Clarifying Science through Natural Events

High School Alignment Document
Next Generation Science Standards, Common Core State Standards, and 21st Century Skills

WHAT STUDENTS DO: Determine the threats and/or benefits of a natural event/hazard.

Natural events (hurricanes, tsunamis, floods, earthquakes, volcanoes, forest fires, comets and asteroids, etc) provide engaging inquiry themes for learning science, technology, math, geography, and problem solving – and in the process students can examine their fears in the light of scientific knowledge. Students study a type of natural event, learn why it occurs, where the probable locations of occurrence are, what causes damage, what conditions create especially destructive events, and what the probability of a destructive event is. It is important that students spend some time thinking about possible ways to reduce the negative impact of damaging natural events to reduce fear and increase empowerment.

NGSS CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES
How do Earth's surface processes and human activities affect each other? *NGSS Core Idea ESS3: Earth and Human Activity* **What is the universe, and what is Earth's place in it?** *NGSS Core Idea ESS1: Earth's Place in the Universe* **How can one explain and predict interactions between objects and within systems of objects?** *NGSS Core Idea PS2: Motion and Stability: Forces and Interactions* **How do engineers solve problems?** *NGSS Core Idea ETS1: Engineering Design*	*Students will be able to* **IO1:** **Use a model to explain a natural event or hazard and their impacts on the stability of the environment and populations** **IO2:** **Investigate and describe viable**

Last edited: October 1, 2014

How do natural hazards affect individuals and societies?

NGSS Core Idea ESS3.B: Natural Hazards

What are the predictable patterns in the solar system?

NGSS Core Idea ESS1.B: Earth and the Solar System

What underlying forces explain the variety of interactions observed?

NGSS Core Idea PS2.B: Types of Interactions

What is the process for developing potential design solutions?

NGSS Core Idea ETS1.B: Developing Possible Solutions

methods to minimize impacts and maximize benefits of natural events

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1.0 About This Activity

Mars lessons leverage *A Taxonomy for Learning, Teaching, and Assessing* by Anderson and Krathwohl (2001) (see *Section 4* and *Teacher Guide* at the end of this document). This taxonomy provides a framework to help organize and align learning objectives, activities, and assessments. The taxonomy has two dimensions. The first dimension, cognitive process, provides categories for classifying lesson objectives along a continuum, at increasingly higher levels of thinking; these verbs allow educators to align their instructional objectives and assessments of learning outcomes to an appropriate level in the framework in order to build and support student cognitive processes. The second dimension, knowledge, allows educators to place objectives along a scale from concrete to abstract. By employing Anderson and Krathwohl's (2001) taxonomy, educators can better understand the construction of instructional objectives and learning outcomes in terms of the types of student knowledge and cognitive processes they intend to support. All activities provide a mapping to this taxonomy in the Teacher Guide (at the end of this lesson), which carries additional educator resources. Combined with the aforementioned taxonomy, the lesson design also draws upon Miller, Linn, and Gronlund's (2009) methods for (a) constructing a general, overarching, instructional objective with specific, supporting, and measurable learning outcomes that help assure the instructional objective is met, and (b) appropriately assessing student performance in the intended learning-outcome areas through rubrics and other measures. Construction of rubrics also draws upon Lanz's (2004) guidance, designed to measure science achievement.

How Students Learn: Science in the Classroom (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students' grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students' prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students' own formative assessment, as well as for educators' diagnosis of areas of confusion and differentiation of further instruction. This five-part sequence is the organizing tool for the Imagine Mars instructional series. The 5E stages can be cyclical and iterative.

2.0 Instructional Objectives, Learning Outcomes, & Standards

Instructional objectives and learning outcomes are aligned with

- National Research Council's, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- Achieve Inc.'s, *Next Generation Science Standards (NGSS)*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)'s, *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and* Technical Subjects
- Partnership for 21st Century Skills, *A Framework for 21st Century Learning*

The following chart provides details on alignment among the core and component NGSS questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NGSS Framework and NGSS.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics** (see Teacher Guide at the end of this lesson).

