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

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Department of Earth and Planetary Sciences
Washington University, St. Louis, MO
Seattle, WA, Oct 24, 2017
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.
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)
**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.]

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

**Articulation of DCIs across grade-bands:**


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

Three Dimensions:

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Performance Expectation

HS-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

**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.**

(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.)

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**Construction Explanations and Designing Solutions**: Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progress 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.

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**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
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#### Performance Expectation

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#### 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.

#### PRACTICES

- 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.

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

1. Three-Dimensional Learning
2. Building K-12 Progressions
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<td>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.</td>
<td>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.</td>
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### Example of K-12 Progressions:

#### Developing and Using Models

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- **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.

- **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 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.

- **Identify limitations of models.**
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- **Distinguish between a model and the actual object, process, and/or events the model represents.**
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- **Compare models to identify common features and differences.**
  - 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 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.
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<td>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.</td>
<td>Modeling in K–2 builds on prior experiences and progresses by creating increasingly simple representations of events and design solutions. • Distinguish between a model and the actual object, process, and/or events the model represents. • Compare models to identify common features and differences.</td>
<td>Modeling in 3–5 builds on K–2 experiences and progresses by building increasingly simple representations and using models to represent events and design solutions. • Identify limitations of models.</td>
<td>Modeling in 6–8 builds on K–5 experiences and progresses by developing and using models to describe, test, and predict more abstract phenomena and design systems. • Evaluate limitations of a model for a proposed object or tool.</td>
<td>Modeling in 9–12 builds on K–8 experiences and progresses by developing and using models to predict and show relationships among variables between systems and their components in the natural and designed world(s). • Evaluate merits and limitations of two different models of the same proposed object, model, 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.</td>
</tr>
<tr>
<td>Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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<td>Develop a simple model based on evidence to represent a proposed object or tool.</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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### 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.
### Example of K-12 Progressions:

#### 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 models, 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.

#### Science and Engineering Practices

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**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

- **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.LS.2.A**
- **MS.LS.4.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.]

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- **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)

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
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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 Curriculum 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
# Accelerated Model Course Pathway:
## 5-Year Model
(For Gifted Students)

<table>
<thead>
<tr>
<th>Course 1</th>
<th>Course 2</th>
<th>Course 3</th>
<th>Course 4</th>
<th>Course 5</th>
</tr>
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<tbody>
<tr>
<td>MS.PS.1 Matter and its Interactions</td>
<td>MS.PS.4 Waves</td>
<td>HS.PS.1 Matter</td>
<td>HS.PS.2 Motion and Forces</td>
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<td>MS.PS.2 Motion and Stability: Forces and Processes</td>
<td>MS.IS.1 Structure and Processes</td>
<td>MS.IS.4 Evolution</td>
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Accelerated Model Course Pathway:
4-Year Model
(For Very Gifted Students)
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**: Earth Science Literacy Principles
- **2011**: A Framework for K-12 Science Education
- **2013**: Next Generation Science Standards
- **2017**: Elevate Science

Teacher Development
Curricula
Instructional Materials
Instruction
Assessment
Timeline for the NGSS & *Elevate Science*

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

**2009 - 2011**
- *Earth Science Literacy Principles*
- *A Framework for K-12 Science Education*
- *Next Generation Science Standards*

**2013 - 2014**
- *Weathering, Erosion, and Deposition in Texas*
- *iQuest: Reflect on Your Chain Reaction Machine*

**2013 - 2017**
- *Human Impacts on Earth’s Systems*

**2008-2011**
- *interactive SCIENCE*

**2009-2012**
- *interactive SCIENCE*

**2012-2013**
- *Weathering, Erosion, and Deposition in Texas*

**2013-2017**
- *Human Impacts on Earth’s Systems*
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
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Illinois
Iowa
Kansas
Kentucky
Maryland
Michigan
Nevada
N. Hampshire
New Jersey
Oregon
Rhode Isl.
Vermont
Washington
(and DC)
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)

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

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

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

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

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

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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)

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

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

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

INTEGRATED SCIENCE MODEL

Course 1
- PS1: Matter and Its Interactions
- PS2: Motion and Stability: Forces and Interactions
- PS3: Energy
- ESS1: Earth’s Place in the Universe

Course 2
- LS1: From Molecules to Organisms
- LS2: Ecosystems, Interactions, Energy, and Dynamics
- LS3: Heredity: Inheritance and Variation of Traits
- PS4: Waves and Their Applications in Technology for Information Transfer

Course 3
- LS4: Biological Evolution: Unity and Diversity
- ESS2: Earth Systems
- ESS3: Earth and Human Activity
Constructing NGSS-designed Instructional Materials

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

PHYSICAL SCIENCE

Course 1
- PS1: Matter and Its Interactions
- PS2: Motion and Stability: Forces and Interactions
- PS3: Energy
- ESS1: Earth's Place on the Universe

Course 2
- LS1: From Molecules to Organisms
- LS2: Ecosystems, Interactions, Energy, and Dynamics
- PS4: Waves and Their Applications in Technology for Information Transfer
- LS3: Heredity: Inheritance and Variation of Traits

