Earth, Earth's Moon, Mars Balloons
K – 4th Grade NGSS, Common Core, and 21st Century Skills Alignment Document

WHAT STUDENTS DO: Construct a planetary model.

Curiosity about our place in space and whether we can travel to distant worlds beyond our own depends upon understanding the size, distance, and other characteristics of moons and planets in our solar system. For this activity, students will construct a balloon scale model to understand the relative sizes of the Earth, Earth's Moon and Mars in relation to each other and their relative distance to each other at this scale. They will use this model to predict distances and reflect on how scientists use models to construct explanations through the scientific process. In this collection, this activity introduces the concept of models, which will be built upon in subsequent lessons, as well as the first set of Earth/Mars comparisons.

NRC CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES
WHAT IS THE UNIVERSE & WHAT IS EARTH'S PLACE IN IT? *NRC Core Question: ESS1: Earth's Place in the Universe*	*Students will be able*
What are the predictable patterns caused by Earth's movement in the solar system? *NRC ESS1.B: Earth & the Solar System*	**IO1: to model** the Earth, Earth's Moon, and Mars system

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.

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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:

WHAT IS THE UNIVERSE & WHAT IS EARTH'S PLACE IN IT?
NRC Core Question: ESS1: Earth's Place in the Universe

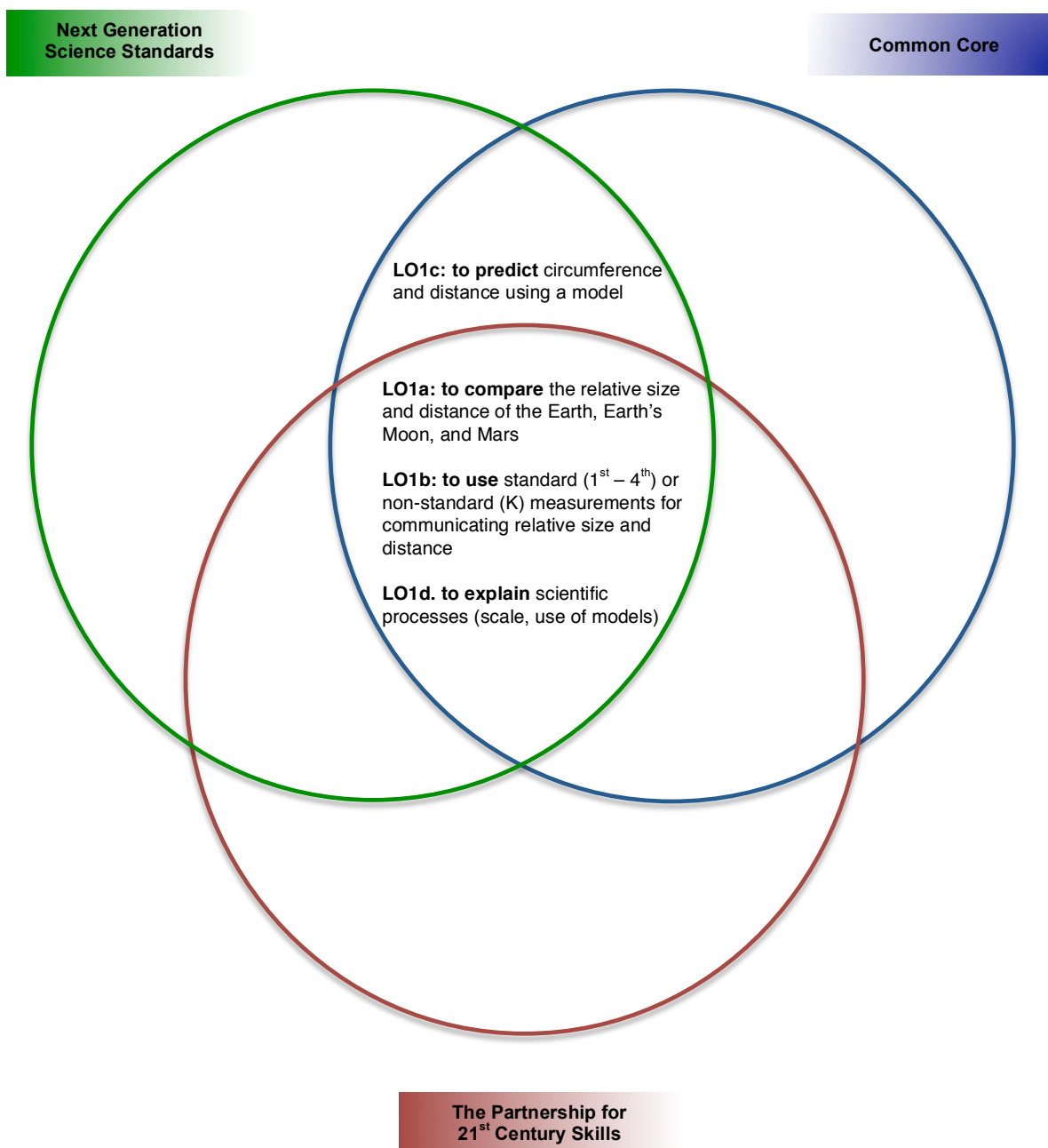### What are the predictable patterns caused by Earth's movement in the solar system?
NRC ESS1.B: Earth & the Solar System

