



Mystery Planet

2nd - 5th Grade NGSS, Common Core, and 21st Century Skills Alignment Document



WHAT STUDENTS DO: Explore a Model Planet to Discover New Features

In this activity, students step into the shoes of real planetary scientists and explore crustal samples from a “Mystery” planet. Using sorting/classification, students will interpret the geologic history of a region from which a sample has been collected and make inferences about past life or the potential for life on the “Mystery” planet.

NGSS CORE & COMPONENT QUESTIONS

HOW CAN ONE EXPLAIN THE STRUCTURE, PROPERTIES, AND INTERACTIONS OF MATTER?

NGSS Core Question: PS1: Matter and It's Interactions

HOW AND WHY IS EARTH CONSTANTLY CHANGING?

NGSS Core Question: ESS2: Earth's Systems

HOW CAN THERE BE SO MANY SIMILARITIES AMONG ORGANISMS YET SO MANY DIFFERENT KINDS OF PLANTS, ANIMALS, AND MICROORGANISMS?

NGSS Core Question: LS4: Biological Evolution: Unity and Diversity

INSTRUCTIONAL OBJECTIVES

Students will be able

IO1: to model
scientific
classification
schemes through
identifying criteria
necessary to sort
and classify
materials and
relate them to the
geologic history of
a region



How do particles combine to form the variety of matter one observes?

NGSS PS1.A: Structure and Properties of Matter

How do Earth's major systems interact?

NGSS ESS2.A: Earth Materials and Systems

How do living organisms alter Earth's processes and structures?

NGSS ESS2.E: Biogeology

What evidence shows that different species are related?

NGSS LS4.A: Evidence of Common Ancestry and Diversity



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.

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. 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 CAN ONE EXPLAIN THE STRUCTURE, PROPERTIES, AND INTERACTIONS OF MATTER?

NGSS Core Question: PS1: Matter and Its Interactions

HOW AND WHY IS EARTH CONSTANTLY CHANGING?

NGSS Core Question: ESS2: Earth's Systems

HOW CAN THERE BE SO MANY SIMILARITIES AMONG ORGANISMS YET SO MANY DIFFERENT KINDS OF PLANTS, ANIMALS, AND MICROORGANISMS?

NGSS Core Question: LS4: Biological Evolution: Unity and Diversity

How do particles combine to form the variety of matter one observes?

NGSS PS1.A: Structure and Properties of Matter

How do Earth's major systems interact?

NGSS ESS2.A: Earth Materials and Systems

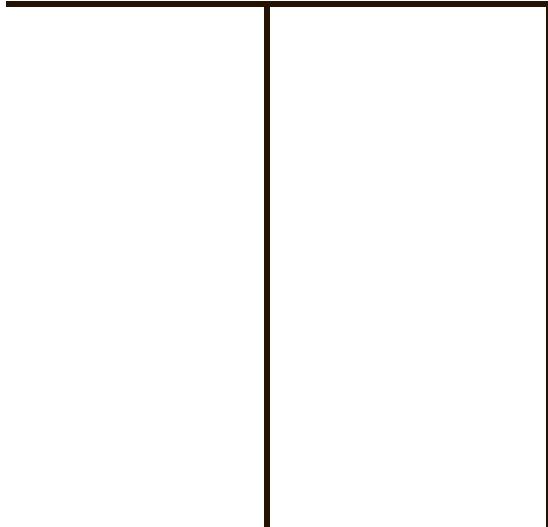
How do living organisms alter Earth's processes and structures?

NGSS ESS2.E: Biogeology

What evidence shows that different species are related?

