Mars – The Xtreme – o – Philes

Middle School Alignment Document
National Resource Council Framework, Next Generation Science Standards, Common Core State Standards, and 21st Century Skills

WHAT STUDENTS DO: Conduct an investigation and construct explanations for the viability of extremophiles in specific Mars environments

In this lesson, students will use research to learn about the similarities and differences between Earth and Mars environments along with the different types of extremophiles that can be found on Earth. The class will continue their exploration through a matching activity to determine which extremophiles could potentially exist in specific environments on Mars because of their unique form of obtaining energy from their environments. Students will:

- Summarize information about Earth and Mars along with types of extremophiles;
- Recognize the difference between living and non-living objects;
- Infer the potential for life in extreme environments on Mars; and
- Explain which regions of Mars are the most likely candidates to find these extremophiles.

NRC FRAMEWORK/NGSS CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES
HOW AND WHY DO ORGANISMS INTERACT WITH THEIR ENVIRONMENT AND WHAT ARE THE EFFECTS OF THESE INTERACTIONS? *NRC/NGSS Core Question: LS2: Ecosystems: Interactions, Energy, and Dynamics* **How do organisms interact with the living and nonliving environments to obtain matter and energy?** *NRC/NGSS LS2.A: Interdependent Relationships in Ecosystems*	*Students will be able to* **IO1: Construct a justification using evidence for a plausible Mars location in the search for life, either past or present, assuming natural laws of the universe are constant, such as biotic and abiotic factors, but remaining open minded to the potential anomalies.**

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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 AND WHY DO ORGANISMS INTERACT WITH THEIR ENVIRONMENT AND WHAT ARE THE EFFECTS OF THESE INTERACTIONS?

NGSS Core Question: LS2: Ecosystems: Interactions, Energy, and Dynamics

How do organisms interact with the living and nonliving environments to obtain matter and energy?

NGSS LS2.A: Interdependent Relationships in Ecosystems

Instructional Objective *Students will be able to*	**Learning Outcomes** *Students will demonstrate the measurable abilities*	**Standards** *Students will address*
IO1: **Construct a justification using evidence for a plausible Mars location in the search for life, either past or present, assuming natural laws of the universe are constant, such as biotic and abiotic factors, but remaining open minded to the potential anomalies.**	**LO1a.** **to investigate the living (biotic) and non-living (abiotic) factors to identify patterns indicating certain regions of Mars are more likely to have or once had living things, since some extremophiles are well suited to similar environments on Earth.** **LO1b.** **to debate data regarding Mars environments to decide their potential to harbor extremophile life and infer the potential to discover life in unique and extreme environments**	**NRC/NGSS Disciplinary Core Idea:** **LS2.A: Interdependent Relationships in Ecosystems** **NRC/NGSS Practices:** **Planning and Carrying Out Investigations** **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Engaging in Argument from Evidence** **Obtaining, Evaluating, and Communicating Information** **NRC/NGSS Cross-Cutting Concept:** **Patterns** **NRC/NGSS Connections to Nature of Science:** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems**