Course 3
- LS4: Biological Evolution: Unity and Diversity
- ESS2: Earth Systems
- ESS3: Earth and Human Activity
Appendix K -- Course Map #1: Conceptual Understanding Model

LIFE SCIENCE

Course 1

- PS1: Matter and Its Interactions
- PS2: Motion and Stability: Forces and Interactions
- PS3: Energy
- ESS1: Earth's Place on the Universe

Course 2

- LS1: From Molecules to Organisms
- LS2: Ecosystems, Interactions, Energy, and Dynamics
- LS3: Heredity: Inheritance and Variation of Traits
- PS4: Waves and Their Applications in Technology for Information Transfer

Course 3

- LS4: Biological Evolution: Unity and Diversity
- ESS2: Earth Systems
- ESS3: Earth and Human Activity
Appendix K -- Course Map #1: Conceptual Understanding Model

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- LS3: Heredity: Inheritance and Variation of Traits
- LS2: Ecosystems, Interactions, Energy, and Dynamics
- PS4: Waves and Their Applications in Technology for Information Transfer

Course 3
- LS4: Biological Evolution: Unity and Diversity
- ESS2: Earth Systems
- ESS3: Earth and Human Activity

EARTH & SPACE SCIENCE
## Bundling the NGSS

### Example Bundles:

*Read First: Introduction and Guide*

<table>
<thead>
<tr>
<th>Kindergarten</th>
<th>Middle School</th>
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<tbody>
<tr>
<td>Thematic Model</td>
<td>Course 1: Phenomenon Model</td>
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# MIDDLE GRADES NATIONAL "ELEVATE"

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<td>1) Properties of Matter</td>
<td>1) How do you describe properties of matter?</td>
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<td>2) Changes in Matter</td>
<td>2) What evidence do we have that matter changes?</td>
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<td>3) Earth’s Systems</td>
<td>3) How can you model the interactions about Earth’s Systems?</td>
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<td>4) Earth’s Water</td>
<td>4) How much water can be found in different places on Earth?</td>
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<td>5) Human Impacts on Earth’s Systems</td>
<td>5) How can science ideas help up protect Earth’s resources and environments</td>
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<td>6) Solar System</td>
<td>6) What is Earth’s place in space?</td>
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<td>7) Movement of the Earth and its Moon Around the Sun</td>
<td>7) How do patterns of light and shade change from day to day and season to season?</td>
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<td>8) Energy and Food</td>
<td>8) Where does food’s energy come from and how is food used?</td>
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<tr>
<td>9) Matter and Energy in Ecosystems</td>
<td>9) How can you model the interactions of living things in an ecosystem?</td>
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</table>
Lesson 1 Maps and Data
Lesson 2 Patterns of Earth's Features
Lesson 3 Rocks, Minerals, and Soil
Lesson 4 Weathering and Erosion

Next Generation Science Standards
6-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.
6-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.
3-ESS1-1 Define a simple design problem reflecting a need or 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.
**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) and SEP4 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 throughout the topic. Some vocabulary in this topic include geology, canyon, boulder, 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 reason to practice this skill through the Reading Check and Literacy Check. Finally, students will practice the math standard MPs7 by using tools to test how a rock can wear away.

**Next Generation Science Standards**

- 4.ESS3.3 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.ESS3.2 Analyze and interpret data from maps to describe patterns of Earth’s features.
- 5-ESS3.1 Define a simple design problem reflecting a need or a want that includes specified criteria or constraints on materials, size, or cost.

**Topic Materials List**

- Consumable
  - Bottom half of a gallon milk jug (10)
  - Plastic cup (45)
  - Sand (2 large bags)
  - Soil (1 large bag)
  - Paper plate (30)
  - Craft stick (30)
  - Foil 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)
  - Magnifying glass (15)
  - Nails (15)
  - Penny (15)
  - Rock samples (1 large bag)
  - Clear jar with lid (15)
  - Safety goggles (30)
  - Plastic spray bottle (15)
  - Streak plate (15)

**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.

**Show What You Know**

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

**Differentiated Instruction**

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?
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

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

#### DCIs CORRELATED TO LESSON

<table>
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<tr>
<th>DCi</th>
<th>Correlation</th>
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<tr>
<td>DCi:</td>
<td>Correlation:</td>
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<tr>
<td>PS1: Structure and Properties of Matter</td>
<td>Matter of any type can be subdivided into particles that are too small to be seen, 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 of a balloon and the effects of air on larger particles or objects. (5-PS1-3)</td>
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#### ELA CCSS CORRELATED TO LESSON

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<thead>
<tr>
<th>ELA CCSS</th>
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<tbody>
<tr>
<td>RI.5.7</td>
<td>Draw on information from multiple print and digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS1-1)</td>
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<tr>
<td>W.5.7</td>
<td>Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-3)</td>
</tr>
<tr>
<td>W.5.8</td>
<td>Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase in notes and finished products. (5-PS1-1)</td>
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#### MATH CCSS CORRELATED TO LESSON