Quick View of Standards Alignment:

The Teacher Guide at the end of this lesson provides full details of standards alignment, rubrics, and the way in which instructional objectives, learning outcomes, 5E activity procedures, and assessments were derived through, and align with, Anderson and Krathwohl's (2001) taxonomy of knowledge and cognitive process types. For convenience, a quick view follows:

How do Earth's surface processes and human activities affect each other?
NGSS Core Idea ESS3: Earth and Human Activity

What is the universe, and what is Earth's place in it?
NGSS Core Idea ESS1: Earth's Place in the Universe

How can one explain and predict interactions between objects and within systems of objects?
NGSS Core Idea PS2: Motion and Stability: Forces and Interactions

How do engineers solve problems?
NGSS Core Idea ETS1: Engineering Design

How do natural hazards affect individuals and societies?
NGSS Core Idea ESS3.B: Natural Hazards

What are the predictable patterns in the solar system?
NGSS Core Idea ESS1.B: Earth and the Solar System

What underlying forces explain the variety of interactions observed?
NGSS Core Idea PS2.B: Types of Interactions

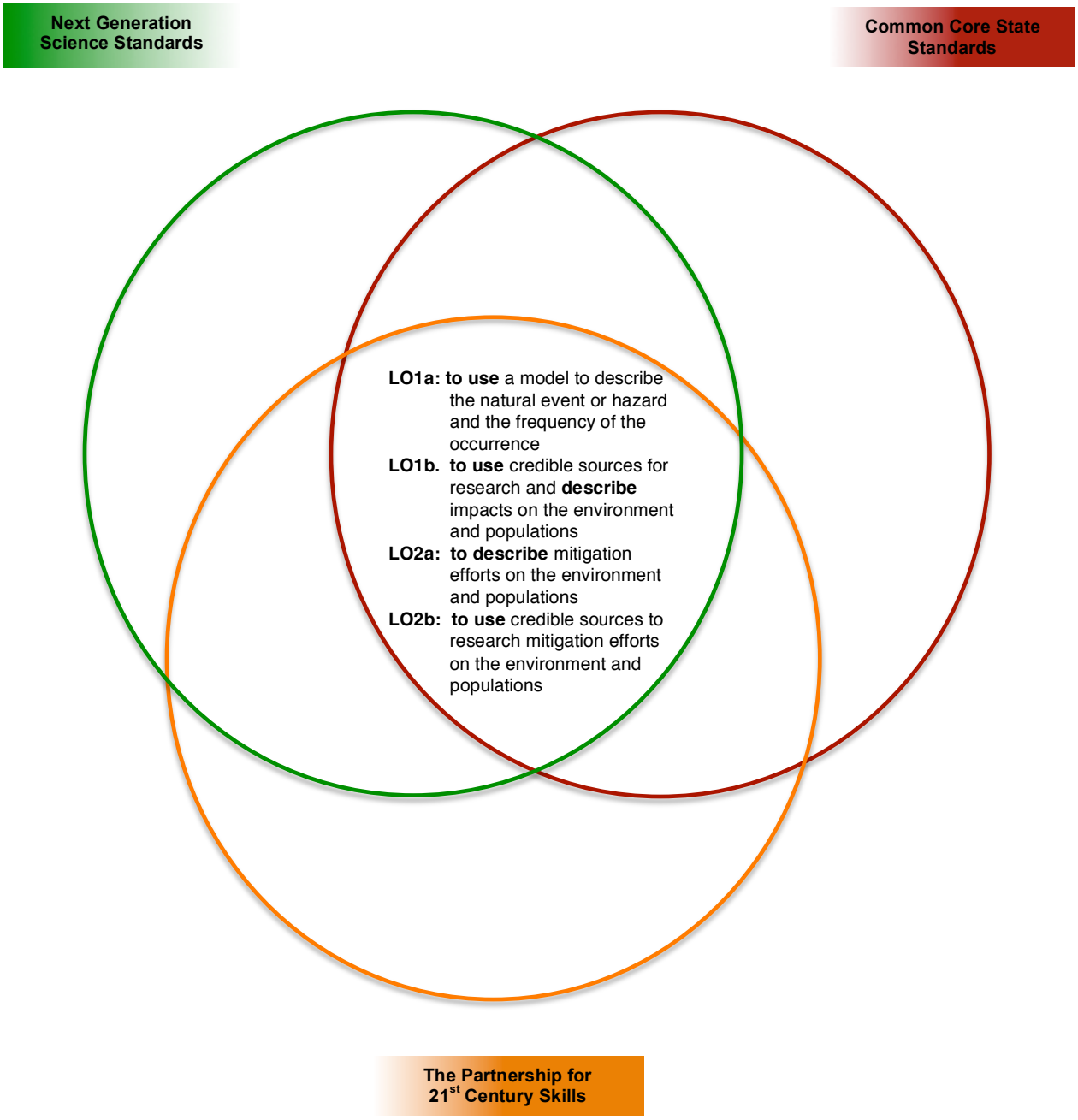
What is the process for developing potential design solutions?
NGSS Core Idea ETS1.B: Developing Possible Solutions

