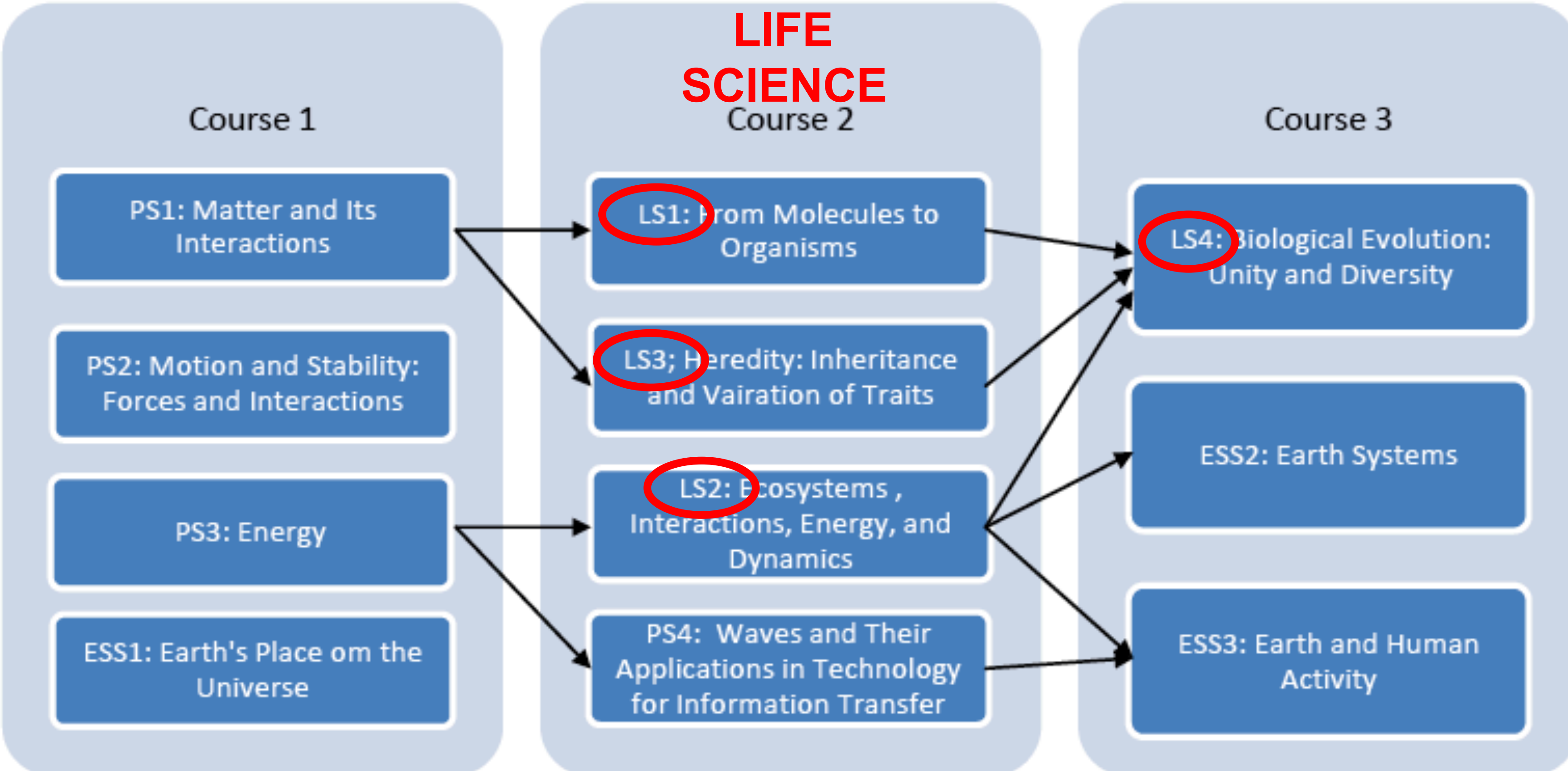

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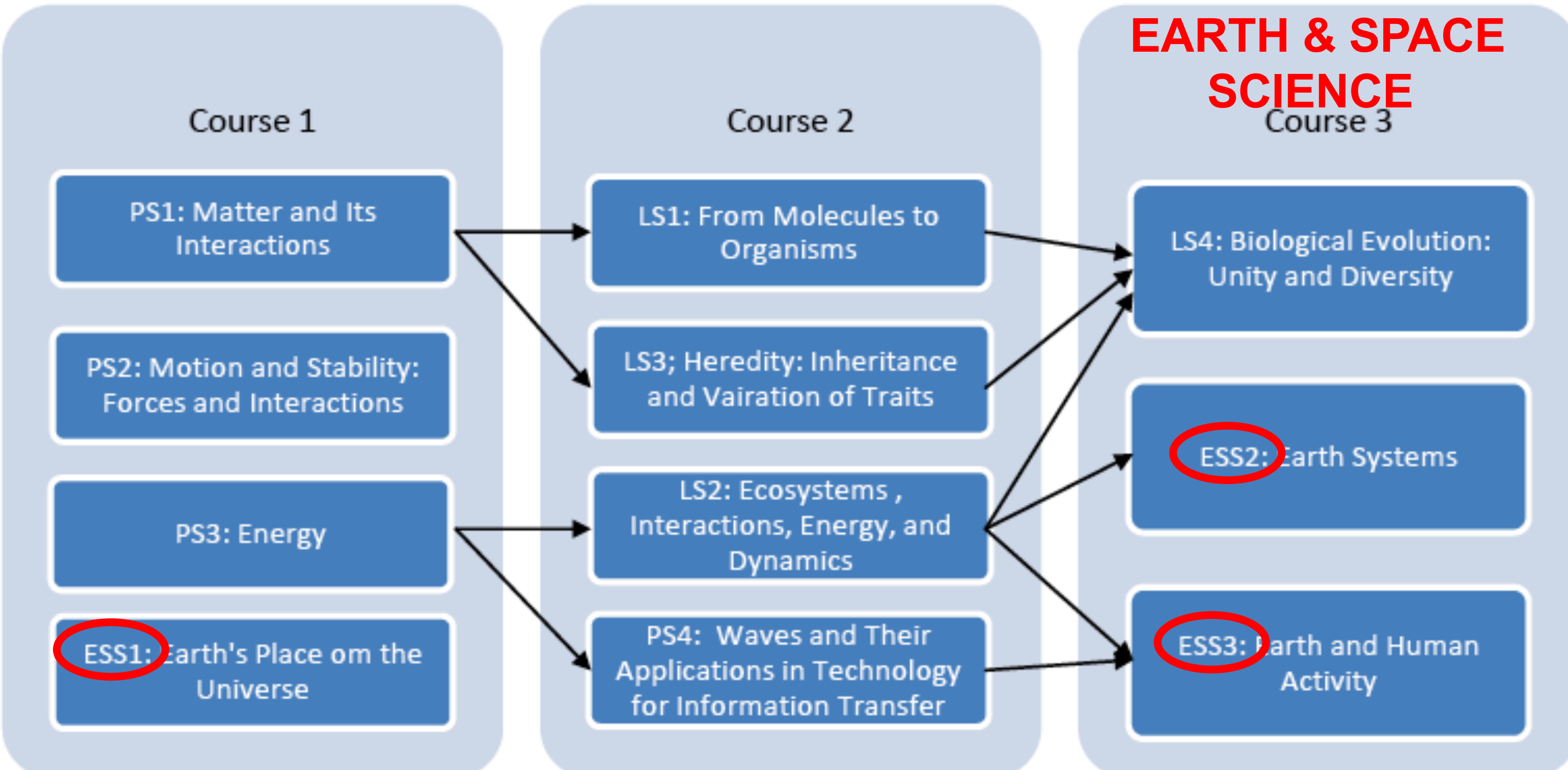

Bundling the NGSS

Example Bundles:

Read First: **Introduction and Guide**

Kindergarten
Thematic Model
Topics Model

1st Grade
Thematic Model
Topics Model

2nd Grade
Thematic Model
Topics Model

3rd Grade
Thematic Model
Topics Model

4th Grade
Thematic Model
Topics Model

5th Grade
Thematic Model
Topics Model

Middle School
Course 1: Phenomenon Model
Course 2: Phenomenon Model
Course 3: Phenomenon Model

Course 1: Topics Model
Course 2: Topics Model
Course 3: Topics Model

High School
Course 1: Conceptual Progressions Model
Course 2: Conceptual Progressions Model
Course 3: Conceptual Progressions Model

Course 1: Modified Domains Model: Chemistry w/Earth and Space Science
Course 2: Modified Domains Model: Physics w/Earth and Space Science
Course 3: Modified Domains Model: Biology w/Earth and Space Science

ELEVATE SCIENCE Table of Contents

MIDDLE GRADES NATIONAL "ELEVATE"

(pink)	Chemistry
(orange)	Physics
(green)	Biology
(light blue)	Earth Science
(dark blue)	Space science

6th Grade	7th Grade	8th Grade
6.1 - Intro to Matter	7.1 - The Cell System	8.1 - Atoms and Per Table
6.2 - Solids, Liquids, Gases	7.2 - Human Body Sys	8.2 - Chemical Reactions
6.3 - Energy	7.3 - Repro and Growth	8.3 - Forces & Motion
6.4 - Thermal Energy	7.4 - Ecosystems	8.4 - Genes & Heredity
6.5 - Earth's Systems	7.5 - Populations/Comm	8.5 - Natural Selection
6.6 - Weather/Atmos	7.6 - Natural Resources	8.6 - History of Earth
6.7 - Mins/Rocks/Geosph	7.7 - Human Impacts	8.7 - Atmosphere & Ocean
6.8 - Plate Tectonics	7.8 - Waves and EM Rad	8.8 - Climate
6.9 - Earth's Surface Sys	7.9 - E&M	8.9 - Earth/Sun/Moon
6.10 - Liv Things/Biosph	7.10 - Infor Technology	8.10 - Sol System & Univ

PHYSICAL SCIENCE

	A	B	C	D	E	F
1	MIDDLE GRADES NATIONAL "ELEVATE"					
2			Chemistry			
3			Physics			
4			Biology			
5			Earth Science			
6			Space science			
7						
8	6th Grade		7th Grade		8th Grade	
9	6.1 - Intro to Matter				8.1 - Atoms and Per Table	
10	6.2 - Solids, Liquids, Gases				8.2 - Chemical Reactions	
11	6.3 - Energy				8.3 - Forces & Motion	
12	6.4 - Thermal Energy					
13						
14						
15						
16			7.8 - Waves and EM Rad			
17			7.9 - E&M			
18			7.10 - Infor Technology			
19						

LIFE SCIENCE

	A	B	C	D	E	F
1	MIDDLE GRADES NATIONAL "ELEVATE"					
2			Chemistry			
3			Physics			
4			Biology			
5			Earth Science			
6			Space science			
7						
8	6th Grade		7th Grade		8th Grade	
9			7.1 - The Cell System			
10			7.2 - Human Body Sys			
11			7.3 - Repro and Growth			
12			7.4 - Ecosystems		8.4 - Genes & Heredity	
13			7.5 - Populations/Comm		8.5 - Natural Selection	
14						
15						
16						
17						
18	6.10 - Liv Things/Biosph					
19						

EARTH AND SPACE SCIENCE

	A	B	C	D	E	F
1	MIDDLE GRADES NATIONAL "ELEVATE"					
2			Chemistry			
3			Physics			
4			Biology			
5			Earth Science			
6			Space science			
7						
8	6th Grade		7th Grade		8th Grade	
9						
10						
11						
12						
13	6.5 - Earth's Systems					
14	6.6 - Weather/Atmos		7.6 - Natural Resources		8.6 - History of Earth	
15	6.7 - Mins/Rocks/Geosph		7.7 - Human Impacts		8.7 - Atmosphere & Ocean	
16	6.8 - Plate Tectonics				8.8 - Climate	
17	6.9 - Earth's Surface Sys				8.9 - Earth/Sun/Moon	
18					8.10 - Sol System & Univ	
19						

ELEVATE SCIENCE (Topic "Essential Questions")

Topics	Topic/Phenomenon-Based Questions
1) Properties of Matter	1) How do you describe properties of matter?
2) Changes in Matter	2) What evidence do we have that matter changes?
3) Earth's Systems	3) How can you model the interactions about Earth's Systems?
4) Earth's Water	4) How much water can be found in different places on Earth?
5) Human Impacts on Earth's Systems	5) How can science ideas help up protect Earth's resources and environments
6) Solar System	6) What is Earth's place in space?
7) Movement of the Earth and its Moon Around the Sun	7) How do patterns of light and shade change from day to day and season to season?
8) Energy and Food	8) Where does food's energy come from and how is food used?
9) Matter and Energy in Ecosystems	9) How can you model the interactions of living things in an ecosystem?