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<tr>
<td>5.MD.4</td>
<td>Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. (5-PS1-1)</td>
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Elevate Science is built from the ground up around the NGSS.
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<tr>
<th>Next Gen Grade</th>
<th>5 TOC</th>
<th>30 lessons</th>
<th>Topic 1: Properties of Matter</th>
<th>Standards Correlated to Lesson and/or Topic</th>
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<tr>
<td><strong>5-PS1-3. Make observations and measurements to identify materials based on their properties.</strong></td>
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<td>Developing and Using Models</td>
<td>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.</td>
<td>Scale, Proportion, and Quantity: Natural objects exist from the very small to the immensely large. (5-PS1-1)</td>
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<tr>
<td>Assessment Boundaries: Assessments do not include distinguishing mass and weight.</td>
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<td>Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-1)</td>
<td><strong>W.5.7</strong></td>
<td>Relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase. Information in notes and finished</td>
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<td>Lesson 1 Observe Matter</td>
<td>5-PS1-3. Make observations and measurements to identify materials based on their properties.</td>
<td><strong>W.5.8</strong></td>
<td>Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-1)</td>
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<tr>
<td>Lesson 2 Model Matter</td>
<td><strong>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.</strong></td>
<td><strong>MP.5</strong></td>
<td>Use appropriate tools strategically. (5-PS1-2)</td>
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**Math/Science Correlated to Lesson and/or Topic:**

<table>
<thead>
<tr>
<th>Topic 2: Changes in Matter</th>
<th>What evidence do we have that matter changes?</th>
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<td>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.</td>
<td><strong>Caution and Effect:</strong> Cause and effect relationships are routinely identified, tested, and used to explain changes. (5-PS1-3)</td>
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<td>Assessment Boundaries: Assessment does not include distinguishing mass and weight.</td>
<td><strong>Science:</strong> Scale, proportion, and quantity: Natural objects exist from the very small to the immensely large. (5-PS1-1)</td>
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**Summary of Objectives:**

- ps1: Structure and Properties of Matter
  - Matter of any type can be divided 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 objects or objects.

**Standards:**

- 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.

**Assessment Boundaries:**

- Assessment does not include distinguishing mass and weight.
Elevate Science is built from the ground up around the NGSS
**Elevate Science** is built from the ground up around the NGSS.
Identifying Science and Engineering Practices:

**How can rain affect land?**

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

**Materials**
- Foam cup with holes
- Water

**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.

**Guiding Inquiry**
If your students need more direction on this lab, use the following procedure:
1. Fill ½ 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 sprayer 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 steps 5. Record your observations in the chart.
Identifying Science and Engineering Practices:

Added teacher support

How can rain affect land?

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

How can rain affect land?

Procedure:

1. How will different aspects of a model influence the results of the investigation?
2. Set up the "land" in the milk jug. Carefully, take each cup upside down in the jug, tuck the cups to release the sides of dirt.
3. Make a graph to test your predictions. Write your data. Show it to your teacher before you begin. Review your observations.

Materials:

- Go online to download the master material list, which also identifies kit materials.
- Alternative Materials: A foam cup with holes 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.
- 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.

Guiding Inquiry:

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

1. Fill ½ 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 finely packed soil.
4. Fill the graduated cylinder with 100 mL of water. Pour the water into a sprayer 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 steps 5. Record your observations in the chart.

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.

5-ESS3 Planning and Carrying Out Investigations Make observations and/or measurements to produce data to serve as the basis for evidence of an explanation for a phenomenon.
Identifying Science and Engineering Practices:

Types of Maps
A physical map shows us earth’s natural physical features, such as hills, valleys, streets, lakes, waterfalls, and parks—usually by using different colors. A political map is the cartographic cousin of a physical map. The map of the United States, named after Davis, uses blue to show the states. Water is usually shown as blue. The lighter and darker green colors show areas that tend to be higher, such as hills and mountains. The lighter green colors show areas that are flatter, such as plains.

Apply: Circle each of the map where there are mountains.

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 shown using different colors to show different kinds of roads. Transit 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, GIS software, or the Global Positioning System. Scientists use that data to produce actual maps, showing:

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 question: Why are certain maps used for specific purposes? What are the 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: What kind of map would you 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.)
Identifying Science and Engineering Practices:

“Science Practice Toolbox”

Types of Maps
A physical map shows us the natural physical features, such as hills, valleys, streams, lakes, wetlands, and key areas such as forests. A thematic is a thematic or part of a theme. In the map of the United States, certain features are shown with different colors. Water is shown in blue. The term red, green, blue, yellow, orange, and magenta. The lighter green colors also show where the water is higher, 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 us countries, states, and other political features such as cities. Political maps are often used with a atlas. Road maps show roads and highways in an area. Roads can be drawn using different colors or images to show different kinds of roads. Road maps can 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. GIS on the Google Earth system, constantly sends out signals that a device uses to plot where it is located.