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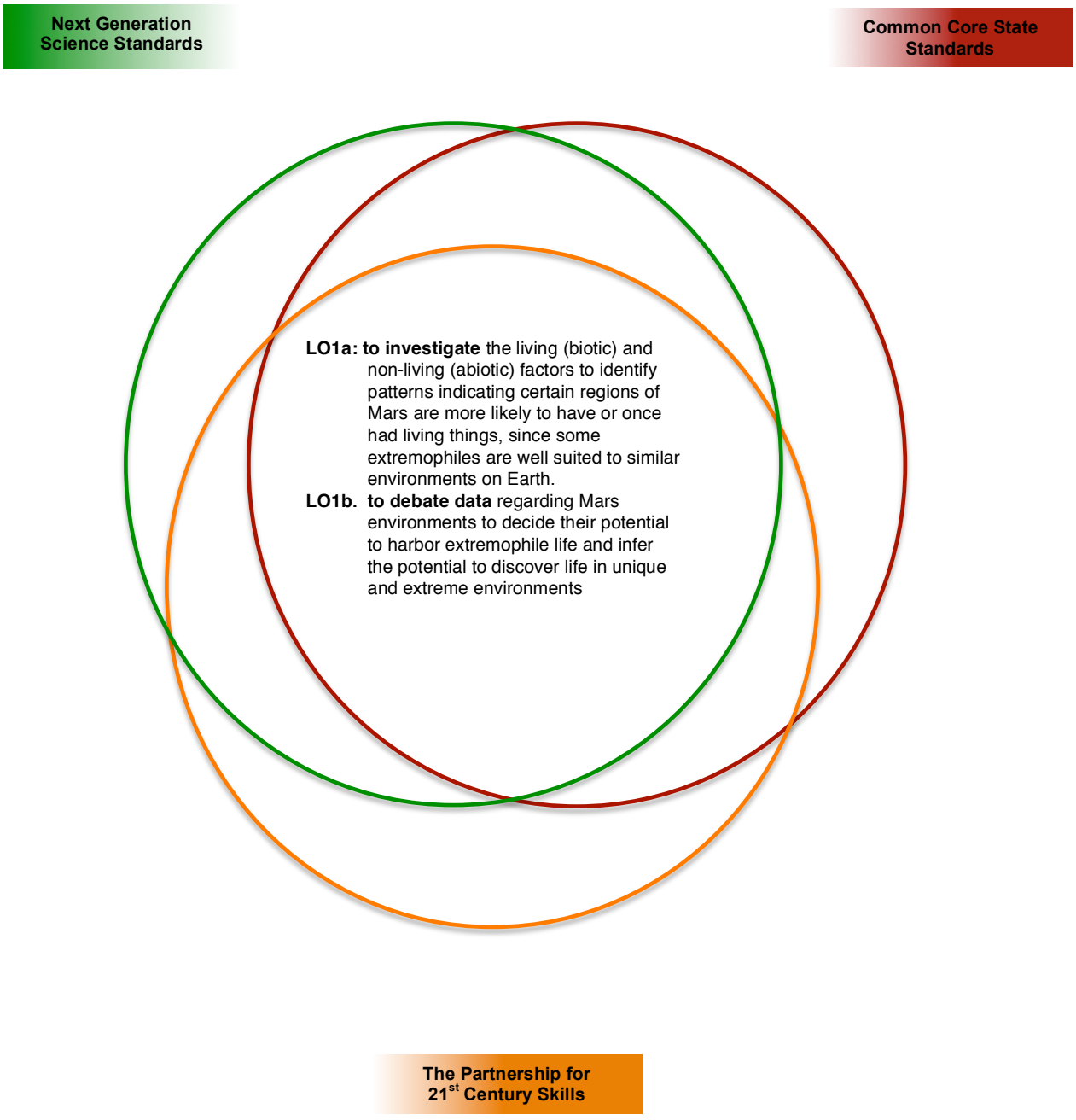
3.0 Learning Outcomes, NGSS, Common Core, & 21st Century Skills Connections

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. Mars – The Xtreme-o-philes NGSS Alignment (1 of 2)

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:

(MS- LS2-1)

Next Generation Science Standards Alignment (NGSS)

Instructional Objective	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
IO1: **Construct a justification using evidence for a plausible Mars location in the search for life, either past or present, assuming natural laws of the universe are constant, such as biotic and abiotic factors, but remaining open minded to the potential anomalies.**	**Constructing Explanation and Designing Solutions:** Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events. Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion **Engaging in Argument from Evidence:** Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Obtaining, Evaluating, and Communicating Information:** Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Patterns:** Graphs, charts, and images can be used to identify patterns in data. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. Science carefully considers and evaluates anomalies in data and evidence.

(L) Teacher Resource. Mars – The Xtreme-o-philes NGSS Alignment (2 of 2)

Next Generation Science Standards Alignment (NGSS)

Learning Outcomes	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
LO1a: **to investigate the living (biotic) and non-living (abiotic) factors to identify patterns indicating certain regions of Mars are more likely to have or once had living things, since some extremophiles are well suited to similar environments on Earth.**	**Planning and Carrying Out Investigations:** Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solution under a range of conditions. **Analyzing and Interpreting Data:** Analyze and interpret data to provide evidence for phenomena. **Obtaining, Evaluating, and Communicating Information:** Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Patterns:** Graphs, charts, and images can be used to identify patterns in data. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. Science carefully considers and evaluates anomalies in data and evidence.

LO1b: **to debate data regarding Mars environments to decide their potential to harbor extremophile life and infer the potential to discover life in unique and extreme environments**	**Engaging in Argument from Evidence:** Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. Respectfully provide and receive critiques about one's explanation, procedures, models, and question by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute and explanation or a model for the phenomenon or a solution to a problem. **Obtaining, Evaluating, and Communicating Information:** Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Patterns:** Graphs, charts, and images can be used to identify patterns in data. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. Science carefully considers and evaluates anomalies in data and evidence.