Elevate Science:

Grade 4: *Topic 4*

(Student Edition)

Topic 4

Earth's Features

Go online to access your digital course.

- VIDEO
- eTEXT
- INTERACTIVITY
- VIRTUAL LAB
- GAME
- ASSESSMENT

Next Generation Science Standards

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

The Essential Question *How can you use maps to understand Earth's features?*

Show What You Know

The movement of water shapes landforms over millions of years. If you were drawing a map of this area, how would you show the features seen here?

Sample answer: I would draw a map looking down on the area and outline where the features are.

Elevate Science:

Grade 4: *Topic 4*

(Teacher Edition)

Topic 4

Earth's Features

Storyline

Using Phenomena Students will come to the classroom having seen different landforms in their everyday lives. As your students progress through this topic, remember to draw on those personal experiences to help them better understand how Earth's features change over time. Students will use observable events that occur in and around Earth's features, such as the events they see in photos and investigations in this topic. They will use their science knowledge to explain or predict these observable events.

In this topic, students will learn to identify landforms, rocks, and minerals. They will provide evidence to explain how Earth's features are formed and change over time. They will examine and make maps to show important land features. They will also explore rocks, minerals, and soil. Students will learn about chemical and physical weathering, and explore how weathering relates to erosion.

Students will be introduced to science and engineering practices SEP.3 and SEP.4 by planning and carrying out investigations to study how rain affects land, and analyzing and interpreting data to observe how Earth's plates form land features.

Key science vocabulary will be introduced thoughout the topic. Some vocabulary in this topic include *legend, canyon, butte, fault, igneous, sedimentary, metamorphic, weathering,* and *erosion.*

Students will also practice the important literacy skill and Crosscutting Concept of identifying patterns. They will use science content as a means to practice this skill through the Reading Checks and Literacy Connection. Finally, students will practice the math standard MP.5 by using tools to test how a rock can wear away.

Next Generation Science Standards

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Topic Materials List

Consumable

- Bottom half of a gallon milk jug (15)
- Plastic cup (45)
- Sand (2 large bags)
- Soil (1 large bag)
- Paper plate (30)
- Craft stick (30)
- Foam and plastic cup (30)
- White glue (15)
- Water (5 gallons)
- Sandstone sample (1 large bag)
- Limestone sample (1 large bag)
- Chalk (15 pieces)
- Cardboard (15 sheets)
- Gravel (15 cups)

Nonconsumable

- Graduated cylinder (15)
- Rectangular sponges (30)
- Mineral samples (1 large bag)
- Hand lens (15)
- Magnet (15)
- Nail (15)
- Penny (15)
- Rock samples (1 large bag)
- Clear jar with lid (15)
- Safety goggles (30)
- Plastic spray bottle (15)
- Streak plate (15)

*Materials listed per class

Differentiated Instruction

Support Struggling Students

Have students name the different features they see in the photo. Ask students how they might show the difference between the water and land on a map. Have them trace the shoreline with their finger, and explain how the shoreline could be shown on a map.

Support Advanced Learners

Encourage students to think about the impact of external influences on the landforms, such as building homes or businesses in an area. Have them create a map that includes such structures, and write a brief summary, outlining the effect that these structures may have on the landscape.

VIDEO

Watch a **Professional Development Video** to develop transferable teaching strategies.

eTEXT

The **Student eTEXT** lets students experience all of the topic pages in a digital context.

INTERACTIVITY

The **Synthesize Activity** is a great way for students to practice applying what they've learned.

INTERACTIVITY

The **Engineering Activity** is a great way for your students to think, plan, and design like engineers.

VIRTUAL LAB

The **Virtual Lab** allows students to use different maps to choose the best location to place a telescope.

GAME

The **Mini Games** provide a fun way for students to practice what they have learned in the lesson.

ASSESSMENT

The **Topic Test** is carefully built to check for deep understanding of key concepts. Remediation is prescribed automatically to provide what students need to demonstrate content mastery.

The Essential Question

As students conduct investigations in each lesson, they will practice demonstrating the topic and lesson standards. At the end of the topic, students will be able to answer the question: *How can you use maps to understand Earth's features?*

Show What You Know

Ask students to look carefully at the photo and describe features in the landscape that they observe. Ask students to explain which features are most important to show on a map.

Any NGSS-designed Curricular Materials Should Incorporate the Five "NGSS Innovations"

1. *Three-Dimensional Learning*

Elevate Science is built from the ground up around the NGSS

NA K–5

B5 — 5-PS1-3. Make observations and measurements to identify materials based on their properties.

	A	B	C	D	E	F	G	H
1	**Next Gen Grade 5 TOC 30 lessons**	**PEs,** Clarification Statements, **&** Assessment Boundaries	**OBJECTIVES USED IN LESSON**	**DCIs CORRELATED TO LESSON**	**SEPs CORRELATED TO LESSON AND/OR TOPIC**	**CCCs CORRELATED TO LESSON AND/OR TOPIC**	**ELA CCSS CORRELATED TO LESSON AND/OR TOPIC**	**MATH CCSS CORRELATED TO LESSON AND/OR TOPIC**
2	**Topic 1: Properties of Matter How do you describe properties of matter?**	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.] 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]		DCIs: PS1.A: Structure and Properties of Matter • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	SEP: 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. • Develop a model to describe phenomena. (5-PS1-1) Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3)	CCC: Scale, Proportion, and Quantity • Natural objects exist from the very small to the immensely large. (5-PS1-1) • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)	RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS1-1) W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-3) W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished	5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. (5-PS1-1)
3	Lesson 1 Observe Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to observe and measure properties of materials.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
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	Topic 2: Changes in Matter What evidence do we have that matter changes?	PE 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]		PS1.A: Structure and Properties of Matter • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) PS1.B: Chemical Reactions • When two or more different substances are mixed, a new	Planning and Carrying Out Investigations • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)	Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) Scale, Proportion, and	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2), (5-PS1-4) W.5.8 Recall relevant	MP.5 Use appropriate tools strategically. (5-PS1-2) Mathematically proficient students consider the available tools when solving a mathematical

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4	Lesson 2 Model Matter	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.	I will know that matter is made of tiny particles too small to be seen.	• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	Develop a model to describe phenomena.	• Natural objects exist from the very small to the immensely large. (5-PS1-1)		
5	Lesson 3 Properties of Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to identify materials based on their properties.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
	Topic 2: Changes in Matter What evidence do we have that matter changes?	PE 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]		PS1.A: Structure and Properties of Matter • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) PS1.B: Chemical Reactions • When two or more different substances are mixed, a new	Planning and Carrying Out Investigations • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)	Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) Scale, Proportion, and	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2), (5-PS1-4) W.5.8 Recall relevant	MP.5 Use appropriate tools strategically. (5-PS1-2) Mathematically proficient students consider the available tools when solving a mathematical

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NA K–5

B5 | 5-PS1-3. Make observations and measurements to identify materials based on their properties.

	A	B	C	D	E	F	G	H
1	**Next Gen Grade 5 TOC 30 lessons**	**PEs,** Clarification Statements, & Assessment Boundaries	**OBJECTIVES USED IN LESSON**	**DCIs CORRELATED TO LESSON**	**SEPs CORRELATED TO LESSON AND/OR TOPIC**	**CCCs CORRELATED TO LESSON AND/OR TOPIC**	**ELA CCSS CORRELATED TO LESSON AND/OR TOPIC**	**MATH CCSS CORRELATED TO LESSON AND/OR TOPIC**
2	**Topic 1: Properties of Matter How do you describe properties of matter?**	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.] 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]		DCIs: PS1.A: Structure and Properties of Matter • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	SEP: 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. • Develop a model to describe phenomena. (5-PS1-1) Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3)	CCC: Scale, Proportion, and Quantity • Natural objects exist from the very small to the immensely large. (5-PS1-1) • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)	RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS1-1) W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-3) W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished	5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. (5-PS1-1)
3	Lesson 1 Observe Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to observe and measure properties of materials.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
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5	Lesson 3 Properties of Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to identify materials based on their properties.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
	Topic 2: Changes in Matter What evidence do we have that matter changes?	PE 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]		PS1.A: Structure and Properties of Matter • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) PS1.B: Chemical Reactions • When two or more different substances are mixed, a new	Planning and Carrying Out Investigations • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)	Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) Scale, Proportion, and	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2), (5-PS1-4) W.5.8 Recall relevant	MP.5 Use appropriate tools strategically. (5-PS1-2) Mathematically proficient students consider the available tools when solving a mathematical

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NA K–5

B5 5-PS1-3. Make observations and measurements to identify materials based on their properties.

	A	B	C	D	E	F	G	H
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2	**Topic 1: Properties of Matter How do you describe properties of matter?**	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.] 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]		DCIs: PS1.A: Structure and Properties of Matter • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	SEP: 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. • Develop a model to describe phenomena. (5-PS1-1) Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3)	CCC: Scale, Proportion, and Quantity • Natural objects exist from the very small to the immensely large. (5-PS1-1) • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)	RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS1-1) W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-3) W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished	5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. (5-PS1-1)
3	Lesson 1 Observe Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to observe and measure properties of materials.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
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B5 | 5-PS1-3. Make observations and measurements to identify materials based on their properties.

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Row	A	B	C	D	E	F	G	H
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2	**Topic 1: Properties of Matter How do you describe properties of matter?**	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.] 5-PS1-3. Make observations and measurements to identify materials based on their properties. [Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.] [Assessment Boundary: Assessment does not include density or distinguishing mass and weight.]		DCIs: PS1.A: Structure and Properties of Matter • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) • Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	SEP: 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. • Develop a model to describe phenomena. (5-PS1-1) Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3)	CCC: Scale, Proportion, and Quantity • Natural objects exist from the very small to the immensely large. (5-PS1-1) • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)	RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS1-1) W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-3) W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished	5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. (5-PS1-1)
3	Lesson 1 Observe Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to observe and measure properties of materials.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
4	Lesson 2 Model Matter	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.	I will know that matter is made of tiny particles too small to be seen.	• Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1)	Develop a model to describe phenomena.	• Natural objects exist from the very small to the immensely large. (5-PS1-1)		
5	Lesson 3 Properties of Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to identify materials based on their properties.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
	Topic 2: Changes in Matter What evidence do we have that matter changes?	PE 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]		PS1.A: Structure and Properties of Matter • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) PS1.B: Chemical Reactions • When two or more different substances are mixed, a new	Planning and Carrying Out Investigations • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)	Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) Scale, Proportion, and	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2), (5-PS1-4) W.5.8 Recall relevant	MP.5 Use appropriate tools strategically. (5-PS1-2) Mathematically proficient students consider the available tools when solving a mathematical

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NA K–5

B5 | 5-PS1-3. Make observations and measurements to identify materials based on their properties.

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B5 — 5-PS1-3. Make observations and measurements to identify materials based on their properties.