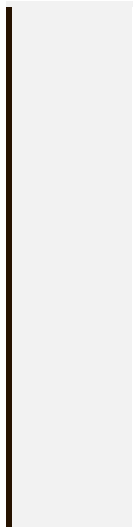
NGSS LS4.A: Evidence of Common Ancestry and Diversity

Instructional Objective <i>Students will be able</i>	Learning Outcomes <i>Students will demonstrate the measurable abilities</i>	Standards <i>Students will address</i>
<p>IO1:</p> <p>to model scientific classification schemes through identifying criteria necessary to sort and classify materials and relate them to the geologic history of a region</p>	<p>LO1a. to classify materials based on physical characteristics</p> <p>LO1b. to explain the classification scheme used</p> <p>LO1c. to explain the geologic history of the region the "mystery" planet material came from</p>	<p>NSES (B): PHYSICAL SCIENCE: Properties of Objects and Materials Grades K-4: B1a, B1b, B1c Grades 5-8: B1a</p> <p>NSES (D): EARTH AND SPACE SCIENCE: Properties of Earth Materials Grades K-4: D1a, D1b, D1c Changes in the Earth and Sky Grades K-4: D3a Structure of the Earth System Grades 5-8: D1d, D1e Earth's History Grades 5-8: D2a, D2b</p> <p>NGSS Disciplinary Core Idea: PS1.A: Structure and Properties of Matter (Grade 2; Grade 5) ESS2.A: Earth Materials and Systems (Grade 2; Grade 4; Grade 5) LS4.A: Evidence of Common Ancestry (Grade 3) ESS2.E: Biogeology (Grade 4)</p> <p>NGSS Practices: Developing and Using Models Planning and Carrying Out Investigations Analyzing and Interpreting Data Using Mathematics and Computational Thinking</p>



Constructing Explanations and Designing Solutions
Scientific Knowledge is Based on Empirical Evidence
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

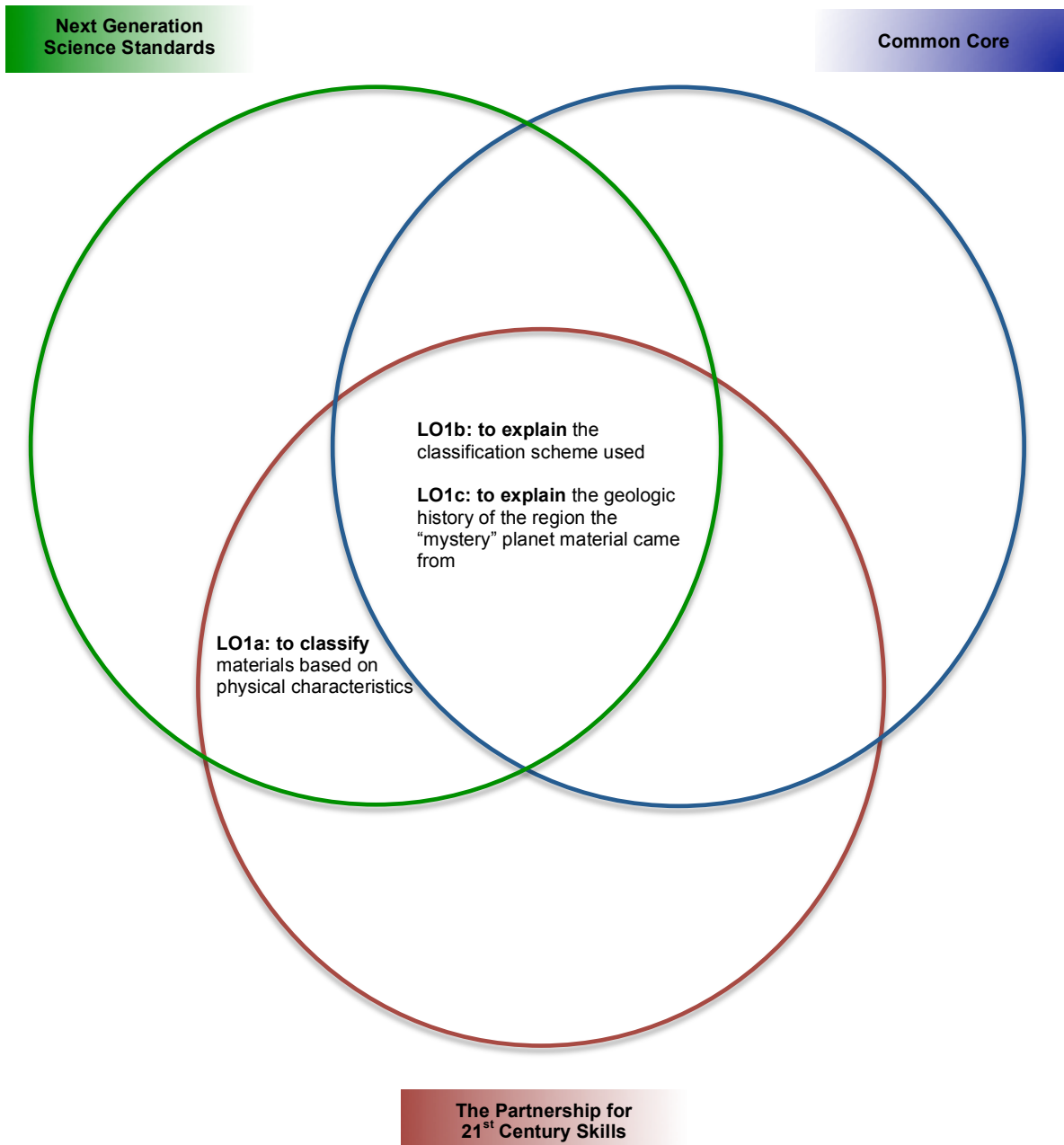
NGSS Cross-Cutting Concept:
Patterns
Scale, Proportion and Quantity
Systems and System Models
Science is a Way of Knowing
Scientific Knowledge Assumes an Order and Consistency in Natural Systems
Science Addresses Questions About the Natural and Material World