Instructional Objective *Students will be able*	Learning Outcomes *Students will demonstrate the measurable abilities*	Standards *Students will address*	

IO1:
 	
to model the Earth, Earth's Moon, and Mars system
	LO1a. **to compare** the relative size and distance of the Earth, Earth's Moon, and Mars
	
	LO1b. **to use** standard (1st – 4th) or non-standard (K) measurements for communicating relative size and distance
	
	LO1c. to predict circumference and distance using a model
	
	LO1d. to explain scientific processes (scale, use of models)
		NSES: UNIFYING CONCEPTS & PROCESSES:
		    K-12: (A2) Evidence, models, and explanations
		
		NGSS Practices:
		    Developing and Using Models
		    Planning and Carrying out Investigations
		    Analyzing and Interpreting Data
		    Using Mathematics and Computational Thinking
		    Scientific Knowledge is Based on Empirical Evidence
		    Science Models, laws, Mechanisms, and theories Explain natural Phenomena
		
		NGSS Cross-Cutting Concept:
		    Scale, Proportion and Quantity	

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.

Next Generation Science Standards

Common Core

LO1c: to predict circumference and distance using a model

LO1a: to compare the relative size and distance of the Earth, Earth's Moon, and Mars

LO1b: to use standard ($1^{st} – 4^{th}$) or non-standard (K) measurements for communicating relative size and distance

LO1d. to explain scientific processes (scale, use of models)

The Partnership for 21st Century Skills

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. Earth, Earth's Moon, Mars Balloons 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 the Earth, Earth's Moon, and Mars system

Related Standard(s)

National Science Education Standards (NSES)
UNIFYING CONCEPTS & PROCESSES

Grades K-12 (A2) Evidence, models, and explanations
Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems. Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. Models help scientists and engineers understand how things work. Models take many forms, including physical objects, plans, mental constructs, mathematical equations, and computer simulations.

Scientific explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements. Different terms, such as "hypothesis," "model," "law," "principle," "theory," and "paradigm" are used to describe various types of scientific explanations.

As students develop and as they understand more science concepts and processes, their explanations should become more sophisticated. That is, their scientific explanations should more frequently include a rich scientific knowledge base, evidence of logic, higher levels of analysis, greater tolerance of criticism and uncertainty, and a clearer demonstration of the relationship between logic, evidence, and current knowledge.

Next Generation Science Standards (NGSS)
Practices: Developing and Using Models
(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

• 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)

Next Generation Science Standards (NGSS)
Practices: Planning and Carrying out Investigations
(Learning Outcomes Addressed: LO1a, LO1b, LO1c, LO1d)

- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. (Grades K-2)
- Make predictions based on prior experiences. (Grades K-2)

- Evaluate appropriate methods and/or tools for collecting data. (Grades 3-5)
- 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, LO1d)

- 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)
- Compare predictions (based on prior experiences) to what occurred (observable events). (Grades K-2)

- 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, LO1c)

- Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs. (Grades K-2)

- Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems. (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)

- 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, LO1d)

- Scientists use drawings, sketches, and models as a way to communicate ideas. (Grades K-2)

Next Generation Science Standards (NGSS)
Cross-Cutting Concepts: Scale, Proportion and Quantity
(Learning Outcomes Addressed: LO1a, LO1b, LO1c)

- 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)

Common Core State Standards
Writing Standards: Text Types and Purposes
(Learning Outcomes Addressed: LO1c, LO1d)

- Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. (Grade K)

- Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. (Grade 1)

Common Core State Standards
Speaking and Listening Standards: Comprehension and Collaboration
(Learning Outcomes Addressed: LO1a, LO1c, LO1d)

- Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups. (Grade K)
    - Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
    - Continue a conversation through multiple exchanges.
- Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (Grade K)

- Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. (Grade 1)
    - Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion).
    - Build on others' talk in conversations by responding to the comments of others through multiple exchanges.
    - Ask questions to clear up any confusion about the topics and texts under discussion.

- Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood. (Grade 1)

- Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups. (Grade 2)
  - o 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).
  - o Build on others' talk in conversations by linking their comments to the remarks of others.
  - o 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)
  - o 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.
  - o 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).
  - o Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
  - o 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)
  - o 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.
  - o Follow agreed-upon rules for discussions and carry out assigned roles.
  - o 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.
  - o Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

Common Core State Standards
Speaking and Listening Standards: Presentation of Knowledge and Ideas
(Learning Outcomes Addressed: LO1a, LO1c, LO1d)

- Add drawings or other visual displays to descriptions as desired to provide additional detail. (Grade K)
- Speak audibly and express thoughts, feelings, and ideas clearly. (Grade K)

- Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings. (Grade 1)
- Produce complete sentences when appropriate to task and situation. (Grade 1)

- Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. (Grade 2)
- Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification. (Grade 2)

- Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification. (Grade 3)

Common Core State Standards
Mathematics - Measurement and Data
(Learning Outcomes Addressed: LO1a, LO1b)

- K.MD.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter.

- 1.MD.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object.

- 2.MD.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
- 2.MD.2 Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.
- 2.MD.3 Estimate lengths using units of inches, feet, centimeters, and meters.
- 2.MD.4 Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.

Common Core State Standards
Mathematics - Geometry
(Learning Outcomes Addressed: LO1a, LO1b)

- K.MD.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- K.MD.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. For

example, directly compare the heights of two children and describe one child as taller/shorter.

- K.MD.3 Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.
- K.MD.4 Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length).

21st Century Skills
Communication
(Learning Outcomes Addressed: LO1d)

- 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, LO1d)

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

(D) Teacher Resource. Earth, Earth's Moon, & Mars Balloons (2 of 2)

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

Learning Outcome	Expert	Proficient	Intermediate	Beginner
LO1a: to compare the relative size and distance of the Earth, Earth's Moon, and Mars	Model is correctly refined from the prediction to reflect the appropriate size and distances of the bodies.	Model is refined from the prediction with a minimal amount of support from the facilitator.	Model is refined from the prediction with a fair amount of support from the facilitator.	Model reflects the predicted model from the beginning of the activity.
LO1b. to use standard (1st – 4th) or non-standard (K) measurements for communicating relative size and distance	Measurements are accurate and appropriate tools are used.	Measurements are relatively accurate and appropriate tools are used.	Measurements are relatively accurate and most tools are appropriate to the task.	Measurements are made with a variety of tools.
LO1c to predict using a model	Prediction is logical and based on evidence from prior examinations of the model planets. Predictions show insightful interpretation of the data.	Prediction is logical and based on evidence from prior examinations of the model planets.	Prediction is logical and uses some evidence from prior examinations of model planets.	Prediction is written and based on personal preferences.
LO1d to explain scientific processes (scale, use of models)	Explanation discusses the use of models as a predictive and explanatory tool that scientists use to test/communicate scientific phenomena.	Explanation discusses the use of models as a predictive or explanatory tool that scientists use to test or communicate scientific phenomena.	Explanation discusses the use of models as an explanatory tool that scientists use to communicate scientific phenomena.	Explanation discusses use of models by scientists.

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(L) Teacher Resource. Earth, Earth's Moon, Mars Balloons Rubric (2 of 3)

### Partnership for 21st Century Skills

	Expert	Proficient	Intermediate	Beginner
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.

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(L) Teacher Resource. Earth, Earth's Moon, Mars Balloons Rubric (3 of 3)

Common Core – ELA

	Expert	Proficient	Intermediate	Beginner
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.
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.
Effective Presentation of Knowledge and Ideas	Includes accurate drawings of concepts, speaks audibly, clearly and in complete sentences, and writes ideas in complete sentences.	Includes accurate drawings of concepts, speaks audibly, and in complete sentences, writes most ideas in complete sentences.	Includes drawings of concepts, speaks audibly, writes most ideas in complete sentences.	Includes drawings of concepts and speaks when spoken to.