Row	Next Gen Grade 5 TOC 30 lessons	PEs, Clarification Statements & Assessment Boundaries	OBJECTIVES USED IN LESSON	DCIs CORRELATED TO LESSON	SEPs CORRELATED TO LESSON AND/OR TOPIC	CCCs CORRELATED TO LESSON AND/OR TOPIC	ELA CCSS CORRELATED TO LESSON AND/OR TOPIC	MATH CCSS CORRELATED TO LESSON AND/OR TOPIC
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Lesson 3 Properties of Matter	5-PS1-3. Make observations and measurements to identify materials based on their properties.	I will know how to identify materials based on their properties.	• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-3)		
Topic 2: Changes in Matter What evidence do we have that matter changes?	PE 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]		PS1.A: Structure and Properties of Matter • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) PS1.B: Chemical Reactions • When two or more different substances are mixed, a new	Planning and Carrying Out Investigations • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)	Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) Scale, Proportion, and	W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2), (5-PS1-4) W.5.8 Recall relevant	MP.5 Use appropriate tools strategically. (5-PS1-2) Mathematically proficient students consider the available tools when solving a mathematical

Identifying Science and Engineering Practices:

uConnect Lab

How can rain affect land?

Objective Students will make simple models to investigate the effect that rain has on landforms. **DOK4**

Time 30 **Grouping**

Understanding the Science Practice

Students will plan an investigation to determine how rain can affect land. In carrying out their investigation, students will study how varying amounts of water can change the physical properties of their landform models. Connect this lab to the topic's uDemonstrate lab where students demonstrate mastery of this science practice.

Materials Go online to download the master material list, which also identifies kit materials.

Alternative Materials A foam cup with holes punched in the bottom can be used as a rain cup in place of the watering can.

Advance Preparation Pour the soil into plastic bins so that the students can easily measure it.

What to Expect Students should observe that the larger mounds will show less erosion than the smaller mounds. Also, students should conclude that more rain results in more soil washing away.

Go online to the Lab Center to get editable versions of this lab.

Next Generation Science Standards and Science and Engineering Practices

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

SEP.3 Planning and Carrying Out Investigations Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.

uConnect Lab

HANDS-ON LAB

4-ESS2-1, SEP.3

How can rain affect land?

When geologists investigate landforms, they want to know how the feature formed. How can you model changes that rain causes in landforms?

Materials
- bottom half of a gallon milk jug
- 3 plastic cups with different amounts of soil
- water

Suggested Materials
- watering can
- metric ruler
- graduated cylinder
- plastic spoon

Science Practice

Scientists **investigate** to provide evidence that supports scientific ideas.

Procedure

1. How will different amounts of rain affect differently sized soil mounds? Write your prediction.

   Sample answer: The smaller mounds will wash away sooner.

2. Set up your "land" in the milk jug. Carefully, turn each cup upside down in the jug. Jiggle the cups to release the mounds of dirt.
3. Make a plan to test your prediction. Write your plan. Show it to your teacher before you begin. Record your observations.

Analyze and Interpret Data

4. **Use Evidence** How can rain affect land? Write your conclusions based on the evidence from your investigation.

   Sample answer: Rain washes away soil. The more water there is, the more soil gets washed away. The smaller a mound of soil is, the faster it will wash away.

Observations

	Water amount #1	Water amount #2
Small mound	Most of the soil washed away.	All of the soil washed away.
Medium mound	Some of the soil washed away.	Most of the soil washed away.
Large mound	The mound held water.	More soil washed away.

Guiding Inquiry

If your students need more direction on this lab, use the following procedure.

1. Fill ¼ cup with packed soil. Turn it upside down on the bottom half of the gallon milk jug. Pack any loose soil together into a firm shape.
2. Make a second mound using ½ cup of firmly packed soil.
3. Make a third mound using 1 cup of firmly packed soil.
4. Fill the graduated cylinder with 100 mL of water. Pour the water into a sprinkler can or spray bottle.
5. Evenly shake the rain over the three mounds. Record your observations in the chart.
6. Measure an additional 100 mL of water and repeat step 5. Record your observations in the chart.

Identifying Science and Engineering Practices:

Added teacher support

uConnect Lab

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Identifying Science and Engineering Practices:

Types of Maps

A physical map shows an area's natural physical features, such as hills, valleys, rivers, lakes, waterfalls, and bays—usually by using different colors. A **feature** is a characteristic or part of something. In the map of the United States, several larger rivers are shown with blue lines. Water is usually shown as blue. The brown and darker green colors show areas where the land is higher, such as hills and mountains. The lighter green colors show areas that are flatter, such as plains.

Apply Circle part of the map where there are mountains. Put a box around where there are plains.

A political map shows countries, states, and cities. Capital cities on political maps are often marked with a star. Road maps show roads and highways in an area. Roads can be drawn using different colors or types of lines to show different kinds of roads. Road maps need to be changed when new roads are built or when old ones are closed.

Most of today's maps are drawn using information collected by space satellites. GPS, or the Global Positioning System, constantly sends out signals that a device uses to pinpoint almost exactly where it is.

Science Practice ▸ Toolbox

Construct Explanations Scientists use reliable sources of information to make an explanation. How does technology help you observe large and small areas to gather information?

21st Century Skills

Interpersonal and Collaborative Skills

Maps are a great visual way to show information and learn about various places. With the rise of satellite imagery and data, maps have become an increasingly popular way of helping people understand the changes in the world. It is now much easier and faster to update data, and show how an area is changing due to natural and human factors. Have students engage in a discussion with peers regarding the importance of using maps to show evidence of climate change, habitat destruction, and population growth. Encourage students to research samples of these types of maps using the Internet. This activity uses the ELA Speaking and Listening skill of participating in collaborative conversations.

Scaffolded Questions

Help students set a frame for reading by asking them to think of an answer to the following guiding questions: *Why are certain maps used for specific purposes? What are these different maps used for?* Then, have them read the section Types of Maps to find out if their answers were correct. When they finish, use the following questions to assess their **Depth of Knowledge** levels of understanding.

List Name the different types of maps described in the text. **DOK1** (physical, political, road maps)

Interpret Determine what kind of map you would use on a hiking trip. **DOK2** (A physical map would show the land features that we would hike around.) What part of the reading provides evidence for your answer? (the first paragraph)

Draw Conclusions Consider the number of satellites in the sky and how it relates to the accuracy of maps. What impact would a decrease in satellites have on the accuracy of maps? **DOK3** (The maps would be less accurate because there would be less data from the satellites to produce the maps.)

Science Practice ▸ Toolbox

Construct Explanations Have students list different sources they use to gather the information needed to construct a supported explanation to the question. Students may say books, Internet resources, or daily activities. Encourage students to share why using reliable resources is very important when obtaining and communicating scientific information.

Identifying Science and Engineering Practices:

"Science Practice Toolbox"

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Identifying Science and Engineering Practices:

uEngineer It! Design STEM

INTERACTIVITY

Assign the **Engineering Activity** after students complete the Design It exercise.

What It Is A highly interactive, multipage digital activity with engaging visuals

What It does Allows students to practice using criteria to evaluate competing design solutions using a fun example

How to use it

- Students will click on the screens to evaluate the width of the canyon at various sites to determine where a bridge should span and which type of bridge should be built.
- Students will finalize the activity by evaluating the pros and cons of each site along the canyon.

Take a Hike!

Using Phenomena When students are asked to explain phenomena and design solutions to problems, they develop deeper and more transferable knowledge. **DOK4**

To set the stage for the Design It activity, ask: **DOK4**

- What does the word *criteria* mean? (Guide students to answer the question by asking if "qualities or characteristics a product needs to have" sounds like a good definition for *criteria*.)
- What does the word *constraint* mean? (Guide students to answer the question by asking if "a limitation or restriction" sounds like a good definition for *constraint*.)
- What are some characteristics of a desert that are important to keep in mind when building a trail? (Guide students to reference key points in the text, such as "The desert is very dry and often very hot during the day," or "Deserts are very sandy or rocky, and sandy soil tends to collapse over time.")

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3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-1

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Go online to identify rocks from around the world.

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Desert terrain can be extremely difficult to cross. The desert is very dry and often very hot during the day. The temperature can become very cold at night or at certain times of the year. High winds can produce sandstorms.

Deserts are very sandy or rocky, so building on them is also difficult. Sandy soil tends to collapse over time. A road built on sand will crumble much faster than one built on more solid ground. Engineers must develop unique solutions to build any kind of structure in a desert.

A popular desert park wants to open a new hiking trail for visitors. The trail will bring visitors over difficult terrain to see some unique desert features. The engineers who will build the trail must come up with some unique solutions. The trail must be easy to walk on. It must also be built without disturbing the environment too much.

Design It

littleBits

The design team at the park has asked for your help in designing the desert trail. They want the trail to be made of natural materials that can withstand both the extreme heat and cold. The materials should be relatively inexpensive. The trail should blend in with the surrounding environment so that it does not disturb the view of the desert.

1. **Identify** What are the criteria for the trail?
   The trail must be made of natural materials and must withstand both the extreme heat and cold. It should be made with inexpensive materials.
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4. **Design** Draw a design for a sample section of your hiking trail. Be sure to include labels on features of your trail that will help it meet the criteria for success.

Trail Design

Design It

As students think about their design of the hiking trail, explain that drawings are often the first step in the planning and design process. Engineers revisit and revise their drawings when solving problems and developing solutions. In this task, have students consider real-life implications of their design:

- Weather patterns vary in the desert. Heavy winds and dry air contribute to sandstorms, which can lead to excess sand build-up alongside trails that were once clear.
- There are many animal and plant species in the desert. Some desert animals protect themselves from enemies through aggressive or harmful behaviors, such as biting, stinging, or even attacking. Students may want to consider how they can protect hikers from these animals.

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Engineering Design Process

Define Problem → **Develop Solutions** → Optimize Solutions

In the uEngineer It! activity, an engineering team at a desert park has asked students to help design a new trail. Briefly explain the engineering design process to students. Start out by asking students to identify the problem. After students complete the activity, have them explain their designs. Suggest that students elaborate on why particular features of the trail will help meet the criteria for success. To complete the design process and optimize solutions, encourage students to think carefully about the practicality of their design in real life. Lead a brief class discussion about other ways they might need to modify or adjust their designs in order to make their designs practical.

Differentiated Instruction

Support Struggling Students

Some students may need help identifying constraints and criteria for their trail. Read the passage with students. Have them highlight or underline important information that they will need to keep in mind as they plan their trails. Then work together to list constraints and criteria.

Support Advanced Learners

Have students select a new location for their hiking trail, such as the mountains or near the coast of an ocean. Ask them to write a brief summary describing which parts of their design would change and what parts would stay the same in the new location.

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Identifying Crosscutting Concepts:

Patterns of Earthquakes and Volcanoes

Patterns of earthquake activity and volcanoes are closely related. Both occur along **faults**, or cracks in Earth's crust. Large faults often occur at plate boundaries. Smaller faults can occur in the middle of plates. Both earthquakes and volcanoes are the result of plates moving along these faults. Volcanoes form at places where magma, or molten rock, reaches Earth's surface. Volcanoes and earthquakes are common along a section of Earth called the Ring of Fire, which is the plate boundaries surrounding the Pacific Ocean.

Crosscutting Concepts ▸ Toolbox

Patterns Finding patterns helps scientists to organize and classify. Analyze the Ring of Fire map. Describe a pattern of Earth's features the map shows.

Quest Connection

How do the features of a mountain differ from the features of a plateau?

Sample answer: A mountain narrows into a pointed shape at the top. A plateau has a flat top.

ELD Support

Reading Use the "Patterns of Earthquakes and Volcanoes" paragraph to help students practice their English vocabulary.

Entering Have students find the context clues that define the word *fault*. Have students use these clues to explain what a fault is.

Beginning Have students identify text details that tell where large and small faults are located.

Developing Have students use text evidence to explain what the Ring of Fire is and where it is located.

Expanding Have students identify the main idea of the paragraph and provide supporting details.

Bridging Have students explain how volcanoes and earthquakes occur, using evidence from the paragraph to support their explanations.