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>

Additional information about obtaining prepared "Mystery" Planet crustal material sample packets can be obtained from the author by writing, to D. Louis Finsand, Spectrum House, 1501 W. 19th St. Cedar Falls, Iowa, 50613, Phone: (319) 273-2760.

**(L) Teacher Resource. Mystery Planet Rubric (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.

Instructional Objective 1: to model scientific classification schemes through identifying criteria necessary to sort and classify materials and relate them to the geologic history of a region.

Related Standard(s)**National Science Education Standards (NSES)****(B) Physical Science: Properties of Objects and Materials**

Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers (Grades K-4: B1a).

Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made and those properties can be used to separate or sort a group of objects or materials (Grades K-4: B1b).

Materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling. (Grades K-4: B1c).

A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties (Grades 5-8: B1a).

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

- (2-PS1-1); (2-ESS2-1)
- (3-LS4-1)
- (4-ESS2-1); (4-ESS2-1)
- (5-PS1-3); (5-ESS2-1)

**Next Generation Science Standards (NGSS)****Practices: Developing and Using Models**

(Learning Outcomes Addressed: LO1a, LO1b)

- Distinguish between a model and the actual object, process, and/or events the



model represents. (Grades K-2)

- Compare models to identify common features and differences. (Grades K-2)
- Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). (Grades K-2)
- Develop and/or use models to describe and/or predict phenomena. (Grades 3-5)
- Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. (Grades 3-5)
- Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system. (Grades 3-5)



Next Generation Science Standards (NGSS)

Practices: Planning and Carrying out Investigations

(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question. (Grades K-2)
- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. (Grades K-2)
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. (Grades 3-5)



Next Generation Science Standards (NGSS)

Practices: Analyzing and Interpreting Data

(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- Record information (observations, thoughts, and ideas). (Grades K-2)
- Use and share pictures, drawings, and/or writings of observations. (Grades K-2)
- Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. (Grades K-2)
- Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. (Grades 3-5)
- Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. (Grades 3-5)
- Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings. (Grades 3-5)