(L) Teacher Resource. Mars – The Xtreme-o-philes NGSS Individual Activity Alignment (3 of 3)

Next Generation Science Standards Activity Alignments (NGSS)

Activity	Phases of 5E Instructional Model	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Conditions for Life	**Engage**	**Constructing Explanations and Designing Solutions:** Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real-world phenomena, examples, or events.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.
(A) Earth/Mars Comparisons Data Chart (Abiotic)	**Explore**	**Obtaining, Evaluating, and Communicating Information:** Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

(B) Extremophile Data Chart (Biotic)	**Explore**	**Obtaining, Evaluating, and Communicating Information:** Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.
(C) Extremophile Selection	**Explore** **Explain**	**Planning and Carrying Out Investigations:** Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solution under a range of conditions. **Analyzing and Interpreting Data:** Analyze and interpret data to provide evidence for phenomena. **Engaging in Argument from Evidence:** Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. Respectfully provide and receive critiques about one's explanation, procedures, models, and question by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Patterns:** Graphs, charts, and images can be used to identify patterns in data. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

(D) Xtreme-o-phile and Mars Match	**Explore** **Explain**	**Planning and Carrying Out Investigations:** Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solution under a range of conditions. **Analyzing and Interpreting Data:** Analyze and interpret data to provide evidence for phenomena. **Engaging in Argument from Evidence:** Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. Respectfully provide and receive critiques about one's explanation, procedures, models, and question by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Structure and Function:** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.
Justification	**Explain** **Evaluate**	**Engaging in Argument from Evidence:** Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. Respectfully provide and receive critiques about one's explanation, procedures, models, and question by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute and explanation or a model for the phenomenon or a solution to a problem.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)	**Patterns:** Graphs, charts, and images can be used to identify patterns in data. **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. Science carefully considers and evaluates anomalies in data and evidence.

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Common Core State Standards

Instructional Objective	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)
IO1: **Construct a justification using evidence for a plausible Mars location in the search for life, either past or present, assuming natural laws of the universe are constant, such as biotic and abiotic factors, but remaining open minded to the potential anomalies.**	**Key Ideas and Details:** **Grade 6-8:** Cite specific textual evidence to support analysis of science and technical texts. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. **Craft and Structure:** **Grade 6-8:** 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 6–8 texts and topics. **Integration of Knowledge and Ideas:** **Grade 6-8:** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	**Text Types and Purposes:** **Grade 6-8:** Write arguments focused on discipline-specific content. • Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. • Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. • Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from and supports the argument presented. **Production and Distribution:** 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 6-8:** Draw evidence from informational texts to support analysis reflection, and research.	**Comprehension and Collaboration:** **Grade 6:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. • Come to discussions prepared, having read or studied required material; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. • Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed. • Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion. • Review the key ideas expressed and demonstrate understanding of multiple perspectives through Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study. Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

			Grade 7: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. • Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. • Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed. • Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed. • Acknowledge new information expressed by others and, when warranted, modify their own views. **Grade 8:** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacherled) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. • Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. • Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed. • Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.

			• Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented. **Presentation of Knowledge and Ideas:** **Grade 6:** Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation. **Grade 7 & 8:** Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

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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 investigate the living (biotic) and non-living (abiotic) factors to identify patterns indicating certain regions of Mars are more likely to have or once had living things, since some extremophiles are well suited to similar environments on Earth.**	**Key Ideas and Details:** **Grade 6-8:** Cite specific textual evidence to support analysis of science and technical texts. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. **Craft and Structure:** **Grade 6-8:** 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 6–8 texts and topics. **Integration of Knowledge and Ideas:** **Grade 6-8:** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	**Text Types and Purposes:** **Grade 6-8:** Write arguments focused on discipline-specific content. • Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. • Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. • Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from and supports the argument presented. **Production and Distribution:** 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 6-8:** Draw evidence from informational texts to support analysis reflection, and research.	**Comprehension and Collaboration:** **Grade 6:** Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study. **Grade 7:** Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study. **Presentation of Knowledge and Ideas:** **Grade 6:** Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation. **Grade 7 & 8:** Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

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LO1b: **to debate data regarding Mars environments to decide their potential to harbor extremophile life and infer the potential to discover life in unique and extreme environments**	**Key Ideas and Details:** **Grade 6-8:** Cite specific textual evidence to support analysis of science and technical texts. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. **Craft and Structure:** **Grade 6-8:** 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 6–8 texts and topics. **Integration of Knowledge and Ideas:** **Grade 6-8:** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).		**Comprehension and Collaboration:** **Grade 6:** Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not. **Grade 7:** Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence. **Grade 8:** Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced. **Presentation of Knowledge and Ideas:** **Grade 6:** Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation. **Grade 7 & 8:** Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