SYNTHESIZE

INTERACTIVITY

Have students complete the **Synthesize Activity**.

What It Is Real-world scenario-based interactivities and engaging images

What It does Supports students in synthesizing and applying what they've learned throughout the lesson

How to use It

- Students click through the screens to learn about mountain ranges. Have students predict how mountain ranges form and discuss their ideas as a class.
- Then, students explore how tectonic plate movement and water can shape different landforms.
- Finally, students categorize different landforms, according to whether they were shaped by plate movement or water. As a class, have students brainstorm other factors that could shape Earth's landforms.

Connecting Concepts ▸ Toolbox

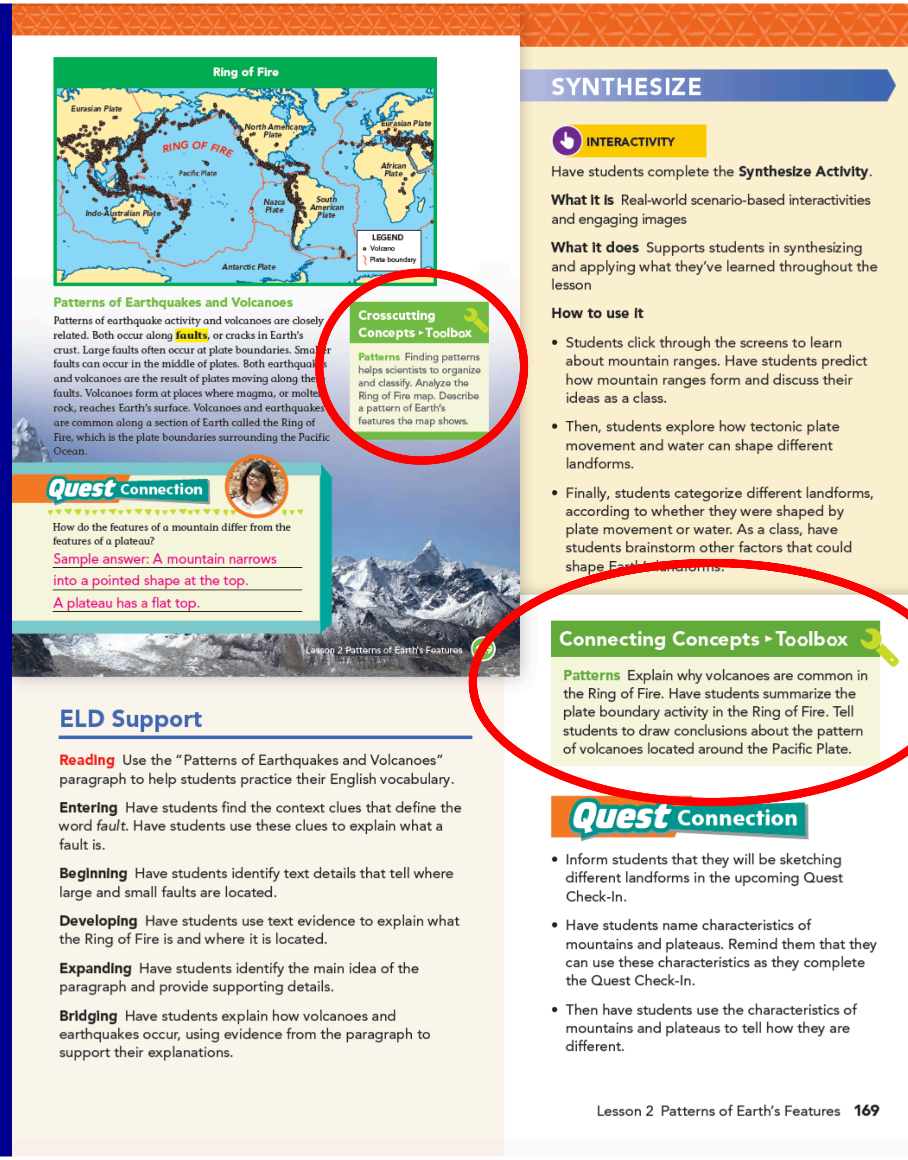
Patterns Explain why volcanoes are common in the Ring of Fire. Have students summarize the plate boundary activity in the Ring of Fire. Tell students to draw conclusions about the pattern of volcanoes located around the Pacific Plate.

Quest Connection

- Inform students that they will be sketching different landforms in the upcoming Quest Check-In.
- Have students name characteristics of mountains and plateaus. Remind them that they can use these characteristics as they complete the Quest Check-In.
- Then have students use the characteristics of mountains and plateaus to tell how they are different.

Identifying Crosscutting Concepts:

"Crosscutting Concepts Toolbox"


Ring of Fire

Patterns of Earthquakes and Volcanoes

Patterns of earthquake activity and volcanoes are closely related. Both occur along **faults**, or cracks in Earth's crust. Large faults often occur at plate boundaries. Smal er faults can occur in the middle of plates. Both earthqua s and volcanoes are the result of plates moving along the faults. Volcanoes form at places where magma, or molte rock, reaches Earth's surface. Volcanoes and earthquakes are common along a section of Earth called the Ring of Fire, which is the plate boundaries surrounding the Pacific Ocean.

Crosscutting Concepts ▸ Toolbox

Patterns Finding patterns helps scientists to organize and classify. Analyze the Ring of Fire map. Describe a pattern of Earth's features the map shows.

Quest Connection

How do the features of a mountain differ from the features of a plateau?

Sample answer: A mountain narrows into a pointed shape at the top. A plateau has a flat top.

Lesson 2 Patterns of Earth's Features

SYNTHESIZE

INTERACTIVITY

Have students complete the **Synthesize Activity**.

What It Is Real-world scenario-based interactivities and engaging images

What It does Supports students in synthesizing and applying what they've learned throughout the lesson

How to use it

- Students click through the screens to learn about mountain ranges. Have students predict how mountain ranges form and discuss their ideas as a class.
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Lesson 2 Patterns of Earth's Features 169

Identifying Performance Expectations in Assessments:

TOPIC 3

Make Analogies Review the concept of action/reaction forces. Explain that when an object exerts a force on a second object, the second object always exerts a force back on the first object. Have students work in groups to think of an analogy for this concept. One example is when people say "Hi" to each other.

Focus on Mastery!

Draw Comparative Inferences Help students analyze the action/reaction forces that DART and the satellite exert on each other by asking students to…

- sketch the events that led up to the collision.
- identify the action that led to the collision.
- describe the force that is a result of the action that led to the collision. *(DART exerted a force on the satellite during the collision.)*
- draw a force arrow to represent this force and label it the *action force*.
- draw a force arrow of equal length and opposite direction as the action force arrow. Label this arrow the *reaction force*. Then describe the force that is represented by the reaction force. *(The satellite exerted a force on DART during the collision.)*

NEXT GENERATION SCIENCE STANDARDS

MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

TOPIC 3 Review and Assess

MS-PS2-1, MS-PS2-2, MS-PS2-4

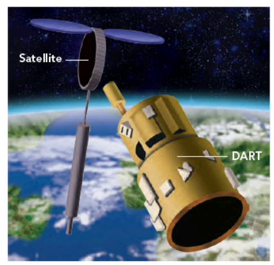
Evidence-Based Assessment

In 2005, NASA sent a robotic spacecraft called DART to a satellite that was orbiting Earth. DART was supposed to demonstrate that it could move around the satellite and communicate with it, without a human on board. The spacecraft was supposed to come close to the satellite without actually touching it.

Here is how the DART system works: The spacecraft's navigation system estimates its position and speed. Then, commands are sent to the thrusters to keep the spacecraft along its intended path. Force from the thrusters causes a change in motion. If the GPS system communicates incorrect navigation data to the spacecraft, then it will travel incorrectly and use up its fuel.

DART made it into space, but then its navigation system failed, providing incorrect data on its position and speed. This failure caused DART to bump into the satellite. The force of the collision changed the motion of the satellite. Luckily it remained in orbit around Earth, but the mission was deemed a failure. Though NASA has had many successes, the science and engineering work involved with space exploration is extremely complex, and sometimes even the best-planned projects fail.

The diagram below shows the relative positions of DART, and the satellite before the collision.



1. **Apply Scientific Reasoning** If the satellite had less mass, but the force of the collision was the same, then the collision would have
   - (A.) caused the satellite to accelerate more quickly.
   - B. caused the satellite to accelerate more slowly.
   - C. caused the satellite to accelerate at the same rate.
   - D. had no effect on the satellite's original motion.

2. **Cite Evidence** Did DART apply a balanced or unbalanced force to the satellite during the collision? What evidence supports your answer?
   The force was unbalanced. The satellite was pushed by DART and it moved—its motion changed.

3. **Draw Comparative Inferences** Describe the action-reaction forces during the collision between DART and the satellite.
   The action force was the force of DART on the satellite, and the reaction force was the force of the satellite on DART. These forces are equal in strength but opposite in direction.

4. **Distinguish Relationships** Which do you think is stronger—the gravitational attraction between DART and Earth, or the gravitational attraction between DART and the satellite? Explain your answer.
   I expect the gravitational attraction between DART and Earth to be stronger. Earth is much more massive than the satellite, so it likely has a greater affect than the distance between DART and the satellite.

5. **Synthesize Information** What labels and symbols could you add to an image to represent the forces acting on DART and the satellite during the collision? Describe what you would draw and write.
   Sample: I would add one arrow on DART and one on the satellite, pointing away from each other, to represent the action-reaction forces. I would also draw an arrow from the spaceraft pointing to Earth, and an arrow from the satellite pointing to Earth, to represent the pull of Earth on both objects.

Quest FINDINGS

Complete the Quest!

Phenomenon Design a way to present your new bumper car design and the results of your testing to your class. Be sure to include how you applied Newton's third law of motion to your design.

Synthesize Information Bumper cars have safety features to protect both the riders and the cars themselves. These features are built around how forces and the laws of motion affect the movement of the cars. What is another example of how forces and laws of motion impact your safety in your daily life?

Sample: When riding my bike, inertia causes me to shift forward on my seat as I apply the brakes.

INTERACTIVITY
Reflect on Your Bumper Car Solution

Scoring Notes

Use the grading rubrics to assess students' responses to short-answer questions.

3. Draw Comparative Inferences DOK 2, 5 points

2pt	Student identifies the forces of DART on the satellite as the action force.
2pt	Student identifies the force of the satellite on DART as the reaction force.
1pt	Student explains that the forces are equal in strength and opposite in direction.

4. Distinguish Relationships DOK 2, 4 points

2pt	Student identifies the attraction between DART and Earth as the stronger force.
2pt	Student refers to the relationship between mass, distance, and gravity while explaining why that force is stronger.

5. Synthesize Information DOK 3, 4 points

2pt	Student explains that arrows and labels can be used to show the action/reaction forces between DART and the satellite during the collision.
2pt	Student explains that arrows and labels can be used to show the gravitational force that Earth exerts on both DART and the satellite.

PROFESSIONAL DEVELOPMENT

Reflect

Which teaching strategies that you used throughout this topic best promoted students' understanding?

DIFFERENTIATED INSTRUCTION

L1 Support Struggling Students

Show students a picture with an object that is changing motion, and ask students to identify all the forces acting on the object. Draw an arrow for each force. Use the arrows to show that the net force is unbalanced, and explain the connection between a change in motion and unbalanced force.

L3 Support Advanced Students

Have students explain why the net force on a satellite travelling at constant speed around Earth is unbalanced.

Quest FINDINGS

INTERACTIVITY

GO ONLINE to access…

Reflect on Your Bumper Car Solution Students synthesize their learning from the Quest activities and lessons by putting together their Findings and answering reflection questions. Through their Findings, students demonstrate their ability to engage in argument from evidence.