Next Generation Science Standards (NGSS)
Practices: Using Mathematics and Computational Thinking

(Learning Outcomes Addressed: LO1a, LO1b)

- Decide when to use qualitative vs. quantitative data. (Grades K-2)
- Use counting and numbers to identify and describe patterns in the natural and designed world(s). (Grades K-2)
- Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs. (Grades K-2)
- Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. (Grades 3-5)
- Organize simple data sets to reveal patterns that suggest relationships. (Grades 3-5)



Next Generation Science Standards (NGSS)
Practices: Constructing Explanations and Designing Solutions

(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (Grades K-2)
- Generate and/or compare multiple solutions to a problem. (Grades K-2)
- Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). (Grades 3-5)
- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. (Grades 3-5)
- Identify the evidence that supports particular points in an explanation. (Grades 3-5)



Next Generation Science Standards (NGSS)
Practices: Scientific Knowledge is Based on Empirical Evidence

(Learning Outcomes Addressed: LO1a, LO1b)

- Scientists look for patterns and order when making observations about the world. (Grades K-2)
- Science findings are based on recognizing patterns. (Grades 3-5)
- Scientists use tools and technologies to make accurate measurements and observations. (Grades 3-5)



Next Generation Science Standards (NGSS)

**Practices: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**

(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- Scientists use drawings, sketches, and models as a way to communicate ideas. (Grades K-2)
- Scientists search for cause and effect relationships to explain natural events. (Grades K-2)
- Science explanations describe the mechanisms for natural events. (Grades 3-5)

**Next Generation Science Standards (NGSS)****Cross-Cutting Concepts: Patterns**

(Learning Outcomes Addressed: LO1a, LO1b)

- Children recognize that patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (Grades K-2)
- Students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions. (Grades 3-5)

**Next Generation Science Standards (NGSS)****Cross-Cutting Concepts: Scale, Proportion and Quantity**

(Learning Outcomes Addressed: LO1a, LO1b)

- Students use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. They use standard units to measure length. (Grades K-2)
- Students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume. (Grades 3-5)

**Next Generation Science Standards (NGSS)****Cross-Cutting Concepts: Systems and System Models**

(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- Students understand objects and organisms can be described in terms of their parts; and systems in the natural and designed world have parts that work together. (Grades K-2)



- Students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions. (Grades 3-5)



Next Generation Science Standards (NGSS)
Cross-Cutting Concepts: Science is a Way of Knowing
(Learning Outcomes Addressed: LO1b, LO1c)

- Science knowledge helps us know about the world. (Grades K-2)
- Science is both a body of knowledge and processes that add new knowledge. (Grades 3-5)
- Science is a way of knowing that is used by many people. (Grades 3-5)



Next Generation Science Standards (NGSS)
Cross-Cutting Concepts: Scientific Knowledge Assumes an Order and Consistency in Natural Systems
(Learning Outcomes Addressed: LO1b, LO1c)

- Science assumes natural events happen today as they happened in the past. (Grades K-2)
- Many events are repeated. (Grades K-2)
- Science assumes consistent patterns in natural systems. (Grades 3-5)
- Basic laws of nature are the same everywhere in the universe. (Grades 3-5)



Next Generation Science Standards (NGSS)
Cross-Cutting Concepts: Science Addresses Questions About the Natural and Material World
(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- Scientists study the natural and material world. (Grades K-2)
- Science findings are limited to what can be answered with empirical evidence. (Grades 3-5)



Next Generation Science Standards (NGSS)
Disciplinary Core Idea: PS1.A: Structure and Properties of Matter
(Learning Outcomes Addressed: LO1a, LO1b)

- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its



observable properties. (Grade 2)

- Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation. (Grade 5)



Next Generation Science Standards (NGSS)

Disciplinary Core Idea: ESS2.A: Earth Materials and Systems

(Learning Outcomes Addressed: LO1b, LO1c)