(M) Teacher Resource. Mars – The Xtreme-o-philes 21st Century Skills Alignment

21st Century Skills		
Learning Outcomes	**21st Century Skill**	**Grade 8 Benchmark**
LO1a: to investigate the living (biotic) and non-living (abiotic) factors to identify patterns indicating certain regions of Mars are more likely to have or once had living things, since some extremophiles are well suited to similar environments on Earth.	**Critical Thinking and Problem Solving**	Students plan and conduct scientific investigations and write detailed explanations based on their evidence. Students compare their explanations to those made by scientists and relate them to their own understandings of the natural and designed worlds.
	Collaboration	Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning.
LO1b: to debate data regarding Mars environments to decide their potential to harbor extremophile life and infer the potential to discover life in unique and extreme environments	**Communication**	Students can identify conventions for writing and speaking scientifically that distinguish scientific communication from other types of expression, and describe reasons behind those differences such as the need in science for precision, detail, and evidence over opinion.
	Collaboration	Students work collaboratively with others, either virtually or face-to-face, while participating in scientific discussions and appropriately using claims, evidence, and reasoning.
	Media Literacy	Students are able to identify and critique arguments in which the claims are not consistent with the evidence given.
	Social and Cross-Cultural Skills	Students are able to structure scientific discussions to allow for differing opinions, observations, experiences, and perspectives.

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(O) Teacher Resource. Mars – The Xtreme-o-philes 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 investigate the living (biotic) and non-living (abiotic) factors to identify patterns indicating certain regions of Mars are more likely to have or once had living things, since some extremophiles are well suited to similar environments on Earth.	Applies the difference between living and non-living factors to the investigation while matching Mars environments for their potential to harbor life. Infers the potential to discover life in unique and extreme environments by extrapolating the evidence from the back of the cards.	Applies the difference between living and non-living factors to the investigation while matching Mars environments for their potential to harbor life.	Matches Mars environments to extremophiles cards based on data contained on the front of the card only.	Matches Mars environments to extremophiles cards based on personal interest.
LO1b: to debate data regarding Mars environments to decide their potential to harbor extremophile life and infer the potential to discover life in unique and extreme environments	Makes a wide variety of claims for potential extremophiles in Mars regions and supports with evidence and/or reconsiders the claim based on information provided by team members and classmates while remaining professional in tone.	Makes claims for potential extremophiles in Mars regions, supported by evidence while reconsidering the claims based on information provided by team members and classmates.	Makes a claim for potential extremophiles in a Mars region supported by evidence.	Makes a claim for potential extremophiles in a Mars region based on personal interest.

(P) Teacher Resource. Mars – The Xtreme-o-philes CCSS Rubric (2 of 3)

Common Core State Standards

	Expert	Proficient	Intermediate	Beginner
Research to Build Produce, 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	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.
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	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.

	and opinions.			
Craft and Structure	Develops strong, accurate vocabulary through research and use of icons.	Develops strong, vocabulary through research and use of icons.	Develops vocabulary through research and use of icons.	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. Mars – The Xtreme-o-philes 21st Century Skills Rubric (3 of 3)

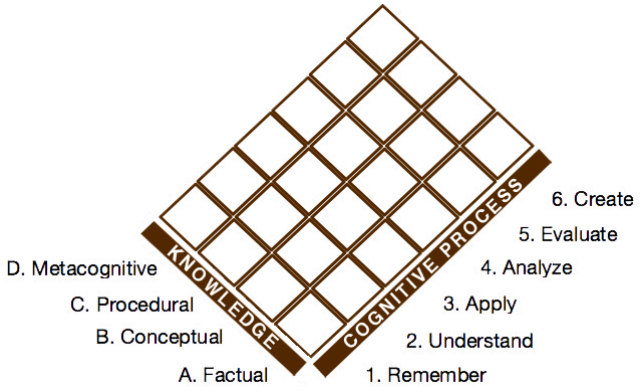
Partnership for 21st Century Skills

	Expert	Proficient	Intermediate	Beginner
Effectiveness of Communication	Successfully uses a variety of models to describe and predict real-world phenomena.	Successfully uses a model to describe and predict real-world phenomena.	Uses a model to attempt a description of real-world phenomena.	Uses prior misconceptions to describe real-world phenomena.
Effectiveness of Media and Information Literacy	Respectfully critiques claims made by peers for evidence used, accurately evaluating when they select only data that supports their claim while ignoring contradictory data.	Critiques claims made by peers for evidence used, accurately evaluating when they select only data that supports their claim while ignoring contradictory data.	Critiques claims made by peers for evidence used, evaluating when they select only data that supports their claim while ignoring contradictory data.	Critiques claims made by peers regardless of data used to support the claim.
Effectiveness of social and cross-cultural 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 peers and relates them to their new understandings.	Develops detailed explanations based on credible evidence. Relates them to their new understandings.	Develops explanations. Relates explanation to their new understandings.	Attempts to explain based on own preconceived understanding.