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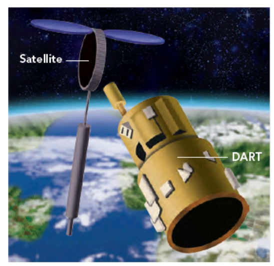

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Any NGSS-designed Curricular Materials Should Incorporate the Five "NGSS Innovations"

1. Three-Dimensional Learning
2. ***Building K-12 Progressions***

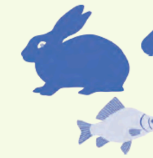
Topic 4 Next Generation Learning Progressions

Earth's Features

Next Generation Science Standards 4-ESS2-1, 4-ESS2-2

Use these pages to identify the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts that students will be working toward in grade 4.

Science and Engineering Practices	Grades K-2 *Students should already be capable of…*	Grade 3-5 *Students are working toward…*	Grade 6-8 *Students will develop the skills of…*	College & Careers *As adults, students can apply these skills by…*
SEP.3 Planning and Carrying Out Investigations	evaluating different ways of observing and/or measuring a phenomenon.	making observations or measurements to produce data to explain a phenomenon.	evaluating the accuracy of various methods for collecting data.	conducting investigations to study the similarities in animal behavior as a zookeeper.
SEP.4 Analyzing and Interpreting Data	using observations to describe patterns and/or relationships in order to answer scientific questions.	comparing and contrasting data collected by different groups in order to discuss similarities and differences in their findings.	analyzing and interpreting data to determine similarities and differences in findings.	

Disciplinary Core Ideas	Grades K-2	Grade 3-5	Grade 6-8	College & Careers
ESS2.A Earth Materials and Systems	recognizing that wind and water change the shape of the land.	understanding that rainfall helps to shape the land and affects the types of living things found in a region.	identifying that energy flows and matter cycles within and among Earth's systems.	using Earth's physical features and yearly rainfall data to plant appropriate crops on a farm.
ESS2.B Plate tectonics and large-scale system interactions	observing how maps show where things are located.	recognizing that Earth's physical features occur in patterns, as do earthquakes and volcanoes, and maps can locate these features.	identifying that plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history.	


Crosscutting Concepts	Grades K-2	Grade 3-5	Grade 6-8	College & Careers
CCC.1 Patterns	recognizing that patterns can be observed, used to describe phenomena, and used as evidence.	identifying similarities and differences in order to sort and classify natural objects and designed products.	realizing that macroscopic patterns are related to the nature of microscopic and atomic-level structure.	observing and identifying cause-and-effect relationships and patterns in the health care field.
CCC.2 Cause and Effect	understanding that events have causes that generate observable patterns.	identifying and testing causal relationships and using these relationships to explain change.	classifying relationships as causal or correlational, and recognizing that correlation does not necessarily imply causation.	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Science and Engineering Practices				
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Disciplinary Core Ideas				
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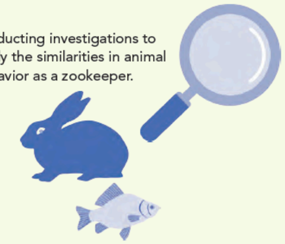

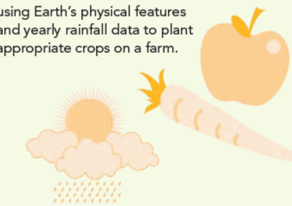

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Science and Engineering Practices				
SEP.3 Planning and Carrying Out Investigations	evaluating different ways of observing and/or measuring a phenomenon.	making observations or measurements to produce data to explain a phenomenon.	evaluating the accuracy of various methods for collecting data.	conducting investigations to study the similarities in animal behavior as a zookeeper.
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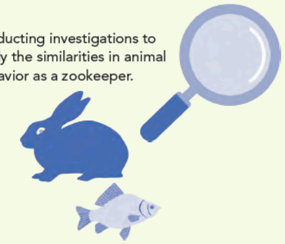

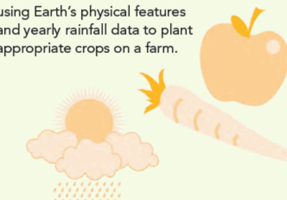

Topic 4 Next Generation Learning Progressions

Earth's Features

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College & Careers

As adults, students can apply these skills by...

conducting investigations to study the similarities in animal behavior as a zookeeper.

using Earth's physical features and yearly rainfall data to plant appropriate crops on a farm.

observing and identifying cause-and-effect relationships and patterns in the health care field.

Earth's Features

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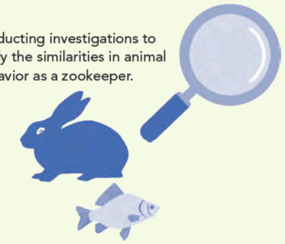
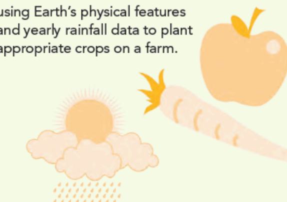
Crosscutting Concepts				
CCC.1 Patterns	recognizing that patterns can be observed, used to describe phenomena, and used as evidence.	identifying similarities and differences in order to sort and classify natural objects and designed products.	realizing that macroscopic patterns are related to the nature of microscopic and atomic-level structure.	observing and identifying cause-and-effect relationships and patterns in the health care field.
CCC.2 Cause and Effect	understanding that events have causes that generate observable patterns.	identifying and testing causal relationships and using these relationships to explain change.	classifying relationships as causal or correlational, and recognizing that correlation does not necessarily imply causation.	





Any NGSS-designed Curricular Materials Should Incorporate the Five "NGSS Innovations"

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. ***Alignment with Common Core English Language Arts and Mathematics***

Identifying Common Core Math Alignments:

LESSON 4

INVESTIGATE

Math Toolbox 6.RP.A.2

Analyze Relationships Guide students to complete the table by reminding them to…

- review the meanings of *mass* and *weight*.
- review the text to find the ratios of mass and weight for each planet and record them.
- carry out the calculations using the mass and weight ratios.
- check that answers are reasonable. Weight will be lower on a planet or moon that has less mass than Earth and will be higher on a planet or moon that has more mass than Earth.

Energy, Forces, and Motion

Teach With Movement The following activity will help students answer the Guiding Question, "How does gravitational potential energy relate to kinetic energy?" Have students lift a notebook 3 cm and then 30 cm. Ask students: Imagine dropping notebooks from a lower and higher point onto a hard surface. What is one difference you might notice when the books hit the surface? (*Sample answer: The notebook dropped from the higher point will make a louder noise.*) Imagine dropping notebooks from a lower and higher point onto soft sand. What is one difference you might notice when the books hit the sand? (*Sample answer: The notebook dropped from the higher point will make a deeper impression in the sand.*)

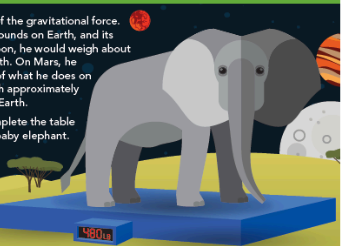
Academic Vocabulary

Teach Strategies Help students better understand the meaning of the word *associate* by asking…

- What is the context of the text where the word *associate* appears?
- *Associate* used as a verb can mean "to think of one thing or person in connection with another thing or person" or "to be together with other people." Which definition is closest to how the word is used in the text?
- The word *associate* is used in different ways. It can be used as a verb, noun, or adjective. Write a sentence using *associate* as a noun.
- Write a sentence using *associate* as an adjective.

Math Toolbox

The Relationship Between Weight and Mass



Weight varies with the strength of the gravitational force. This baby elephant weighs 480 pounds on Earth, and its mass is 218 kilograms. On the moon, he would weigh about one-sixth of what he does on Earth. On Mars, he would weigh just over one-third of what he does on Earth. On Jupiter, he would weigh approximately 2.5 times as much as he does on Earth.

Analyze Relationships Complete the table using the information about the baby elephant.

Location	Earth	Moon	Mars	Jupiter
Mass (kg)	218	218	218	218
Weight (lbs)	480	80	160	1200

Energy, Forces, and Motion

By now, you can see how forces such as gravity and friction relate to motion. Recall that forces and motion are also related to energy.

Gravitational Potential Energy As you know, the potential energy of an object is the energy stored in the object. There are several different types of potential energy, based on different types of forces. The type of potential energy that we **associate** with gravity is called gravitational potential energy. On Earth, gravitational potential energy (GPE) is based on an object's position. In general, the higher up an object is, the greater its GPE. For example, as a diver climbs the ladder to a diving board, her GPE increases. The GPE of a skydiver increases as he rides the helicopter to his jumping point. You can calculate the GPE of an object on Earth based on the mass of the object, the acceleration due to gravity (9.8 m/s²), and the height of the object above Earth's surface.

Gravitational potential energy (GPE) = Mass × Acceleration due to gravity × Height

Academic Vocabulary

Used as a verb, *associate* means to connect something to something else in one's mind. Write a sentence using *associate* as a noun.

Sample: I have an associate who helps me complete a project.

PROFESSIONAL DEVELOPMENT

Reflect

How might students apply the information on friction in this lesson to the design of a better bumper car?

The lesson connected gravitational force to gravitational potential energy. What prior knowledge did you review to help students make the connection? What would you change the next time you taught this material?

Identifying Common Core Math Alignments:

"Math Toolbox"


LESSON 4

INVESTIGATE

Math Toolbox 6.RP.A.2

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156 Forces and Motion

Math Toolbox

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156 Forces and Motion

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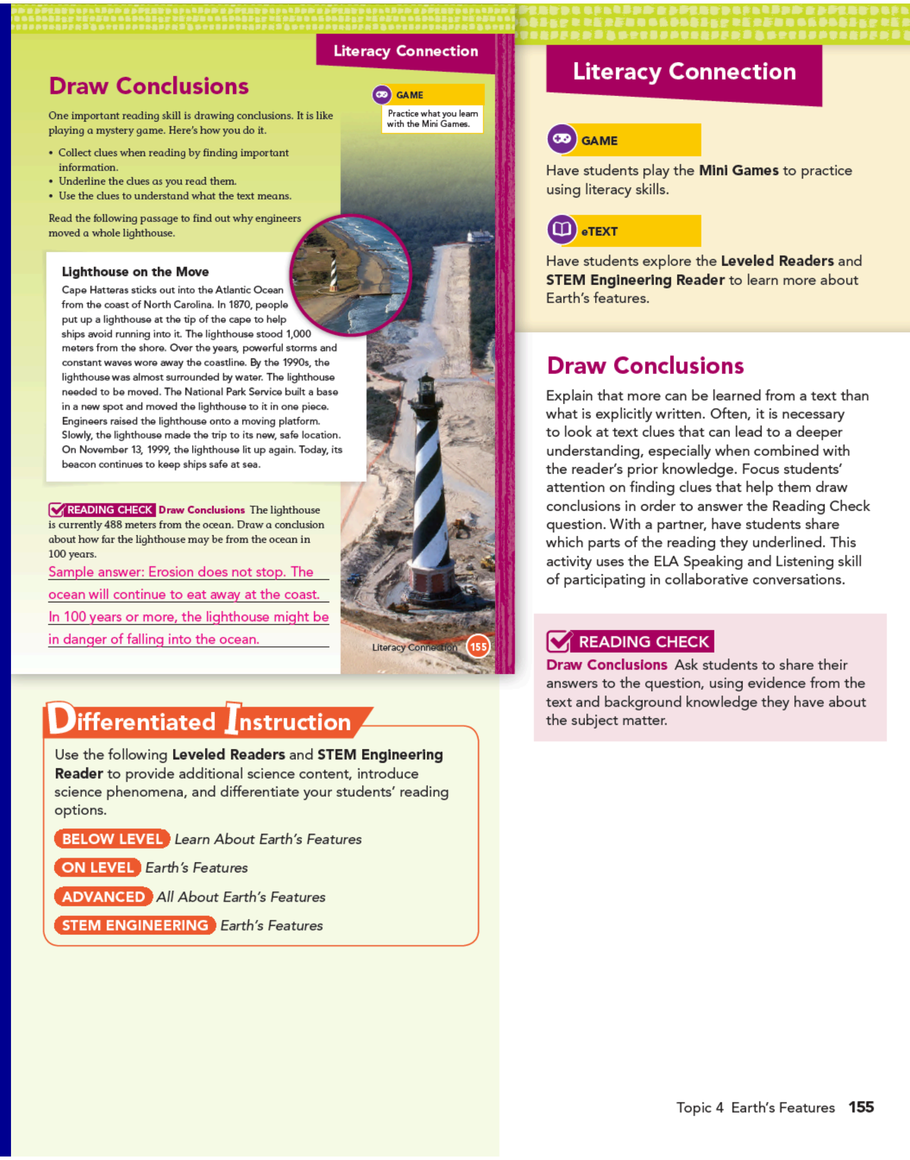

Literacy Connection

Draw Conclusions

GAME

Practice what you learn with the Mini Games.

One important reading skill is drawing conclusions. It is like playing a mystery game. Here's how you do it.

- Collect clues when reading by finding important information.
- Underline the clues as you read them.
- Use the clues to understand what the text means.

Read the following passage to find out why engineers moved a whole lighthouse.

Lighthouse on the Move

Cape Hatteras sticks out into the Atlantic Ocean from the coast of North Carolina. In 1870, people put up a lighthouse at the tip of the cape to help ships avoid running into it. The lighthouse stood 1,000 meters from the shore. Over the years, powerful storms and constant waves wore away the coastline. By the 1990s, the lighthouse was almost surrounded by water. The lighthouse needed to be moved. The National Park Service built a base in a new spot and moved the lighthouse to it in one piece. Engineers raised the lighthouse onto a moving platform. Slowly, the lighthouse made the trip to its new, safe location. On November 13, 1999, the lighthouse lit up again. Today, its beacon continues to keep ships safe at sea.

READING CHECK **Draw Conclusions** The lighthouse is currently 488 meters from the ocean. Draw a conclusion about how far the lighthouse may be from the ocean in 100 years.

Sample answer: Erosion does not stop. The ocean will continue to eat away at the coast. In 100 years or more, the lighthouse might be in danger of falling into the ocean.

Differentiated Instruction

Use the following **Leveled Readers** and **STEM Engineering Reader** to provide additional science content, introduce science phenomena, and differentiate your students' reading options.

BELOW LEVEL *Learn About Earth's Features*

ON LEVEL *Earth's Features*

ADVANCED *All About Earth's Features*

STEM ENGINEERING *Earth's Features*

Literacy Connection

GAME

Have students play the **Mini Games** to practice using literacy skills.

eTEXT

Have students explore the **Leveled Readers** and **STEM Engineering Reader** to learn more about Earth's features.

Draw Conclusions

Explain that more can be learned from a text than what is explicitly written. Often, it is necessary to look at text clues that can lead to a deeper understanding, especially when combined with the reader's prior knowledge. Focus students' attention on finding clues that help them draw conclusions in order to answer the Reading Check question. With a partner, have students share which parts of the reading they underlined. This activity uses the ELA Speaking and Listening skill of participating in collaborative conversations.

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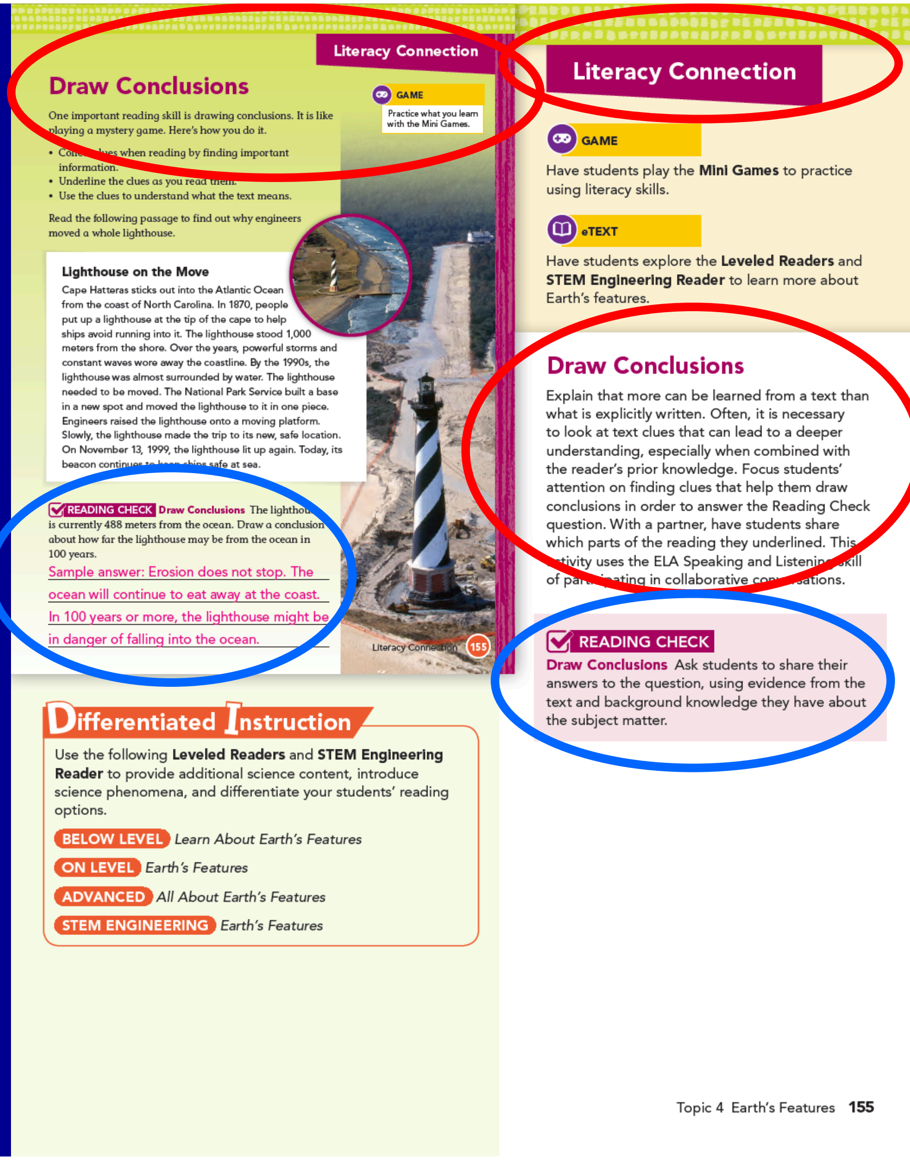

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Any NGSS-designed Curricular Materials Should Incorporate the Five "NGSS Innovations"

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. Alignment with Common Core English Language Arts and Mathematics
4. ***Making Sense of Phenomena and Designing Solutions to Problems***

Topic 4

Earth's Features

Storyline

Using Phenomena Students will come to the classroom having seen different landforms in their everyday lives. As your students progress through this topic, remember to draw on those personal experiences to help them better understand how Earth's features change over time. Students will use observable events that occur in and around Earth's features, such as the events they see in photos and investigations in this topic. They will use their science knowledge to explain or predict these observable events.

In this topic, students will learn to identify landforms, rocks, and minerals. They will provide evidence to explain how Earth's features are formed and change over time. They will examine and make maps to show important land features. They will also explore rocks, minerals, and soil. Students will learn about chemical and physical weathering, and explore how weathering relates to erosion.

Students will be introduced to science and engineering practices SEP.3 and SEP.4 by planning and carrying out investigations to study how rain affects land, and analyzing and interpreting data to observe how Earth's plates form land features.

Key science vocabulary will be introduced thoughout the topic. Some vocabulary in this topic include *legend, canyon, butte, fault, igneous, sedimentary, metamorphic, weathering,* and *erosion.*

Students will also practice the important literacy skill and Crosscutting Concept of identifying patterns. They will use science content as a means to practice this skill through the Reading Checks and Literacy Connection. Finally, students will practice the math standard MP.5 by using tools to test how a rock can wear away.

Next Generation Science Standards

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Topic Materials List

Consumable

- Bottom half of a gallon milk jug (15)
- Plastic cup (45)
- Sand (2 large bags)
- Soil (1 large bag)
- Paper plate (30)
- Craft stick (30)
- Foam and plastic cup (30)
- White glue (15)
- Water (5 gallons)
- Sandstone sample (1 large bag)
- Limestone sample (1 large bag)
- Chalk (15 pieces)
- Cardboard (15 sheets)
- Gravel (15 cups)

Nonconsumable

- Graduated cylinder (15)
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- Hand lens (15)
- Magnet (15)
- Nail (15)
- Penny (15)
- Rock samples (1 large bag)
- Clear jar with lid (15)
- Safety goggles (30)
- Plastic spray bottle (15)
- Streak plate (15)

*Materials listed per class

Differentiated Instruction

Support Struggling Students

Have students name the different features they see in the photo. Ask students how they might show the difference between the water and land on a map. Have them trace the shoreline with their finger, and explain how the shoreline could be shown on a map.

Support Advanced Learners

Encourage students to think about the impact of external influences on the landforms, such as building homes or businesses in an area. Have them create a map that includes such structures, and write a brief summary, outlining the effect that these structures may have on the landscape.

VIDEO

Watch a **Professional Development Video** to develop transferable teaching strategies.

eTEXT

The **Student eTEXT** lets students experience all of the topic pages in a digital context.

INTERACTIVITY

The **Synthesize Activity** is a great way for students to practice applying what they've learned.

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VIRTUAL LAB

The **Virtual Lab** allows students to use different maps to choose the best location to place a telescope.

GAME

The **Mini Games** provide a fun way for students to practice what they have learned in the lesson.

ASSESSMENT

The **Topic Test** is carefully built to check for deep understanding of key concepts. Remediation is prescribed automatically to provide what students need to demonstrate content mastery.

The Essential Question

As students conduct investigations in each lesson, they will practice demonstrating the topic and lesson standards. At the end of the topic, students will be able to answer the question: *How can you use maps to understand Earth's features?*

Show What You Know

Ask students to look carefully at the photo and describe features in the landscape that they observe. Ask students to explain which features are most important to show on a map.

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Ask students to look carefully at the photo and describe features in the landscape that they observe. Ask students to explain which features are most important to show on a map.

Topic 4

Earth's Features

Storyline

Using Phenomena Students will come to the classroom having seen different landforms in their everyday lives. As your students progress through this topic, remember to draw on those personal experiences to help them better understand how Earth's features change over time. Students will use observable events that occur in and around Earth's features, such as the events they see in photos and investigations in this topic. They will use their science knowledge to explain or predict these observable events.

In this topic, students will learn to identify landforms, rocks, and minerals. They will provide evidence to explain how Earth's features are formed and change over time. They will examine and make maps to show important land features. They will also explore rocks, minerals, and soil. Students will learn about chemical and physical weathering, and explore how weathering relates to erosion.

Students will be introduced to science and engineering practices SEP.3 and SEP.4 by planning and carrying out investigations to study how rain affects land, and analyzing and interpreting data to observe how Earth's plates form land features.

Key science vocabulary will be introduced thoughout the topic. Some vocabulary in this topic include *legend, canyon, butte, fault, igneous, sedimentary, metamorphic, weathering,* and *erosion*.

Students will also practice the important literacy skill and Crosscutting Concept of identifying patterns. They will use science content as a means to practice this skill through the Reading Checks and Literacy Connection. Finally, students will practice the math standard MP.5 by using tools to test how a rock can wear away.

Next Generation Science Standards

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Topic Materials List

Consumable

- Bottom half of a gallon milk jug (15)
- Plastic cup (45)
- Sand (2 large bags)
- Soil (1 large bag)
- Paper plate (30)
- Craft stick (30)
- Foam and plastic cup (30)
- White glue (15)
- Water (5 gallons)
- Sandstone sample (1 large bag)
- Limestone sample (1 large bag)
- Chalk (15 pieces)
- Cardboard (15 sheets)
- Gravel (15 cups)

Nonconsumable

- Graduated cylinder (15)
- Rectangular sponges (30)
- Mineral samples (1 large bag)
- Hand lens (15)
- Magnet (15)
- Nail (15)
- Penny (15)
- Rock samples (1 large bag)
- Clear jar with lid (15)
- Safety goggles (30)
- Plastic spray bottle (15)
- Streak plate (15)

*Materials listed per class

Differentiated Instruction

Support Struggling Students

Have students name the different features they see in the photo. Ask students how they might show the difference between the water and land on a map. Have them trace the shoreline with their finger, and explain how the shoreline could be shown on a map.

Support Advanced Learners

Encourage students to think about the impact of external influences on the landforms, such as building homes or businesses in an area. Have them create a map that includes such structures, and write a brief summary, outlining the effect that these structures may have on the landscape.

VIDEO
Watch a **Professional Development Video** to develop transferable teaching strategies.

eTEXT
The **Student eTEXT** lets students experience all of the topic pages in a digital context.

INTERACTIVITY
The **Synthesize Activity** is a great way for students to practice applying what they've learned.

INTERACTIVITY
The **Engineering Activity** is a great way for your students to think, plan, and design like engineers.

VIRTUAL LAB
The **Virtual Lab** allows students to use different maps to choose the best location to place a telescope.

GAME
The **Mini Games** provide a fun way for students to practice what they have learned in the lesson.

ASSESSMENT
The **Topic Test** is carefully built to check for deep understanding of key concepts. Remediation is prescribed automatically to provide what students need to demonstrate content mastery.

The Essential Question

As students conduct investigations in each lesson, they will practice demonstrating the topic and lesson standards. At the end of the topic, students will be able to answer the question: *How can you use maps to understand Earth's features?*

Show What You Know

Ask students to look carefully at the photo and describe features in the landscape that they observe. Ask students to explain which features are most important to show on a map.

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Does X Mark the Spot? That's Up to You!

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Focus on Mastery!

Analyzing and Interpreting Data Throughout the Quest, students will use models to gather evidence that will help them explain how Earth's features form and change over time. Discuss the ways that geologists may collect data and analyze it to better understand Earth's features and how they have been formed and changed over time. Then have students list examples of evidence that they will need to analyze how buried treasure can be found throughout the Quest. Examples include:

- Other scientists' studies
- Observation and study of landform examples
- Models of landforms
- Maps from different time periods

Have students share their examples and keep them handy as they work through the Quest.

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In this problem-based learning activity, you will study maps, build landform models, test how those landforms may change over time, search for treasure, and present your findings.

Follow the path to discover what you need to do to complete the Quest. The Quest Check-In activities will help you complete the Quest. You can check off every step you complete with a QUEST CHECK OFF. Go online for more Quest activities.

VIDEO
Watch a video about a geologist.

Quest Check-In 1
Lesson 1
Learn how to read different types of maps. Find out how understanding parts of maps will help you locate the buried treasure.

Quest Check-In 2
Lesson 2
Learn about the patterns of some landforms, where they occur, and how they are made.

Quest Check-In Lab 3
Lesson 3
Discover how rocks, minerals, and soil form and how they create Earth's landforms.

Quest Check-In Lab 4
Lesson 4
See how the effects of weathering and erosion shape landforms. Learn how these processes can help you find the treasure.

Quest Findings
Use what you have learned about maps, models, and Earth's features to describe changes your landform underwent and how you discovered the treasure.

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Quest Kickoff 153

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VIDEO

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What It Is Video, short answer prompts, and interactive screens

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How to use It

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4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

Quest Path

Using Phenomena Quests are problem-based learning projects for students to work on throughout a topic. They help bring the topic content alive for students. By taking on a real-world problem and solving it, students come to understand why it is important for them to know about a particular science topic. Quests also provide the opportunity for students to demonstrate mastery of Performance Expectations (PEs), engage in Science and Engineering Practices (SEPs), and interact with Crosscutting Concepts (CCCs) and Disciplinary Core Ideas (DCIs).

Encourage students to track their progress by checking off the white circles for each step of the Quest.

- In the Check-In for Lesson 1, students will implement 4-ESS2-2 when they learn how to create a legend, a common map tool. This will help them think about how land features are represented on a map as they begin their search for treasure.
- In the Check-In for Lesson 2, students are introduced to the patterns of different landforms. They will practice 4-ESS2-2 while looking closely at the characteristics of the landforms, including how they are made.
- In the Check-In Lab for Lesson 3, students apply their understanding of rocks, minerals, and soil to discover how they compose Earth's landforms, practicing 4-ESS2-1 and SEP.3.
- In the Check-In Lab for Lesson 4, students explore how the processes of weathering and erosion form new landforms. Understanding these processes will help students find the treasure as they practice 4-ESS2-1 and SEP.3.
- In the Findings, students will plan and produce a presentation that shows how weathering and erosion impact Earth's landforms. They practice 4-ESS2-1, 4-ESS2-2, and SEP.3 when constructing their presentation.

VIDEO

Have students complete the **Quest Kickoff** digital activity.

What It Is Video, short answer prompts, and interactive screens

What It does Connects the topic career, a geologist, to the Quest project and provides the purpose of the Quest

How to use It

- Have students watch the video to explore the career of a geologist.
- Students will practice following instructions to read a map to determine the location of a buried treasure on the map.
- Then have students complete the screens in which they ask questions about the Quest.

DOCUMENT

Have students use the **Quest Checklist** as a Quest management tool. This tool will help them keep track of the Quest tasks they have completed.

DOCUMENT

The **Quest Rubric** is a self-assessment tool to help students evaluate their own performance as they complete the Quest project. The rubric also provides you with a consistent way of evaluating students' performance-based project.

INTERACTIVITY

The **Quest Findings** digital activity provides students with the opportunity to discover how landforms are formed and change over time.

Quest Kickoff

Does X Mark the Spot? That's Up to You!

Using Phenomena Students are introduced to the topic Quest by reading a letter from Salena Patrick, a geologist. The letter explains the problem-based learning project students will work on throughout the Quest. The art on the path shows different landforms that were formed through Earth's processes. Have students explain how a geologist may use these land features to figure out how land changes over millions of years.

Focus on Mastery!

Analyzing and Interpreting Data Throughout the Quest, students will use models to gather evidence that will help them explain how Earth's features form and change over time. Discuss the ways that geologists may collect data and analyze it to better understand Earth's features and how they have been formed and changed over time. Then have students list examples of evidence that they will need to analyze how buried treasure can be found throughout the Quest. Examples include:

- Other scientists' studies
- Observation and study of landform examples
- Models of landforms
- Maps from different time periods

Have students share their examples and keep them handy as they work through the Quest.

Next Generation Science Standards

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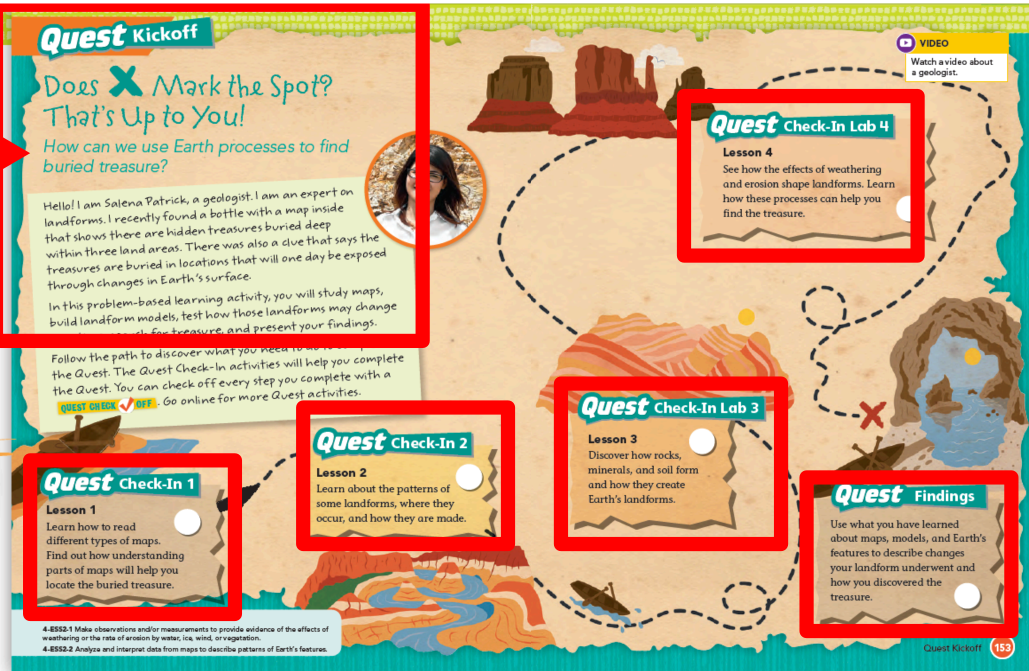

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INTERACTIVITY

The **Quest Findings** digital activity provides students with the opportunity to discover how landforms are formed and change over time.

QUEST connections in each lesson of each chapter:

Physical Weathering

Physical weathering happens when wind, water, ice, or plants cause rock to flake or crack. The force of these materials causes rock to wear away or break into smaller pieces. As the wind blows, small particles of sand and other materials hit the rock, cutting and shaping it. Some plant roots can grow inside rock, forcing the rock to crack. Flowing water can cause rocks to hit one another and break apart. Water can also enter cracks in rock. If temperatures are cold enough, the water will freeze. The frozen water in the cracks expands and pushes against the rock, breaking it. Another way that ice weathers rock is in the form of glaciers. Glaciers are large sheets of slow-moving ice that cut and crack rock as they scrape over land.

Science Practice ▸ Toolbox

Ask Questions What questions would you ask if you were to design a way to prevent the physical weathering of an important stone monument?

Quest Connection

Describe how weathering affects mountains, plateaus, and cliffs by the coast.

Sample answer: Weathering can cause mountains and cliffs to become smoother. It can carve out land into plateaus.

Possible Misconception

Weathering

Students may think that physical weathering occurs in a short amount of time. For example, if water freezes in a rock's crack overnight and then melts the next day, the rock will likely not crack apart immediately. Address this misconception by reminding students that weathering occurs over a long period of time. The repetition of freezing and thawing of water in a crack over a length of months or even years will most likely break apart a rock. Have students think of examples of physical weathering that they have seen, such as potholes in streets during the spring melt, plants growing in cracks in rocks, or weathered shells found along a shoreline.

Science Practice ▸ Toolbox

Ask Questions Have students discuss how a stone monument can be weathered both physically and chemically. Encourage students to discuss which form of weathering would be more crucial to prevent. Have students propose their questions with support, and guide students to critique each other's ideas.

Scaffolded Questions

Use the following questions to assess students' **Depth of Knowledge** levels of understanding.

Recall What causes physical weathering? **DOK1** (Physical weathering is caused by wind, water, ice, or plants.)

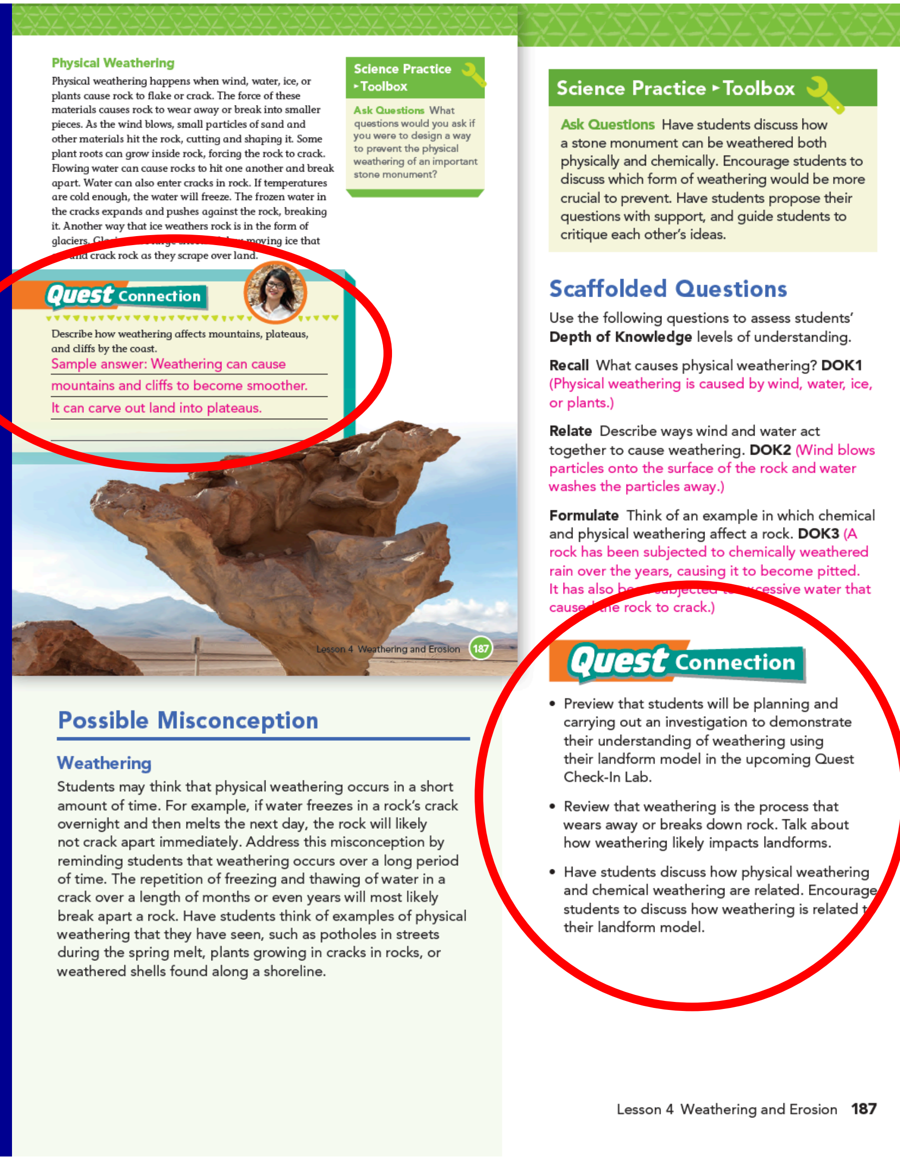
Relate Describe ways wind and water act together to cause weathering. **DOK2** (Wind blows particles onto the surface of the rock and water washes the particles away.)

Formulate Think of an example in which chemical and physical weathering affect a rock. **DOK3** (A rock has been subjected to chemically weathered rain over the years, causing it to become pitted. It has also been subjected to excessive water that caused the rock to crack.)

Quest Connection

- Preview that students will be planning and carrying out an investigation to demonstrate their understanding of weathering using their landform model in the upcoming Quest Check-In Lab.
- Review that weathering is the process that wears away or breaks down rock. Talk about how weathering likely impacts landforms.
- Have students discuss how physical weathering and chemical weathering are related. Encourage students to discuss how weathering is related to their landform model.

QUEST **connections in each lesson of each chapter:**



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Any NGSS-designed Curricular Materials Should Incorporate the Five "NGSS Innovations"

1. Three-Dimensional Learning
2. Building K-12 Progressions
3. Alignment with Common Core English Language Arts and Mathematics
4. Making Sense of Phenomena and Designing Solutions to Problems
5. ***All Standards, All Students***

Differentiation and Diverse Student Support

Visual Literacy Connection

INVESTIGATE

VIRTUAL LAB

Students will use a street map, a physical map, and a topographic map to choose the best location to place a telescope. Go online to find the detailed teacher support document for the activity.

Teach with Visuals

Before students begin reading the visual, ask them: *What do the images tell you about how you can see the same place in different ways?*

- Model how to compare the features shown on each map. Use the area near the Golden Gate Bridge as a reference point to find the same area on all three maps.
- Ask students to look closely to see what features make each map similar or different from the other maps.
- Discuss how the maps provide visual information to understand San Francisco in different ways.

Focus on Mastery!

Analyzing and Interpreting Data Explain that maps are made for different purposes. Guide students to think about what professions would find each type of map the most useful.

- Environmental scientists would use topographic maps and data to understand the various land features of a location.
- City tour guides would use attractions maps to guide tourists from location to location.
- Have students consider professions that would use street maps of San Francisco. Ask them to explain why those professions would need to use street maps rather than other types of maps.

Visual Literacy Connection

How can you see the same place in different ways?

These maps are all maps of San Francisco. Each map shows different information. Look at each map and see what information it includes.

Street Map Use a marker to trace the most direct route to go from Daly City to the bridge that crosses the San Francisco Bay.

Topographic Map This map shows the land surface of San Francisco using contour lines. Contour lines that are closer together show steeper land. Contour lines farther apart show flatter land. Circle one of the highest points in San Francisco. Is San Francisco flat or hilly? How do you know?

Sample answer: I can see a lot of closer lines that represent hills and less far apart lines, so it must be hilly.

INTERACTIVITY Complete an activity about maps.

Satellite Map A satellite map shows an image of a place taken from a satellite. Map features, such as roads, are highlighted on the satellite image. Describe how a satellite map is different from the other maps.

Sample answer: A satellite map shows real forests because it is an actual image of a location.

Local Attractions Map What types of attractions are there to see in San Francisco?

Sample answer: a ballpark, Fisherman's Wharf, the Golden Gate Bridge, and a zoo

160 Topic 4 Earth's Features

Lesson 1 Maps and Data 161

Differentiated Instruction

Support Struggling Students

Have students work with a partner to find the Pacific Ocean on one of the maps. Then have them label the Pacific Ocean on the topographic map. Be sure students understand that although the three maps show different features of an area, they all still show the same location.

Support Advanced Learners

Challenge advanced learners to research two different maps of their hometown. Ask them to compare these maps and draw conclusions about how certain types of maps serve different purposes.

ELD Support

Speaking Use the text and images in the Visual Literacy Connection to help students practice their English vocabulary.

Entering Have students say the name of the city and state represented in the visual.

Beginning Have students take turns telling whether San Francisco is flat or hilly.

Developing Have students use examples from the map to explain why San Francisco is flat or hilly.

Expanding Have students use details to prove whether San Francisco is flat or hilly.

Bridging Have students identify whether each attraction is located in a flat or hilly section of San Francisco.

SYNTHESIZE

INTERACTIVITY

Have students complete the **Synthesize Activity.**

What It Is Real world scenario-based interactivities and engaging images

What It does Supports students in synthesizing and applying what they've learned throughout the lesson

How to use it

- Students will click through the screens to explore the features of various types of maps.

DOCUMENT

Assign the **Enrichment Activity** to have students practice map skills by creating three different types of maps of their neighborhood.

Scaffolded Questions

Use the following questions to assess students' **Depth of Knowledge** levels of understanding.

Identify Choose the map you would use to find your way from the airport to the Golden Gate Bridge. Explain why this map would help you with this task. **DOK1** (The street map will provide the names of streets for a route I can take to get to the Golden Gate Bridge.)

Summarize Relate the topographic map to the local attractions map. What information do you gain by using both together? **DOK2** (The topographic map shows the elevation of different land features in the area, while the local attractions map shows the man-made features of the area. By looking at both maps together, I am able to understand which attractions are located on hills in San Francisco and which are closer to sea level.)

Formulate Think about where you live. Which of these maps would be used most by the people in your community? Explain your reasoning. **DOK3** (Answers will vary, but students will consider whether their community has many attractions or varying topography. Depending on the features of the area, a road map may be most used by people in the community.)

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Visual Literacy Connection

INVESTIGATE

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DOCUMENT

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Scaffolded Questions

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Differentiation and Diverse Student Support

Visual Literacy Connection

INVESTIGATE

VIRTUAL LAB

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- Discuss how the maps provide visual information to understand San Francisco in different ways.

Focus on Mastery!

Analyzing and Interpreting Data Explain that maps are made for different purposes. Guide students to think about what professions would find each type of map the most useful.

- Environmental scientists would use topographic maps and data to understand the various land features of a location.
- City tour guides would use attractions maps to guide tourists from location to location.
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Visual Literacy Connection

How can you see the same place in different ways?

These maps are all maps of San Francisco. Each map shows different information. Look at each map and see what information it includes.

Street Map Use a marker to trace the most direct route to go from Daly City to the bridge that crosses the San Francisco Bay.

Topographic Map This map shows the land surface of San Francisco using contour lines. Contour lines that are closer together show steeper land. Contour lines farther apart show flatter land. Circle one of the highest points in San Francisco. Is San Francisco flat or hilly? How do you know?

Sample answer: I can see a lot of closer lines that represent hills and less far apart lines, so it must be hilly.

INTERACTIVITY

Complete an activity about maps.

Satellite Map A satellite map shows an image of a place taken from a satellite. Map features, such as roads, are highlighted on the satellite image. Describe how a satellite map is different from the other maps.

Sample answer: A satellite map shows real forests because it is an actual image of a location.

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Differentiated Instruction

Support Struggling Students

Have students work with a partner to find the Pacific Ocean on one of the maps. Then have them label the Pacific Ocean on the topographic map. Be sure students understand that although the three maps show different features of an area, they all still show the same location.

Support Advanced Learners

Challenge advanced learners to research two different maps of their hometown. Ask them to compare these maps and draw conclusions about how certain types of maps serve different purposes.

ELD Support

Speaking Use the text and images in the Visual Literacy Connection to help students practice their English vocabulary.

Entering Have students say the name of the city and state represented in the visual.

Beginning Have students take turns telling whether San Francisco is flat or hilly.

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SYNTHESIZE

INTERACTIVITY

Have students complete the **Synthesize Activity.**

What it is Real world scenario-based interactivities and engaging images

What it does Supports students in synthesizing and applying what they've learned throughout the lesson

How to use it

- Students will click through the screens to explore the features of various types of maps.

DOCUMENT

Assign the **Enrichment Activity** to have students practice map skills by creating three different types of maps of their neighborhood.

Scaffolded Questions

Use the following questions to assess students' **Depth of Knowledge** levels of understanding.

Identify Choose the map you would use to find your way from the airport to the Golden Gate Bridge. Explain why this map would help you with this task. **DOK1** (The street map will provide the names of streets for a route I can take to get to the Golden Gate Bridge.)

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Formulate Think about where you live. Which of these maps would be used most by the people in your community? Explain your reasoning. **DOK3** (Answers will vary, but students will consider whether their community has many attractions or varying topography. Depending on the features of the area, a road map may be most used by people in the community.)

Differentiation and Diverse Student Support

Visual Literacy Connection

INVESTIGATE

VIRTUAL LAB

Students will use a street map, a physical map, and a topographic map to choose the best location to place a telescope. Go online to find the detailed teacher support document for the activity.

Teach with Visuals

Before students begin reading the visual, ask them: *What do the images tell you about how you can see the same place in different ways?*

- Model how to compare the features shown on each map. Use the area near the Golden Gate Bridge as a reference point to find the same area on all three maps.
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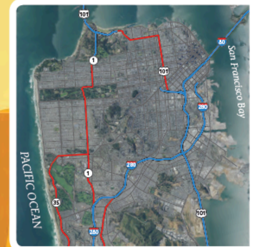

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160 Topic 4 Earth's Features

Lesson 1 Maps and Data 161

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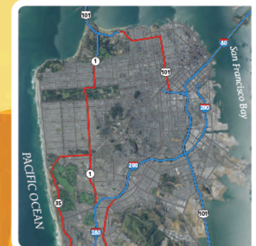

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160 Topic 4 Earth's Features

Lesson 1 Maps and Data 161

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