Instructional Objective *Students will be able*	**Learning Outcomes** *Students will demonstrate the measurable abilities*	**Standards** *Students will address*
IO1: **Use a model to explain a natural event or hazard and their impacts on the stability of the environment and populations**	**LO1a.** to use a model to describe the natural event or hazard and the frequency of the occurrence **LO1b.** to use credible sources for research and describe impacts on the environment and populations	**DISCIPLINARY CORE IDEA:** ESS3.B: Natural Hazards ESS1.B: Earth and the Solar System PS2.B: Types of Interactions **PRACTICES:** 1. Developing and Using Models 2. Constructing Explanations and Designing Solutions 3. Obtaining, Evaluating, and Communicating Information **CROSSCUTTING CONCEPTS:** 1. Patterns 2. Scale, Proportion, and Quantity 3. Cause and Effect 4. Stability and Change
IO2: **Investigate and describe viable methods to minimize impacts and maximize benefits of natural events**	**LO2a:** to describe mitigation efforts on the environment and populations **LO2b:** to use credible sources to research mitigation efforts on the environment and populations	**DISCIPLINARY CORE IDEA:** ESS3.B: Natural Hazards ESS1.B: Earth and the Solar System PS2.B: Types of Interactions EST1.B: Developing Possible Solutions **PRACTICES:** 1. Constructing Explanations and Designing Solutions 2. Obtaining, Evaluating, and Communicating Information **CROSSCUTTING CONCEPTS:** 1. Cause and Effect 2. Stability and Change

Last edited: October 1, 2014

3.0 Learning Outcomes, NGSS, Common Core, & 21st Century Skills Connections

The connections diagram is used to organize the learning outcomes addressed in the lesson to establish where each will meet the Next Generation Science Standards, ELA Common Core Standards, and the 21st Century Skills and visually determine where there are overlaps in these documents.



4.0 Evaluation/Assessment

Rubric: A rubric has been provided to assess student understanding of the simulation and to assess metacognition. A copy has been provided in the Student Guide for students to reference prior to the simulation. This rubric will allow them to understand the expectations set before them.

5.0 References

Achieve, Inc. (2013). *Next generation science standards*. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS.

Anderson, L.W., & Krathwohl (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York: Longman.

Bybee, R., Taylor, J., Gardner, A., Van Scotter, P., Carson Powell, J., Westbrook, A., Landes, N. (2006) *The BSCS 5E instructional model: origins, effectiveness, and applications.* Colorado Springs: BSCS.

Donovan, S. & Bransford, J. D. (2005). *How Students Learn: History, Mathematics, and Science in the Classroom.* Washington, DC: The National Academies Press.

Miller, Linn, & Gronlund. (2009). *Measurement and assessment in teaching*. Upper Saddle River, NJ: Pearson.

National Academies Press. (1996, January 1). *National science education standards*. Retrieved February 7, 2011 from http://www.nap.edu/catalog.php?record_id=4962

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: Authors.

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

The Partnership for 21st Century Skills (2011). *A framework for 21st century learning.* Retrieved March 15, 2012 from http://www.p21.org

(L) Teacher Resource. Clarifying Science through Natural Events NGSS Alignment (1 of 3)

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

Related Standard(s)

This lesson supports the preparation of students toward achieving Performance Expectations using the Practices, Cross-Cutting Concepts and Disciplinary Core Ideas defined below:

(HS-ESS3-1), (HS-ESS1-4), (HS-PS2-4), (HS-ETS1-3)

Next Generation Science Standards Alignment (NGSS)

Instructional Objective	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
IO1: **Use a model to explain a natural event or hazard and their impacts on the stability of the environment and populations**	**Developing and Using Models:** 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. **Constructing Explanations and Designing Solutions:** Construct and revise 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. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**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. (HS-ESS3-1) **ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) **PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)	**Stability and Change**: Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability.