21st Century Skills
Interpersonal and Collaborative Skills
Maps are a great visual way to show information. They are an important way for people to understand the changes in the world. It is also 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 current and future implications of these types of maps using the Internet. This activity uses the ELA Speaking and Listening skill of participating in collaborative conversations.

Scaffold Questions
Help students set a frame for reading by asking them to think of an answer to the following guiding question: What 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 in the text. DOK1 (physical, political, road maps)

Interpret: Determine what kind of map you would use on a hiking trip. DOK2 (physical map)

Think about how would you use the land features that are used in this map? DOK3 (physical map)

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 satellite to produce the maps)

Science Practice Toolbox
Construct Explorations: Have students list different sources that 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:

**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:

- **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.”)

**Engineering Design Process**

**Define Problem**

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 designs 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.

**Develop Solutions**

**Optimize Solutions**

**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 trail. 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.

**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 revist and revise their drawings when asking problems and developing solutions. In this task, 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 harmless behaviors, such as biting, stinging, or even attacking. Students may want to consider how they can protect hikers from these animals.

**littleBits**

Go online to access your digital course for student activities and teacher support.

If your students enjoyed this activity, then encourage them to explore and investigate the littleBits challenges in their digital course. These unique opportunities allow students to design and evaluate different kinds of tasks as they continue their study of the engineering design process.
Identifying Science and Engineering Practices:

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:

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- 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 and rocky, and sandy soil tends to collapse over time.")

Next Generation Science Standards

3-5-ETS1-1. Define a simple design problem reflecting a need or an opportunity that includes specified criteria and constraints. Materials, time, or cost

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.

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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.

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 research and develop their drawings when making new 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 protective behaviors, such as biting, stinging, or spining their thorns. Students may want to consider how they can design a trail with these animals.

littleBits

Go online to access your digital course for student activities and teacher support. If your students enjoyed this activity, then encourage them to explore and investigate the littleBits challenges in their digital course. These unique opportunities allow students to design and evaluate different types of trails as they continue their study of the engineering design process.
Identifying Science and Engineering Practices:

**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:

- **What does the word criterion 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.)
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- **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.”)

**Next Generation Science Standards**

**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.

**Engineering Design Process**

Define ▶ Develop ▶ Optimize

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.

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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.
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 eruptions involve the movement of molten rock called magma. When magma reaches the surface, it forms volcanoes. Volcanic eruptions are common along a section of Earth called the Ring of Fire, which is the rim of boundaries surrounding the Pacific Ocean.

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.

Synchronize
Have students complete the Synchronize 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 scenarios 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. At 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”

Patterns of Earthquakes and Volcanoes
Patterns of earthquake activity and volcanoes are closely related. Both occur along faults or cracks in Earth’s crust. Earthquakes often occur at plate boundaries. Some faults are near the middle of plates. Their movements are spread over deep, slow-moving plates. Volcanoes form at plate margins. Volcanoes and earthquakes are common along a section of Earth called the Ring of Fire, which is the place that forms the surrounding Pacific Plate.

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.

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.

SYNTHESIZE

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. At a class, have students brainstorm other factors that could shape Earth's surface.
Identifying Performance Expectations in Assessments:

**TOPIC 3 Review and Assess**

**Evidence-Based Assessment**

1. Apply Scientific Reasoning to the satellite had less mass, but the force of the collision was the same, then the collision would have caused the satellite to decelerate more quickly. Why? It caused the satellite to decelerate at the same rate. It had the effect on the satellite's original motion. If the satellite moved at a balanced force, the collision would have caused it to come to a stop.

2. The Evidence DidDART apply a balanced or unbalanced force to the satellite during the collision? What evidence supports your answer? The force was unbalanced. The force was applied by DART and its speed decreased.

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 drawings show 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 has a greater pull than the distance between DART and the satellite.

5. Synthesize Information What words and symbols could you add to an image to represent the action-reaction forces? Describe how you would draw and write the force of one arrow on DART and one on the satellite, pointing in opposite directions from each other, to represent the action-reaction forces. I would draw an arrow from the spacecraft pointing to Earth, and an arrow from the condition pointing to Earth, to represent the pull of Earth on both objects.

**Quest FINDINGS**

**Complete the Quest**

Phenomenon: Design a way to prevent your bumper car design and the rest of your testing to your class. Assess how your design meets the third tier of mastery in your design.

**Scenario**

Student refers to the relationship between mass, distance, and gravity while explaining why that force is stronger.

**NEXT GENERATION SCIENCE STANDARDS**

- MS-LS2-1 Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.
- MS-LS2-3 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.

**PROFESSIONAL DEVELOPMENT**

**DIFFERENTIATED INSTRUCTION**

**L1 Support Struggling Students**

Show students a picture of 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 in balance, and explain the connection between a change in motion and unbalanced forces.

**L3 Support Advanced Students**

Have students explain why the net force on a satellite traveling at constant speed around Earth is unbalanced.
Identifying Performance Expectations in Assessments:

**Evidence-Based Assessment**

1. Apply Scientific Reasoning to explain how the force of the collision between Earth and the satellite caused the satellite to become unbalanced and move away from Earth.
2. Use Data from the simulation to explain how the force of the collision caused the satellite to change direction and move away from Earth.
3. Synthesize Information: What additional forces could you add to the simulation to cause the satellite to move in a different direction than it did in the simulation?

**Supporting Students**

- **L1 Support Struggling Students**
  - Provide visual aids to help students understand the concept of unbalanced forces.
  - Break down the problem into smaller, manageable parts.
- **L3 Support Advanced Students**
  - Challenge students to design their own simulations with different forces acting on the satellite.
  - Encourage them to explore the effects of different masses and speeds on the satellite's motion.
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.

Grades K-2
Students should already be capable of...
- Evaluating different ways of observing and/or measuring a phenomenon.
- Using observations to describe patterns and/or relationships in order to answer scientific questions.

Disciplinary Core Ideas
- ESS2.A Earth Materials and Systems
  - Recognizing that wind and water change the shape of the land.
- ESS2.B Plate tectonics and large-scale system interactions
  - Observing how maps show where things are located.

Crosscutting Concepts
- CCC.1 Patterns
  - Recognizing that patterns can be observed, used to describe phenomena, and used as evidence.
- CCC.2 Cause and Effect
  - Understanding that events have causes that generate observable patterns.

Science and Engineering Practices
- SEP3 Planning and Carrying Out Investigations
- SEP4 Analyzing and Interpreting Data

Grade 3-5
Students are working toward...
- Making observations or measurements to produce data to explain a phenomenon.
- Comparing and contrasting data collected by different groups in order to discuss similarities and differences in their findings.
- Understanding that rainfall helps to shape the land and affects the types of living things found in a region.
- Recognizing that Earth's physical features occur in patterns, as do earthquakes and volcanoes, and maps can locate these features.
- Identifying similarities and differences in order to sort and classify natural objects and designed products.
- Identifying and testing causal relationships and using these relationships to explain change.

Grade 6-8
Students will develop the skills of...
- Evaluating the accuracy of various methods for collecting data.
- Analyzing and interpreting data to determine similarities and differences in findings.
- Identifying that energy flows and matter cycles within and among Earth's systems.
- Identifying that plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history.
- Realizing that macroscopic patterns are related to the nature of microscopic and atomic-level structure.
- Classifying relationships as causal or correlational, and recognizing that correlation does not necessarily imply causation.

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 healthcare field.
Topic 4 Next Generation Learning Progressions

Earth's Features

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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.

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Students should already be capable of...
- making observations or measurements to produce data to explain a phenomenon.
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- understanding that rainfall helps to shape the land and affects the types of living things found in a region.
- recognizing that Earth's physical features occur in patterns, as do earthquakes and volcanoes, and maps can locate these features.
- identifying similarities and differences in order to sort and classify natural objects and designed products.
- identifying and testing causal relationships and using these relationships to explain change.

Science and Engineering Practices
- SEP.3 Planning and Carrying Out Investigations: evaluating different ways of observing and/or measuring a phenomenon.
- SEP.4 Analyzing and Interpreting Data: using observations to describe patterns and/or relationships in order to answer scientific questions.

Disciplinary Core Ideas
- ESS2.A Earth Materials and Systems: recognizing that wind and water change the shape of the land.
- ESS2.B Plate Tectonics and Large-Scale System Interactions: observing how maps show where things are located.

Crosscutting Concepts
- CCC.1 Patterns: recognizing that patterns can be observed, used to describe phenomena, and used as evidence.
- CCC.2 Cause and Effect: understanding that events have causes that generate observable patterns.

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.

Grade 3-5
Students are working toward...
- evaluating the accuracy of various methods for collecting data.
- analyzing and interpreting data to determine similarities and differences in findings.
- identifying that energy flows and matter cycles within and among Earth's systems.
- identifying that plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history.
- realizing that macroscopic patterns are related to the nature of microscopic and atomic-level structure.
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Science and Engineering Practices
- **SEP 1 Planning and Carrying Out Investigations**
  - Grades K-2: Students should already be capable of...
  - Grades 3-5: Students are working toward...

- **SEP 4 Analyzing and Interpreting Data**
  - Grades K-2: Evaluating different ways of observing and measuring a phenomenon.
  - Grades 3-5: Comparing and contrasting data collected by different groups in order to discuss similarities and differences in their findings.

Disciplinary Core Ideas
- **ESS2.A Earth Materials and Systems**
  - Grades K-2: Recognizing that wind and water change the shape of the land.
  - Grades 3-5: Recognizing that Earth's physical features occur in patterns, as do earthquakes and volcanoes, and maps can locate these features.

- **ESS2.B Plate Tectonics and Large-Scale System Interactions**
  - Grades K-2: Observing how maps show where things are located.
  - Grades 3-5: Identifying similarities and differences in order to sort and classify natural objects and designed products.