- Wind and water can change the shape of the land. (Grade 2)
- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (Grade 4)
- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (Grade 5)



Next Generation Science Standards (NGSS)

Disciplinary Core Idea: LS4.A: Evidence of Common Ancestry

(Learning Outcomes Addressed: LO1b, LO1c)

- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Grade 3)
- Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (Grade 3)



Next Generation Science Standards (NGSS)

Disciplinary Core Idea: ESS2.E: Biogeology

(Learning Outcomes Addressed: LO1b, LO1c)

- Living things affect the physical characteristics of their regions. (Grade 4)



Common Core State Standards

**Speaking and Listening Standards Grades 2 - 5:
Comprehension and Collaboration**

(Learning Outcomes Addressed: LO1b, LO1c)



- Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups. (Grade 2)
 - Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
 - Build on others' talk in conversations by linking their comments to the remarks of others.
 - Ask for clarification and further explanation as needed about the topics and texts under discussion.
- Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue. (Grade 2)

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly. (Grade 3)
 - Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
 - Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
 - Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
 - Explain their own ideas and understanding in light of the discussion.
- Ask and answer questions about information from a speaker, offering appropriate elaboration and detail. (Grade 3)

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly. (Grade 4)
 - Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
 - Follow agreed-upon rules for discussions and carry out assigned roles.
 - Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
 - Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.



- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly. (Grade 5)
 - Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
 - Follow agreed-upon rules for discussions and carry out assigned roles.
 - Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
 - Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.



21st Century Skills Creativity and Innovation

(Learning Outcomes Addressed: LO1b)

- Students are able to describe how science and engineering involve creative processes that include generating and testing ideas, making observations, and formulating explanations; and can apply these processes in their own investigations. (Grade 8 Benchmark)



21st Century Skills Critical Thinking and Problem Solving

(Learning Outcomes Addressed: LO1a, LO1b)

- Students construct their own scientific understanding and develop their scientific process skills by asking scientific questions, designing and conducting investigations, constructing explanations from their observations, and discussing their explanations with others. (Grade 4 Benchmark)



21st Century Skills Communication

(Learning Outcomes Addressed: LO1a, LO1c)

- Students understand that models are simplified representations of real objects and processes, and that models serve as a means to communicate ideas and knowledge about how things work. (Grade 4 Benchmark)



21st Century Skills Collaboration

(Learning Outcomes Addressed: LO1a, LO1b)

- Students work collaboratively with others, both in small and large groups, in their science classroom. (Grade 4 Benchmark)



- Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning. (Grade 8 Benchmark)



21st Century Skills

Social and Cross-Cultural Skills

(Learning Outcomes Addressed: LO1a, LO1b)

- Students are able to structure scientific discussions to allow for differing opinions, observations, experiences, and perspectives. (Grade 8 Benchmark)

**(L) Teacher Resource. Mystery Planet Rubric (1 of 3)****Learning Outcomes Assessment:**

	Expert	Proficient	Intermediate	Beginner
LO1a: to classify materials based on physical characteristics	Classified materials demonstrate organization and appropriate groupings.	Classified materials are well organized.	Classified materials have a reasonable classification scheme.	Classification scheme is difficult to determine.
LO1b: to explain the classification scheme used	Explanation is complex and thoughtful.	Explanation is thoughtful.	Explanation is somewhat thoughtful.	Explanation is basic.
LO1c: to explain the geologic history of the region the “mystery” planet material came from	Explanation is complex and thoughtful and uses geology concepts at a high level of understanding.	Explanation is thoughtful and uses an understanding of geology concepts.	Explanation is somewhat thoughtful and uses a basic understanding of geology concepts.	Explanation is basic and has a lack of understanding of geology concepts..

**(L) Teacher Resource. Mystery Planet Rubric (2 of 3)****Partnership for 21st Century Skills**

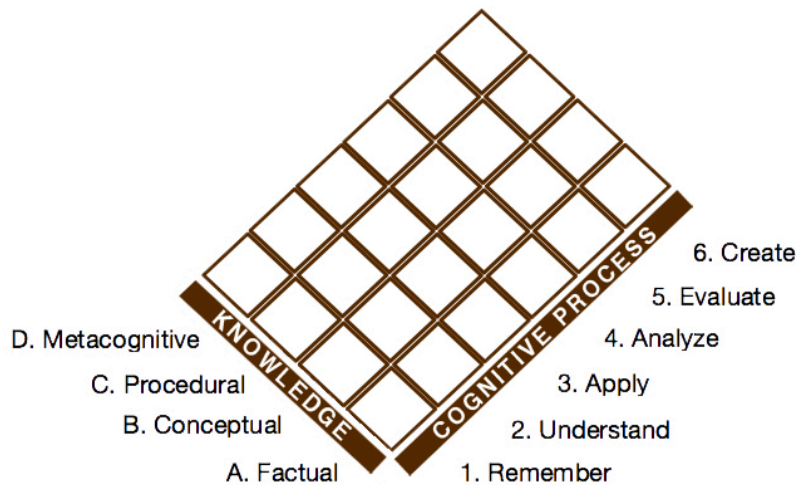
	Expert	Proficient	Intermediate	Beginner
Effectiveness of Creativity and Innovation	Model is an excellent representation of a wide variety of generating and testing of ideas to achieve equilibrium while acquiring high science return.	Model is an excellent representation of a wide variety of generating and testing of ideas to achieve equilibrium while acquiring moderate science return.	Model is a representation of a variety of generating and testing of ideas to achieve equilibrium while acquiring moderate science return.	Model is a representation of generating and testing of ideas to attempt to achieve equilibrium while acquiring at least one science return.
Effectiveness of collaboration with team members and class.	Extremely Interested in collaborating in the simulation. Actively provides solutions to problems, listens to suggestions from others, attempts to refine them, monitors group progress, and attempts to ensure everyone has a contribution.	Extremely Interested in collaborating in the simulation. Actively provides suggestions and occasionally listens to suggestions from others. Refines suggestions from others.	Interested in collaborating in the simulation. Listens to suggestions from peers and attempts to use them. Occasionally provides suggestions in group discussion.	Interested in collaborating in the simulation.
Effectiveness in communication	Communicates ideas in a clearly organized and logical manner that is consistently maintained.	Communicates ideas in an organized manner that is consistently maintained.	Communications of ideas are organized, but not consistently maintained.	Communicates ideas as they come to mind.
Effectiveness of critical thinking	Develops detailed explanations based on credible evidence. Compares explanations to those made by scientists and relates them to their own understandings of the geology.	Develops detailed explanations based on credible evidence. Relates them to their own understandings of the geology.	Develops explanations. Relates explanation to their own understandings of the geology.	Attempts to explain the geology based on own understanding of geology.

**(L) Teacher Resource. Mystery Planet Rubric (3 of 3)****Common Core – ELA**

	Expert	Proficient	Intermediate	Beginner
Effective Demonstration of Comprehension and Collaboration	Clearly articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Extremely prepared drawing from experiences. Asks clarifying questions to ensure full understanding of content. Articulates own ideas related to the discussion and connects others ideas to own.	Articulates ideas in collaborative discussion while following agreed upon class rules for discussion. Prepared for discussion by drawing from experiences. Asks questions. Articulates own ideas related to the discussion.	Interested in collaborative discussion. Asks questions. Articulates own ideas related to the discussion.	Interested in collaboration with peers.



(M) 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.

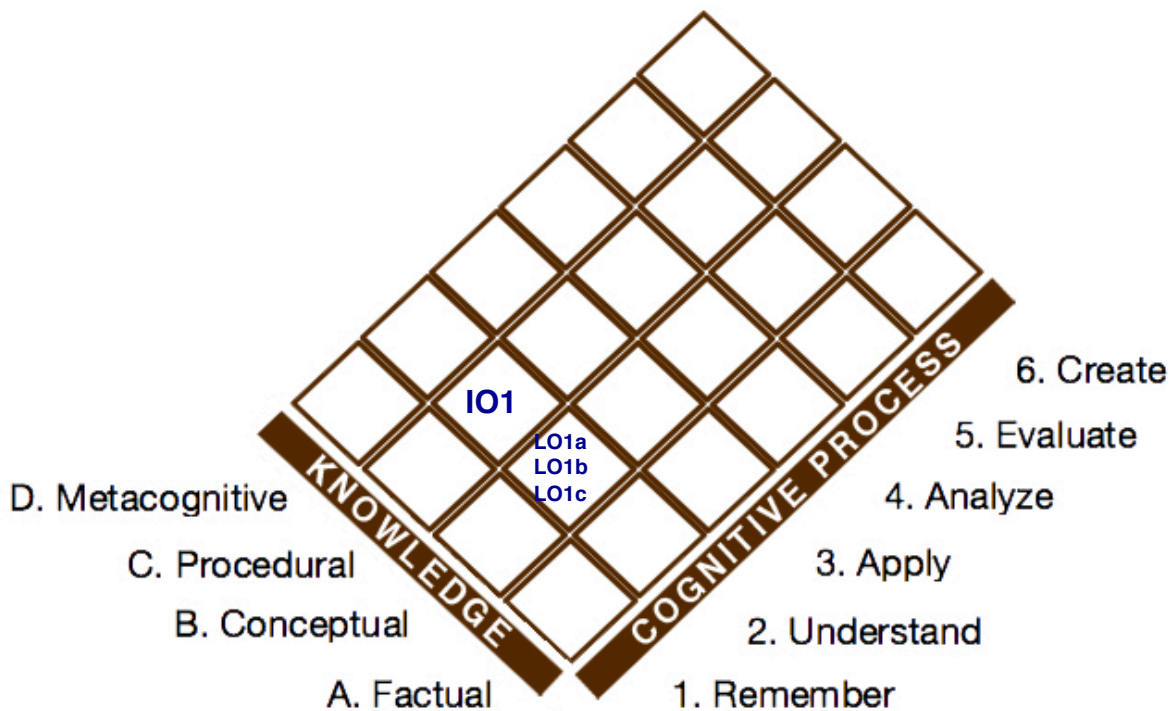
Knowledge	Cognitive Process
A. Factual Aa: Knowledge of Terminology Ab: Knowledge of Specific Details & Elements B. Conceptual Ba: Knowledge of classifications and categories Bb: Knowledge of principles and generalizations Bc: Knowledge of theories, models, and structures C. Procedural Ca: Knowledge 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)





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

- IO 1:** to model scientific classification schemes through identifying criteria necessary to sort and classify materials and relate them to the geologic history of a region (2.7; Cb)
LO1a: to classify materials based on physical characteristics (2.3; Ba)
LO1b: to explain the classification scheme used (2.7; Ba)
LO1c: to explain the geologic history of the region the “mystery” planet material came from (2.7; Bb)



**(M) 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 5.0 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 (M, 1 of 3) for the full list of categories in the taxonomy from which the following were selected. The prior page (M, 2 of 3) 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: To model scientific classification schemes through identifying criteria necessary to sort and classify materials and relate them to the geologic history of a region (2.7; Cb)

2.7: to explain

Cb: Knowledge of subject-specific techniques and methods

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

LO1a: to classify materials based on physical characteristics

2.3: to classify

Ba: knowledge of classifications and categories

LO1b: to explain the classification scheme used

2.7: to explain

Ba: knowledge of classifications and categories

LO1c: to explain the geologic history of the region the "mystery" planet material came from

2.7: to explain

Bb: knowledge of principles and generalizations