IO2: **Investigate and describe viable methods to minimize impacts and maximize benefits of natural events**	**Obtaining, Evaluating, and Communicating Information:** Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	**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. (HS-ESS3-1) **ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) **PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	**Stability and Change**: Feedback (negative or positive) can stabilize or destabilize a system. Systems can be designed for greater or lesser stability.

(L) Teacher Resource. Clarifying Science through Natural Events NGSS Alignment (2 of 3)

Next Generation Science Standards Alignment (NGSS)

Learning Outcomes	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
LO1a: to use a model to describe the natural event or hazard and the frequency of the occurrence	**Developing and Using Models:** 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. **Constructing Explanations and Designing Solutions:** Construct and revise 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. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**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. (HS-ESS3-1) **ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) **PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)	**Patterns:** Mathematical representations are needed to identify some patterns. Empirical evidence is needed to identify patterns. **Scale, Proportion, and Quantity:** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
LO1b: to use credible sources for research and describe impacts on the environment and populations	**Obtaining, Evaluating, and Communicating Information:** Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.	**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. (HS-ESS3-1) **ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	**Cause and Effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Changes in systems may have various causes that may not have equal effects.

	Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). **Constructing Explanations and Designing Solutions:** Construct and revise 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. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	(HS-ESS1-4) **PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4)	
LO2a: **to describe mitigation efforts on the environment and populations**	**Constructing Explanations and Designing Solutions:** Construct and revise 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. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**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. (HS-ESS3-1) **ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) **PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take	**Cause and Effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Changes in systems may have various causes that may not have equal effects.

		into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	
LO2b: **to use credible sources to research mitigation efforts on the environment and populations**	**Obtaining, Evaluating, and Communicating Information:** Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**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. (HS-ESS3-1) **ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) **PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	**Cause and Effect:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Changes in systems may have various causes that may not have equal effects.

(M) Teacher Resource. Clarifying Science through Natural Events CCSS Alignment (1 of 3)

Common Core State Standards			
Instructional Objective	**Reading Standards for Literacy in Science and Technical Subjects**	**Writing Standards for Literacy in Science and Technical Subjects**	**Speaking and Listening Standards**
IO1: **Use a model to explain a natural event or hazard and their impacts on the stability of the environment and populations** **IO2:** **Investigate and describe viable methods to minimize impacts and maximize benefits of natural events**	**Key Ideas and Details:** **Grade 9-10:** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **Grade 11-12:** 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. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **Craft and Structure:** **Grade 9-10:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics. **Grade 11-12:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and	**Text Types and Purposes:** **Grade 9-10:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).	**Comprehension and Collaboration:** **Grade 9-10:** Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source. **Grade 11-12:** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

	topics. **Integration of Knowledge and Ideas:** **Grade 9-10:** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **Grade 11-12:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.	**Grade 11-12:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). **Production and Distribution:** **Grade 9-10:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **Grade 11-12:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

		Research to Build and Present Knowledge: **Grades 9-10:** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. Draw evidence from informational texts to support analysis, reflection, and research. **Grades 11-12:** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. Draw evidence from informational texts to support analysis, reflection, and research.	

(M) Teacher Resource. Clarifying Science through Natural Events CCSS Alignment (2 of 3)

Common Core State Standards

Learning Outcome	Reading Standards for Literacy in Science and Technical Subjects (6-8)	Writing Standards for Literacy in Science and Technical Subjects (6-8)	Speaking and Listening Standards (6-8)
LO1a: to use a model to describe the natural event or hazard and the frequency of the occurrence **LO2a:** to describe mitigation efforts on the environment and populations	**Key Ideas and Details:** **Grade 9-10:** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **Grade 11-12:** 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. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **Craft and Structure:** **Grade 9-10:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics. **Grade 11-12:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.	**Text Types and Purposes:** **Grade 9-10:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).	**Comprehension and Collaboration:** **Grade 9-10:** Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source. **Grade 11-12:** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

	Integration of Knowledge and Ideas: **Grade 9-10:** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **Grade 11-12:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.	**Grade 11-12:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). **Production and Distribution:** **Grade 9-10:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **Grade 11-12:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

		Research to Build and Present Knowledge: **Grades 9-10:** Draw evidence from informational texts to support analysis, reflection, and research. **Grades 11-12:** Draw evidence from informational texts to support analysis, reflection, and research.	
LO1b: **to use credible sources for research and describe impacts on the environment and populations** **LO2b:** **to use credible sources to research mitigation efforts on the environment and populations**	**Key Ideas and Details:** **Grade 9-10:** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **Grade 11-12:** 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. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. **Craft and Structure:** **Grade 9-10:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics. **Grade 11-12:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.	**Text Types and Purposes:** **Grade 9-10:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).	**Comprehension and Collaboration:** **Grade 9-10:** Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source. **Grade 11-12:** Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

	Integration of Knowledge and Ideas: **Grade 9-10:** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. **Grade 11-12:** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.	**Grade 11-12:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. • Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic). **Production and Distribution:** **Grade 9-10:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. **Grade 11-12:** Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	

		Research to Build and Present Knowledge: **Grades 9-10:** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. Draw evidence from informational texts to support analysis, reflection, and research. **Grades 11-12:** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. Draw evidence from informational texts to support analysis, reflection, and research.	

(M) Teacher Resource. Clarifying Science through Natural Events CCSS Alignment (3 of 3)

21st Century Skills

Learning Outcomes	21st Century Skill	Grade 12 Benchmark
LO1a: to use a model to describe the natural event or hazard and the frequency of the occurrence	**Communication**	Students model the practices of research science by informing others about their work, developing effective explanations, constructing and defending reasoned arguments, and responding appropriately to critical comments about their explanations.
	Flexibility and Adaptability	Students are able to revise their own scientific ideas and hypotheses based on new evidence or information. Students are able to successfully apply their scientific knowledge and scientific reasoning skills to a variety of situations and new areas of study.
LO1b: to use credible sources for research and describe impacts on the environment and populations	**Communication**	Students model the practices of research science by informing others about their work, developing effective explanations, constructing and defending reasoned arguments, and responding appropriately to critical comments about their explanations.
LO2a: to describe mitigation efforts on the environment and populations	**Flexibility and Adaptability**	Students are able to revise their own scientific ideas and hypotheses based on new evidence or information. Students are able to successfully apply their scientific knowledge and scientific reasoning skills to a variety of situations and new areas of study.
	Productivity and Accountability	Students can describe and provide examples of how people may be impacted positively or negatively by the outcomes of scientific studies, technical developments, and scientific approaches applied to real world problems.
LO2b: to use credible sources to research mitigation efforts on the environment and populations		

(O) Teacher Resource. Clarifying Science through Natural Events NGSS Rubric (1 of 3)

Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

Next Generation Science Standards Alignment (NGSS)

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a: to use a model to describe the natural event or hazard and the frequency of the occurrence	Description of the event or hazard is covered accurately and fully, using evidence from the model. Student fully and accurately addressees the frequency of the event and or the ability to predict.	Description of the event or hazard is adequate, using evidence from the model. Student correctly addressees the frequency of the event and or the ability to predict.	Description of the event or hazard uses some evidence from the model and some prior misconception. Student discusses the frequency of the event and or the ability to predict.	Description of the event and frequency is based on and supported by evidence of prior misconceptions.
LO1b: to use credible sources for research and **describe** impacts on the environment and populations	Resources for research are from many credible, primary sources (such as journal publications and .gov sites) and avoiding .com sites, blogs, and secondary sources of information (such as news sites). Description of the impacts is covered accurately and fully, using evidence from the research.	Resources for research are mostly from credible, primary sources (such as journal publications and .gov sites) and only using one .com site, blog, or secondary source of information (such as news sites). Description of the impacts is covered accurately and fully, using evidence from the research.	Some resources for research are credible, primary sources (such as journal publications and .gov sites), but a few are from .com sites, blogs, or secondary source of information (such as news sites). Description of the impacts is discussed, using evidence from the research.	Majority or all of resources are from secondary sources. Impacts are discussed and may be based on prior misconceptions.
LO2a: to describe mitigation efforts on the environment and populations	Description of the mitigation effort is covered accurately and fully, using evidence from the research.	Description of the mitigation effort is adequate, using evidence from the research	Description of the mitigation effort uses some evidence from the research and some prior misconception.	Description of the mitigation effort is based on and supported by evidence of prior misconceptions.