Crosscutting Concepts
- **CCC 1 Patterns**
  - Grades K-2: Recognizing that patterns can be observed, used to describe phenomena, and used as evidence.
  - Grades 3-5: Identifying and testing causal relationships and using these relationships to explain change.

- **CCC 2 Cause and Effect**
  - Grades K-2: Understanding that events have causes that generate observable patterns.

Grade 3-5
- **Students are working toward...**
  - Making observations or measurements to produce data to explain a phenomenon.
  - Comparing and contrasting data collected by different groups in order to discuss similarities and differences in their findings.

Grade 6-8
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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
Identifying Common Core Math Alignments:

LESSON 4

INVESTIGATE

Math Tool x 6.RP.2

Analyze Relationships: Guide students to complete the table by reminding them to: analyze the meaning of mass and weight; analyze the text to find the ratio of mass and weight for each planet and record them; analyze the calculations using the mass and weight ratios; analyze 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.

Math Tool x 6.RP.2

The Relationship Between Weight and Mass

Weight varies with the strength of the gravitational force. This baby elephant weighs 400 pounds on Earth, and its mass is 250 kilograms. On Mars, he would weigh about one-third of what he does on Earth. On Mars, he would weigh just over one-seventh of what he does on Earth. In Jupiter, he would weigh approximately 2.5 times as much as he does on Earth.

<table>
<thead>
<tr>
<th>Location</th>
<th>Earth</th>
<th>Moon</th>
<th>Mars</th>
<th>Jupiter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (kg)</td>
<td>400</td>
<td>30</td>
<td>116</td>
<td>345</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>880</td>
<td>60</td>
<td>66</td>
<td>735</td>
</tr>
</tbody>
</table>

Energy, Forces, and Motion

Teach Movement: The following activity will help students answer the Guiding Questions: How does gravitational potential energy relate to kinetic energy? Here's how students can create a table: 1. Find the equation for kinetic energy: kinetic energy = 1/2 * mass * velocity^2. 2. Use the equation to calculate the kinetic energy of the object at each location. 3. Compare the kinetic energy at each location. 4. Analyze the data to determine if there is a relationship between gravitational potential energy and kinetic energy.

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, a verb, and an adjective.

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 related to an 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 the object's position. If an object is on a hill, the greater its GPE, the greater its GPE. For example, an object that is on a hill has greater GPE than an object at the bottom of a valley. The GPE of an object increases as it rises the farther it is from the Earth. 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/s^2), and the height of the object above Earth's surface:

Gravitational potential energy (GPE) = mass x acceleration due to gravity x height

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:

Energy, Forces, and Motion

Teach With Movement: The following activity will help students understand the concepts. Ask students to imagine dropping notebooks from a lower and higher point onto a hard surface. What is the 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 the 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 - 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 ratio of mass and weight for each planet and record them.
- Carry out the calculations using the mass and weight ratio.
- 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

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 mass. In general, the higher an object is, the greater its GPE. For example, if a diver climbs the ladder to a diving board, her GPE increases. The GPE of a skydiver decreases as he falls toward the earth at a 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

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 English Alignments:

**Draw Conclusions**

- This important reading skill is drawing conclusions. It’s like playing a mystery game. Here’s how you do it:
  - Collect clues by 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 1825, people put up a lighthouse at the tip of the cape to help ships avoid running into it. The lighthouse stood 100 feet from the shore. Over the years, powerful storms and constant waves move 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 new one in a safe spot and moved the lighthouse to it in one piece. Engineers moved the lighthouse into a moving platform. Finally, the lighthouse made the trip to its new, safe location.

On November 10, 1999, the lighthouse is up again. Today, its beam continues to help ships sail safe at sea.

**LEARNING CHECK: Draw Conclusions**

The lighthouse is currently 100 feet from the ocean. Divide 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.
- **TEXT:** 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 ELL Speaking and Listening skill of participating in collaborative conversations.

**READING CHECK: Draw Conclusions**

Ask students to share their answers to the question, using evidence from the text and background knowledge they have about the subject matter.
Identifying Common Core English Alignments:

**Lighthouse on the Move**

Cape Hatteras sits out into the Atlantic Ocean from the coast of North Carolina. In 1903, people put up a lighthouse on the tip of this cape to help ships avoid running onto it. The lighthouse stood 150 feet from the shore. Over the years, powerful storms and constant waves wore away the coastline. By 1960s, the lighthouse was almost surrounded by water. The lighthouse needed to be moved. The National Park Service built a new one in a new spot and moved the old lighthouse to it in one piece. Engineers raised the lighthouse into a moving platform. Finally, the lighthouse made the trip to its new, safe location. On November 15, 1999, the lighthouse is up again. Today, its beacon continues to keep ships safe at sea.

**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 on 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 paraphrasing in collaborative conversations.

**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.

- **BECOME A WORKER** Learn About Earth's Features
- **ON LEVEL** Earth's Features
- **ADVANCED** All About Earth's Features
- **STEM ENGINEERING** Earth's Features

**Literacy Connection**

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

**TEXT**

Have students explore the Leveled Readers and STEM Engineering Reader to learn more about Earth's features.
Identifying Common Core English Alignments:

**Draw Conclusions**

Have important reading skills in drawing conclusions. It's like solving a mystery game. Here’s how you do it:

- Underline the clues as you read. Underline.
- Write the clues in your own words.
- Read the clues to understand what the text means.

Read the following passage to find not why engineers named a whole lighthouse.

**Lighthouse on the Move**

Cape Hatteras sticks out into the Atlantic Ocean from the coast of North Carolina. In 1803, people put up a lighthouse at the tip of the cape to help ships avoid running on it. The lighthouse stood 1,000 feet from the shore. Over the years, powerful storms and constant waves wore away the coastline. By 1999, the lighthouse was almost surrounded by water. The lighthouse needed to be moved. The National Park Service built a new house in a deep spot, and moved the lighthouse to its new place.

**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**

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

**Text**

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 Informational text feature and collaborative conversations.
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
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 SEPs 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 throughout the topic. Some vocabulary in this topic include: legend, canyon, butte, fault, gneiss, sedimentary, metamorphic, weathering, and erosion.

Students will also practice the important literacy skill of “closely reading” a text. They will carefully read the text and study the illustrations to gain a better understanding of the topic. They will practice the math standards 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 role of erosion by water, ice, wind, or vegetation.

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

5-ESS3-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
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 these 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 SEPs 3 and SEPs 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 throughout the topic. Some vocabulary in this topic include: legacy, 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.

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 sponge (30)
- Mineral samples (1 large bag)
- Hand lens (15)
- Magnifier (15)
- Nal (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.

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.
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 SLP9 and SLP10 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 throughout 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 of Close-reading 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 MP5 by using tools to test how a rock can wear away.

Next Generation Science Standards

4-ESS2-1 Make observations and measurements to provide evidence of the effects of weathering or the rain cycle on land by water, ice, wind, or vegetation.

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

5-ESS3-1 Design a simple design project reflecting a need or a want in the environment for success and constraints on materials, time, or cost.

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)
- Lime 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)
- Magnets (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

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.

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.

The Essential Question

How can you use maps to understand Earth's features?
**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 act 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 to understand why 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.

**Quest Path**

Using Phenomena: Quests are problem-based learning projects for students to work on throughout a topic. They help bring the topic’s content alive for students. By taking 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 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 4-ESS3-1.
- In the Check-In 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 4-ESS3-1.
- 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 4-ESS3 when constructing their presentation.

**Quest Check-In 1**

Lesson 1

Learn how to read different kinds of maps.

Find out how understanding the use of maps will help you locate the buried treasure.

**Quest Check-In 2**

Lesson 2

Learn about the patterns of some landforms, where they are, and how they are made.

**Quest Check-In 3**

Lesson 3

Discover how rocks, minerals, and soil help to shape Earth’s landforms under the surface and how you discovered the treasure.

**Quest Check-In 4**

Lesson 4

Learn how the effects of weathering and erosion shape landscapes. Learn how these processes can help you find the treasure.

**Quest Findings**

The students take notes about maps, models, and Earth’s features to help design their treasure map, build handouts, and prepared for their presentation.

**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 different landforms.

152 Topic 4 Earth’s Features

**Quest Kickoff** 153
Does X Mark the Spot? That’s Up to You!

How can we use Earth processes to find buried treasure?

Using Phenomena: Students are introduced to the theme of earth processes and change over time. They will learn how geologists use evidence to map and analyze processes that have formed Earth's features. Students will also learn how to use maps to identify features, such as valleys and ridges, that may indicate the presence of hidden treasures. They will then be asked to work with partners to identify features and find buried treasure.

Focus on Mastery!

Analyzing and Interpreting Data: Throughout the Quest, students will use models and evidence to help them explore how Earth's features form and change over time. The models will be used to help students understand how features form and change. Students will then be asked to use evidence to make predictions and test their hypotheses.

Quest Path

Using Phenomena: Quests are problem-based learning projects for students to work on throughout a topic. They help bring the content into context 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 the particular science topic. Quests also provide the opportunity to demonstrate mastery of performance expectations (PDEs), 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 Lab 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 land features and how they form.
- In the Check-In Lab 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 SEPs.
- 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 SEPs.
- 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 SEPs when constructing their presentation.

Quest Kickoff

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

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Using Phenomena: Students are introduced to the theme of earth processes and change over time. They will learn how geologists use evidence to map and analyze processes that have formed Earth's features. Students will also learn how to use maps to identify features, such as valleys and ridges, that may indicate the presence of hidden treasures. They will then be asked to work with partners to identify features and find buried treasure.

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- 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 SEPs.
- 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 SEPs.
- 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 SEPs when constructing their presentation.
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 examples and keep them handy as they work through the Quest.

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.

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 (CCGs) 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 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 SEP3.
- In the Check-In for Lesson 4, students explore the processes of weathering and erosion as new landforms. Understanding these processes will help students find the treasure as they practice 4-ESS2-2 and SEP3.
- 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 SEP3 when constructing their presentation.
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 treasures 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

- 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).