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(M) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (1 of 3)
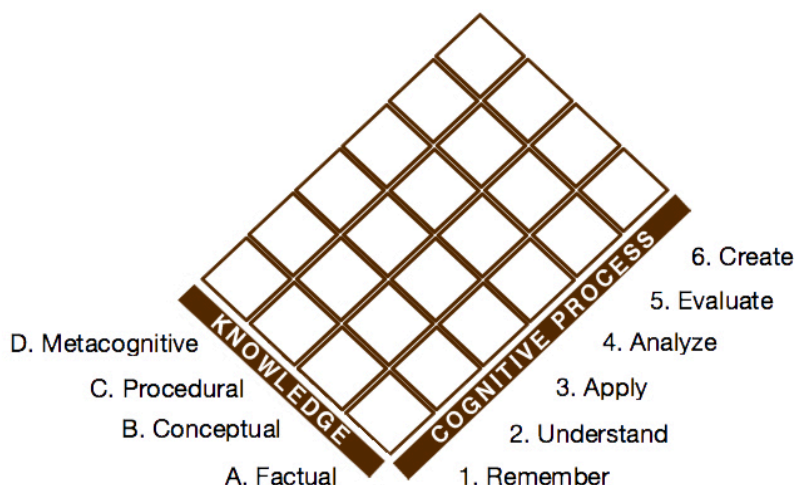
This lesson adapts Anderson and Krathwohl's (2001) taxonomy, which has two domains: Knowledge and Cognitive Process, each with types and subtypes (listed below). Verbs for objectives and outcomes in this lesson align with the suggested knowledge and cognitive process area and are mapped on the next page(s). Activity procedures and assessments are designed to support the target knowledge/cognitive process.
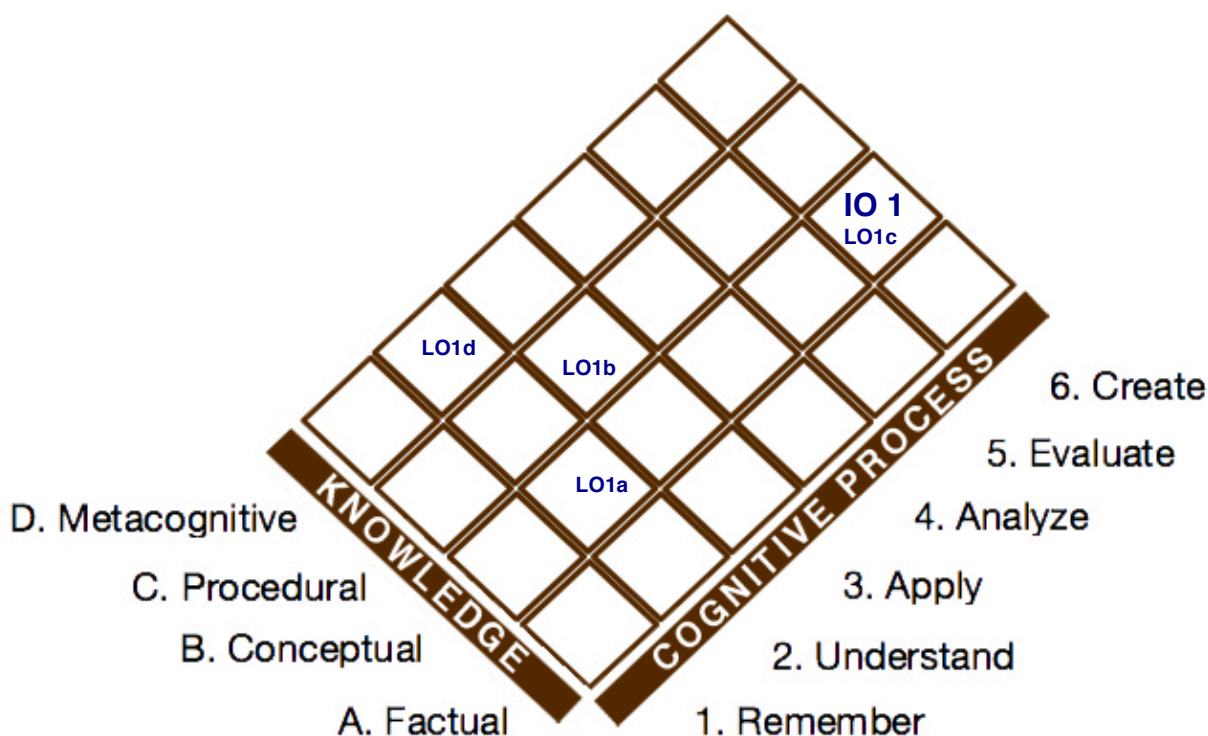
Knowledge	Cognitive Process

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)

IO1: to model the Earth, Earth's Moon, and Mars system (6.3; Bc)

- **LO1a.** **to compare** the relative size and distance of the Earth, Earth's Moon, and Mars (2.6; Bc)
- **LO1b.** **to use** standard ($1^{st} – 4^{th}$) or non-standard (K) measurements for communicating relative size and distance (3.1; Ca)
- **LO1c.** **to predict** using a model (6.1; Bb)
- **LO1d** **to explain** scientific processes (scale, use of models) (2.7; Da)

Teacher Guide

(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 construct a simple model**
  6.3: to construct
  Bc: knowledge of theories, models, and structures

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

LO1a: **to compare size/distance in model**
  2.6: to compare
  Bc: knowledge of theories, models, and structures
LO1b: **to use standard (1st – 4th) or non-standard (K) measurements**
  3.1: to use
  Ca: knowledge of subject-specific skills and algorithms
LO1c: **to predict using a model**
  6.1: to predict
  Bb: knowledge of principles and generalizations
LO1d: **to explain scientific processes**
  2.7: to explain
  Da: strategic knowledge