LO2b: to use credible sources to research mitigation efforts on the environment and populations	Resources for research are from many credible, primary sources (such as journal publications and .gov sites) and avoiding .com sites, blogs, and secondary sources of information (such as news sites).	Resources for research are mostly from credible, primary sources (such as journal publications and .gov sites) and only using one .com site, blog, or secondary source of information (such as news sites).	Some resources for research are credible, primary sources (such as journal publications and .gov sites), but a few are from .com sites, blogs, or secondary source of information (such as news sites).	Majority or all of resources are from secondary sources.

(P) Teacher Resource. Clarifying Science through Natural Events CCSS Rubric (2 of 3)

Common Core State Standards

	Expert	Proficient	Intermediate	Beginner
Research to Build and Present Knowledge	Recalls relevant information from experience; summarizes information in finished work; draws evidence from informational texts to support analysis, reflection, and research.	Recalls relevant information from experience; draws evidence from informational texts to support analysis, reflection, and research.	Recalls information from experience; draws evidence from informational texts to support analysis, reflection, and research.	Recalls information from experience.
Effective Demonstration of Comprehension and Collaboration and Production and Distribution	Uses a variety of media formats and accurately applies them to clearly describe the natural event or hazard and mitigation efforts.	Uses a variety of media formats and applies them to describe the natural event or hazard and mitigation efforts.	Uses one media format and applies it to describe the natural event or hazard and mitigation efforts.	Attempts to describe the natural event/hazard, and/or mitigation efforts without the use of media.
Text Types and Purpose	Introduces topic clearly, provides a general observation and focus, and groups related information logically; Develops the topic with facts, definitions, concrete details, or other examples related to the topic; Links ideas using words, phrases, and clauses; Use domain-specific vocabulary to explain the topic; Provides a concluding statement related to the explanation.	Introduces topic clearly, provides a general observation, or groups related information logically; Develops the topic with concrete details, or other examples related to the topic; Links ideas using words or phrases; Uses domain-specific vocabulary to explain the topic; Provides a concluding statement related to the explanation.	Introduces topic, provides a general observation; Develops the topic with details, or other examples related to the topic; Links ideas using words or phrases; Uses domain-specific vocabulary to explain the topic; May or may not provide a concluding statement.	Introduces topic; Develops the topic with details, or other examples, potentially unrelated; Uses specific vocabulary to explain the topic; May or may not provide a concluding statement.
Key Ideas and Details	Uses specific evidence from text to support ideas. Develops an accurate and in depth summary, extending prior understanding and opinions.	Uses specific evidence from text to support ideas. Develops an in depth summary, extending prior understanding and opinions.	Uses information from text to support ideas. Develops a summary, extending prior understanding and opinions.	Supports ideas with details, relying on prior understanding and opinions.

Craft and Structure	Develops strong, accurate vocabulary through research and mitigation efforts.	Develops strong, vocabulary through research and mitigation efforts.	Develops vocabulary through research and mitigation efforts.	Vocabulary is rudimentary and based on prior understanding.
Integration of Knowledge	Successfully combines information from lesson with resources to develop a deep understanding of the topic.	Successfully combines information from lesson with resources to develop an understanding of topic.	Combines information from lesson with resources to develop a summary of topic.	References text from resources to develop a summary of topic.

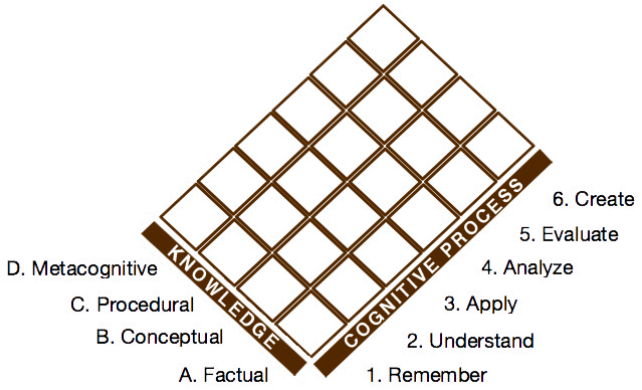
(Q) Teacher Resource. Clarifying Science through Natural Events 21st Century Skills Rubric (3 of 3)

Partnership for 21st Century Skills

	Expert	Proficient	Intermediate	Beginner
Effectiveness of Communication	Successfully uses a variety of techniques to describe and predict real-world phenomena to others.	Successfully uses a technique to describe and predict real-world phenomena to others.	Uses a technique to attempt a description of real-world phenomena to others	Uses prior misconceptions to describe real-world phenomena.
Effectiveness of Productivity and Accountability	Chooses an appropriate mitigation effort through deep evaluation of positive and negative outcomes and fully and accurately describes these potential outcomes.	Chooses an appropriate mitigation effort through evaluation of positive and negative outcomes and describes these potential outcomes.	Chooses an appropriate mitigation effort through evaluation of positive and negative outcomes and provides a brief description of these potential outcomes.	Chooses a mitigation technique indiscriminately.
Effectiveness of Flexibility and Adaptability	Successfully corrects thinking on natural events and hazards using a variety of evidence and uses that information to choose an appropriate mitigation effort.	Successfully corrects majority of thinking on natural events and hazards using a variety of evidence and uses that information to choose an appropriate mitigation effort.	Primarily uses evidence on natural events and hazards to correct thinking with a few beliefs embedded and uses that information to choose an appropriate mitigation effort.	Uses beliefs on natural events and hazards to choose a mitigation effort.

(R) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)

This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.



Knowledge	Cognitive Process
A. Factual **Aa:** Knowledge of Terminology **Ab:** Knowledge of Specific Details & Elements **B. Conceptual** **Ba:** Knowledge of classifications and categories **Bb:** Knowledge of principles and generalizations **Bc:** Knowledge of theories, models, and structures **C. Procedural** **Ca:** Knowledge of subject-specific skills and algorithms **Cb:** Knowledge of subject-specific techniques and methods **Cc:** Knowledge of criteria for determining when to use appropriate procedures **D. Metacognitive** **Da:** Strategic Knowledge **Db:** Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge **Dc:** Self-knowledge	**1. Remember** **1.1** Recognizing (Identifying) **1.2** Recalling (Retrieving) **2. Understand** **2.1** Interpreting (Clarifying, Paraphrasing, Representing, Translating) **2.2** Exemplifying (Illustrating, Instantiating) **2.3** Classifying (Categorizing, Subsuming) **2.4** Summarizing (Abstracting, Generalizing) **2.5** Inferring (Concluding, Extrapolating, Interpolating, Predicting) **2.6** Comparing (Contrasting, Mapping, Matching) **2.7** Explaining (Constructing models) **3. Apply** **3.1** Executing (Carrying out) **3.2** Implementing (Using) **4. Analyze** **4.1** Differentiating (Discriminating, distinguishing, focusing, selecting) **4.2** Organizing (Finding coherence, integrating, outlining, parsing, structuring) **4.3** Attributing (Deconstructing) **5. Evaluate** **5.1** Checking (Coordinating, Detecting, Monitoring, Testing) **5.2** Critiquing (Judging) **6. Create** **6.1** Generating (Hypothesizing) **6.2** Planning (Designing) **6.3** Producing (Constructing)

(R) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (2 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Pedagogically, it is important to ensure that objectives and outcomes are written to match the knowledge and cognitive process students are intended to acquire.

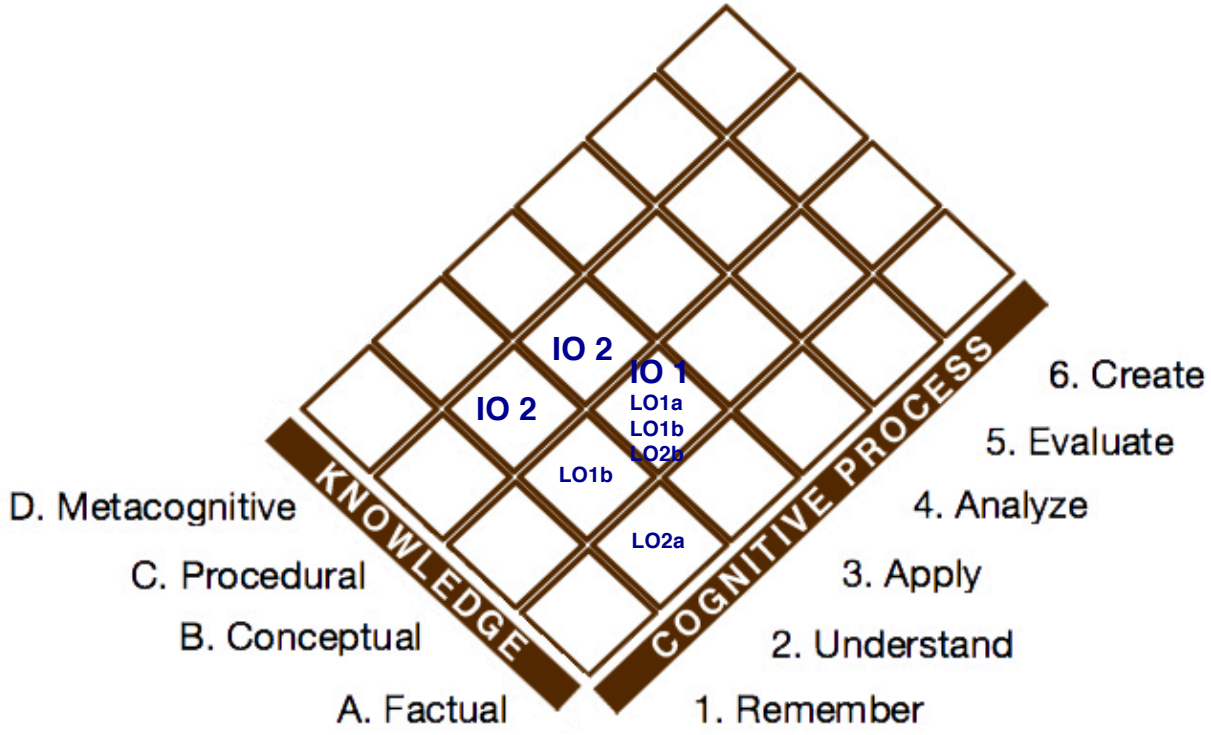
IO1: Use a model to explain a natural event or hazard and their impacts on the stability of the environment and populations (3.2; Bc)
IO2: Investigate and describe viable methods to minimize impacts and maximize benefits of natural events (3.1 & 2.4; Cc)

LO1a. to use a model to describe the natural event or hazard and the frequency of the occurrence (3.2; Bc)

LO1b. to use credible sources for research and **describe** impacts on the environment and populations (3.2 & 2.4; Bc)

LO2a. to describe mitigation efforts on the environment and populations (2.4; Ab)

LO2b. to use credible sources to research mitigation efforts on the environment and populations (3.2; Bc)



(R) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (3 of 3)

The design of this activity leverages Anderson & Krathwohl's (2001) taxonomy as a framework. Below are the knowledge and cognitive process types students are intended to acquire per the instructional objective(s) and learning outcomes written for this lesson. The specific, scaffolded 5E steps in this lesson (see Procedures) and the formative assessments (worksheets in the Student Guide and rubrics in the Teacher Guide) are written to support those objective(s) and learning outcomes. Refer to previous pages for the full list of categories in the taxonomy from which the following were selected. The prior page provides a visual description of the placement of learning outcomes that enable the overall instructional objective(s) to be met.

At the end of the lesson, students will be able

IO1: Use a model
- **3.2:** to use
- **Bc:** Knowledge of theories, models, and structures

IO2: Investigate and describe
- **3.1:** to carry out
- **2.4:** to summarize
- **Cc:** Knowledge of criteria for determining when to use appropriate procedures

To meet that instructional objective, students will demonstrate the abilities:

LO1a: to use
- 3.2: to use
- Bc: Knowledge of theories, models, and structures

LO1b: to use; to describe
- 3.2: to use
- 2.4: to summarize
- Bc: Knowledge of theories, models, and structures

LO2a: to describe
- 2.4: to summarize
- Ab: Knowledge of Specific Details & Elements

LO2b: to use
- 3.2: to use
- Bc: Knowledge of theories, models, and structures