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- 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 4, students apply their understanding of rocks, minerals, and soil to discover how they compose Earth’s landforms, practicing 4-ESS2-1 and SEP3.
- 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-ESS2-2 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.

Quest Kickoff

Video

What it is: Video, short answer prompts, and interactive screens

What it does: Connects the topic career, a geologist, to the Quest 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.

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

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 act 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

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 different landforms.

**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 (CCs) 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.
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- 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 SEP3 when constructing their presentation.

**Quest Kickoff**

Have students complete the Quest Kickoff digital activity.

What it does: Connects the topic, career, a geologist, to the Quest and project 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.
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- Other scientists’ studies
- Observation and study of landmark examples
- Models of landforms
- Maps from different time periods

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

**Quest Path**

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**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.

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

Using Phenomena: Students are introduced to the topic Quest by reading a letter from Saliena Patrick, a geologist. The letter explains the problem-based learning project students will work on throughout the Quest. The act 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.

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:

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**Quest Path**

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

How can we use Earth processes to find buried treasure?

**Using Phenomena:** Students are introduced to the topic Quest by reading a letter from Salena Furr, a geologist. The letter explains the problem-based learning project students will work on throughout the Quest. The story 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 can tectonics and analyze data to interpret the 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:
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152 Topic 4 Earth’s Features
QUEST connections in each lesson of each chapter:

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. Here 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.
QUEST connections in each lesson of each chapter:

Physical Weathering

Physical weathering happens when wind, water, ice, or plants cause rock to change or break. The force of these agents causes rock to wear away or break into smaller pieces. As the wind blows, small particles of sand and dust erode mountains and the rock, carrying and depositing them. Some plant roots can grow inside rock, breaking the rock or cracking it. Thawing water causes rocks to shift 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 weathering occurs is the force of eroding glaciers. Glaciers grind down rock as they move and travel.

Science Practice Toolbox

Ask Questions: What questions would you ask if you were trying to interpret the physical weathering of an important monument?

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 erosive water that moved the rock to a crack.

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 break 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. Here 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.

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.
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

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.

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.

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.

How do you gain by using both together?

Synthesize

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.

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.
Differentiation and Diverse Student Support

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?

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Differentiated Instruction
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SYNTHESIZE
INTERACTIVITY
Have students complete the Synthesis Activity.
What it is: Real-world scenario-based interactives 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 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

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.

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 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 are used in 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
Have students complete the Synthesize Activity.
What it is: Real-world skill-based activities 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 screen to explore the features of various types of maps.

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 Golden Gate Bridge. Explain why this map would help with this task. DOK 2 (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? DOK 2 (The topographic map shows the elevation of different land features in the area, while the local attractions map shows the main 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. DOK 3 (Answers will vary, but students will consider whether their community has many attractions or varies in 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

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.

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 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 different 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.

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

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

SYNTHESIZE

INTERACTIVITY

Have students complete the Synthesizing 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.

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Focus on Mastery!

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Teach with Visuals

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

**Differentiation and Diverse Student Support**

**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**
- These maps are all maps of San Francisco. Each map shows different information. Look at each map and see what information it includes.
- The street map shows the land surface of San Francisco. Areas that are closer together show steeper land features. Areas that are farther apart show flatter land. The map shows 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.

**Topographic Map**
- The topographic map shows the land surface of San Francisco. Areas that are closer together show steeper land features. Areas that are farther apart show flatter land. The map shows 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.

**Local Attractions Map**
- The local attractions map shows tourist sites in San Francisco. Areas that are closer together show tourist sites that are close to each other. Areas that are farther apart show tourist sites that are farther apart. The map shows 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.

**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 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 talk about the city and state represented in the visual.

**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**

**Have students complete the Synthesis Activity.**

**What it is** A real-world scenario-based activity 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.

**DOK 1** (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?

**DOK 2** (The topographic map shows the elevation of different land features in the area. The local attractions map shows the map-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 most used by the people in your community? Explain your reasoning.

**DOK 3** (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

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!
Analysing and Interpreting Data Explain that maps are designed 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 an area.
- City tour guides would use street 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
The map shows the lands and streets of San Francisco on an inset map. Continue lines that are drawn together show water land.

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

Topographic Map
The map shows the land surface of San Francisco using contour lines. Continue lines that are drawn together show naked land.

Sample answer: In the 1940s, an H-shaped road called the Bay Bridge was built to connect the city to the peninsula.

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

Sample answer: a baseball park, Fisherman's Wharf, the Golden Gate Bridge, and a zoo.

SYNTHESIZE

INTERACTIVITY
Have students complete the Synthesize Activity.
What it is: Real-world scenario-based activities 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 made-up 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 varies in 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

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 street 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.

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 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

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.
Keep in mind the “Five NGSS Innovations” when creating/adopting NGSS-designed Instructional Materials, and your classes will look like this....
Keep in mind the “Five NGSS Innovations” when creating/adopting NGSS-designed Instructional Materials, and your classes will look like this….

and not…..