(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)

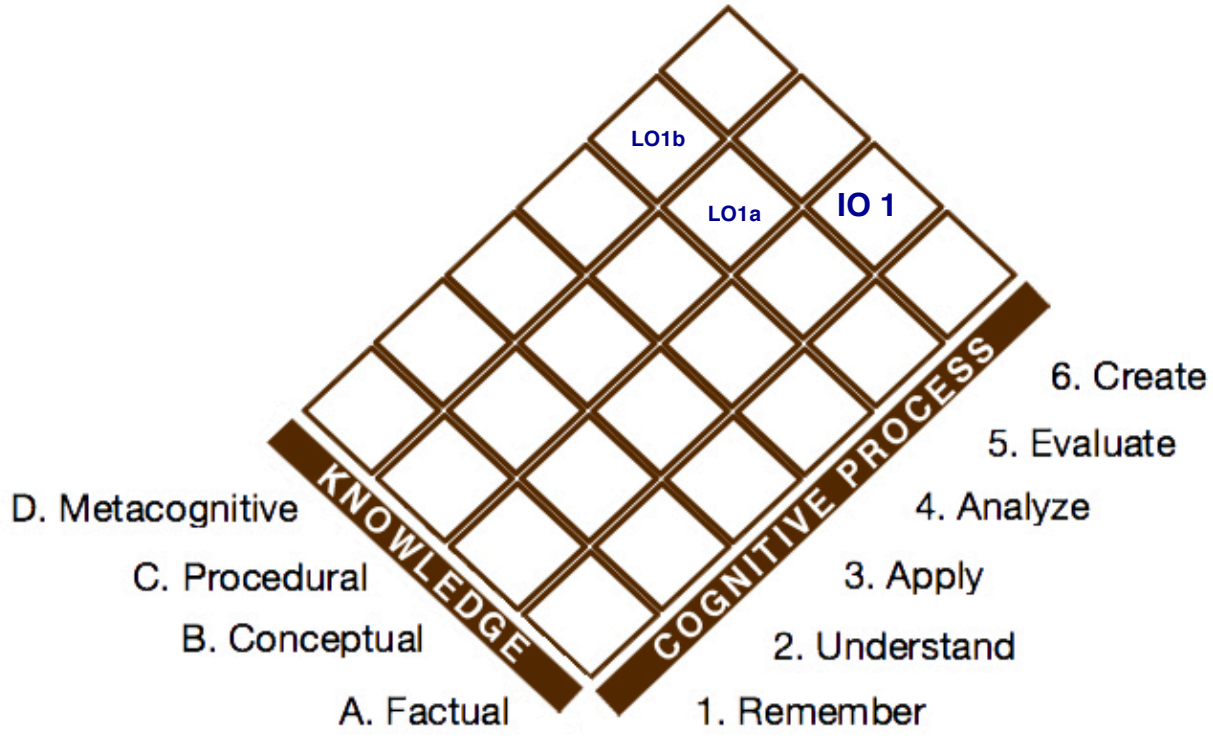
(R) Teacher Resource. Placement of Instructional Objective and Learning Outcomes in Taxonomy (2 of 3)

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: Construct a justification using evidence for a plausible Mars location in the search for life, either past or present, assuming natural laws of the universe are constant, such as biotic and abiotic factors, but remaining open minded to the potential anomalies. (6.3; Ba)

LO1a. to investigate the living (biotic) and non-living (abiotic) factors to identify patterns indicating certain regions of Mars are more likely to have or once had living things, since some extremophiles are well suited to similar environments on Earth. (5.1; Cb)

LO1b. to debate data regarding Mars environments to decide their potential to harbor extremophile life and infer the potential to discover life in unique and extreme environments (5.2; Db)



(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: To construct

6.3: to construct

Ba: Knowledge of classifications and categories

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

LO1a: to investigate

5.1: to test

Cb: Knowledge of subject-specific techniques and methods

LO1b: to debate

5.2: to critique

Db: Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge