



LESSON TITLE:

Mars Trek: To Boldly Go Where No PEARLS 7th Grader Has Gone Before

Grade: 7

Lesson Duration: 1 Week

Course Name(s): 7th Grade Honors Earth Science

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BIG IDEAS

1. Scientists use their existing knowledge wisely when analyzing data, but they keep an open mind without rushing to conclusions (Dey, 1993).
2. "Scientific knowledge is constrained by human capacity, technology, and materials" (Achieve, 2013, p. 6).
3. "Science is both a body of **knowledge** and the **processes and practices** used to add to that body of knowledge" (Achieve, 2013, p. 6).
4. "Science investigations use a variety of methods and tools to make measurements and observations" (Achieve, 2013, p. 6).
5. "Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings" (Achieve, 2013, p. 6).
6. "Science knowledge is based upon **logical and conceptual connections** between **evidence** and
7. **explanations**" (Achieve, 2013, p. 6).

EDUCATION STANDARDS

Science Performance Expectations (or state Science standard): MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system

objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.]

[Assessment Boundary:

Assessment does not include recalling facts about properties of the planets and other solar system bodies.]

<p>Science and Engineering Practices: Analyze and interpret data to determine similarities and differences in findings</p>	<p>Disciplinary Core Ideas: ESS1.B: Earth and the Solar System The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.</p>	<p>Crosscutting Concepts: Scale, Proportion, and Quantity Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.</p>
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Common Core State Standards:

Math: MP.4 Model with mathematics

ELA:

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest
E5. Read, write, and speak grounded in evidence
E3. Obtain, synthesize, and report findings clearly and effectively, in response to task and purpose

MEASURABLE STUDENT LEARNING OBJECTIVES

1. Students will be able to ask open and closed questions about the scale of Yellowstone Volcano and Olympus Mons while using both GIS systems.
2. Students will be able to collect quantitative data on the diameters of Olympus Mons and Yellowstone and use quantitative analyses to compare the selected volcanoes on Earth and Mars.
3. Students will be able to develop scaled comparative models of Yellowstone Volcano and Olympus Mons using cash register tape.
4. Students will be able to write an evidence-based claim about which volcano is

larger.

5. Students will be able to collect data on the diameter of Yonkers and New York State and use quantitative analyses to compare Olympus Mons and their community.

MATERIALS NEEDED

- [Google Earth](#) Flyer Over Tour: Yellowstone
- PowerPoint Plugin: [PollEverywhere](#)
- [NASA Mars Trek](#)
- [Touring The Lunar South Pole With NASA Moon Trek](#)
- [See, Think, Wonder](#)
- 1 Cash register tape per group of 2
- 1 Ruler per student
- 1 Calculator per student
- 1 Pencil per student
- [Station_Mars Trek](#)
- Computer

ENGAGING CONTEXT/PHENOMENON

A culturally responsive anchoring phenomenon is local or community-based, observable, puzzling, complex, and engages students in the STEM disciplines using the science and engineering practices crosscutting concepts, and disciplinary core ideas (Penuel & Bell, 2016; Vasquez, 2015). In essence, it “spark[s] curiosity and wonder” (Bozeman Science, 2019, July 9) for four reasons. First, the phenomenon—a field trip to explore volcanoes on Mars and Earth—sparks curiosity because it includes an adventure to a world unexplored by the students, that is Mars. Second, the phenomena, Yellowstone and Olympus Mons, treat the solar system as a broad community; therefore, the sites are worthy destinations for a field trip. Third, from the surface, the volcanoes are observable. Fourth, the sense-making process of figuring out the scale of the volcanoes requires computational analysis.

REAL-WORLD CONNECTIONS FOR STUDENTS

Observing the Yellowstone volcano in the United States provides the students with a sense of place (Doering & Veletsianos, 2008) that is, a broader perspective of their country. According to Doering and Veletsianos (2008), a “sense of place is considered a constituent of cultural identity” (p. 219). In addition, the students have the opportunity to include Yonkers and New York State data in the assessment process which narrows the perspective to make the lesson personally meaningful and contextually significant.

DATA INTEGRATION

In the explore phase of the lesson, students are collecting and analyzing data from the [NASA Mars Trek](#) visualization system.

TEACHER BACKGROUND KNOWLEDGE

Technology Knowledge: Knowing how to navigate the Mars Trek modeling system

is critical. Viewing the video, [Touring The Lunar South Pole With NASA Moon Trek](#) highlights the relevant knowledge and skills needed to visualize Olympus Mons in the lesson. Though the video focuses on Earth's Moon, the process of navigating the GIS system is the teacher's primary focus.

Science Disciplinary Knowledge: On Mars, the tallest volcano is Olympus Mons is approximately 27km (16.8miles) high, 600km (373miles) in diameter (NASA/JPL-Caltech/USGS, 2016, February 1). In the United States, the Yellowstone volcano is approximately 80 km long and 65km wide (USGS Science for Changing World, n.d.). From east to west, New York State is about 330 miles (530km) and 285 miles (460km) from north to south. Yonkers is 4.2km in length (Yonkers Chamber of Commerce, 2024).

DIFFERENTIATION OF INSTRUCTION

The teacher should survey the class to find out which students are inexperienced with using Google Earth and pair them with their more knowledgeable peers.

The teacher should provide students with access to the edited version of [Touring The Lunar South Pole With NASA Moon Trek](#) so that they can view additional guidance in navigating the Mars Trek mapping system.

The teacher provides students with an evidence-based claim graphic organizer to scaffold the argumentation process.

In the explore phase, tiering using ratios of 1km=1cm, 3km = 1cm, and student choice maintain the rigor for all students. The ratio 1km=1cm gives all students the opportunity to engage with the calculation. The ratio of 3km = 1cm adds a dimension of quantitative rigor. The most rigor occurs when students are devising their own ratio. This level should be assigned to students with the most mathematical advanced skills.

In the explore and elaborate phases, the *tool talk* to demonstrate the numerical setup prior to the construction of the scaled models provides guided instruction for students to visualize the computational thinking involved in the process.

In the quiz provided in the evaluate phase, a map of Yonkers is provided for students to duplicate in order to visually represent Olympus Mons from the perspective of Yonkers. In addition, a link to the needed evidence on the length of Yonkers is also provided.

POSSIBLE PRIOR or MISCONCEPTIONS

Since Mars is smaller than Earth, students might think that the landforms are also smaller. For example, volcanoes on Mars are smaller on Mars than on Earth.

Since satellite images of Olympus Mons are scaled, students might think that the volcano is smaller than what appears in reality.

LESSON PROCEDURE

5E	Details of 5E Lesson Implementation
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Engage

Lesson Objective: Students will be able to ask open and closed questions about the scale of Yellowstone Volcano and Olympus Mons while using both GIS systems.

Standards Addressed ELA:

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest

E3. Obtain, synthesize, and report findings clearly and effectively, in response to task and purpose

Materials & Resources

- Computer
- [Google Earth](#) Flyer Over Tour: Yellowstone
- [Edited version of Touring The Lunar South Pole With NASA Moon Trek](#)
- [NASA Mars Trek](#)
- [See, Think, Wonder](#)
- [Station Mars Trek](#): See Adaptation of See, Think, Wonder
- PowerPoint Plugin: [PollEverywhere](#)

Procedure:

In this phase, the teacher elicits students' local/funds of knowledge and curiosities about Yellowstone and Olympus Mons.

To engage students, in the beginning of the lesson, the teacher will say: Space, the final frontier. These are the voyages of Dr. Redway's class. It's a 1-week mission to explore and compare a volcano from a strange world and to boldly go where no PEARLS 7th grade has gone before.

The teacher discusses the difference between an open-ended and a close-ended question.

Students complete a Google Earth fly over tour of the Yellowstone.

Teacher plays [Edited version of Touring The Lunar South Pole With NASA Moon Trek](#) to prepare students for [NASA Mars Trek](#). The teacher tells the students that while the video segment addresses Moon Trek, it provides guidance for navigating [NASA Mars Trek](#) GIS system.

Students observe Olympus Mons and collect quantitative data on its diameter.

	<p>Students ask open-ended and close-ended questions about both phenomena using the See, Think, Wonder thinking routine. The teacher should encourage students to ask a variety of questions including scale or quantitative questions.</p> <p>Students select their scale or quantitative questions to share with the class via the PowerPoint Plugin: PollEverywhere.</p> <p>Formative/Summative Assessments Students share their open-ended questions in the Poll Everywhere app. The teacher “looks for” questions address that scale or quantity regarding both phenomena.</p> <p>Modifications: Students use the thinking routine: See, Think, Wonder to help with question generation.</p>
<p><u>Explore</u></p>	<p>Lesson Objective: Students will be able to develop scaled comparative models of Yellowstone Volcano and Olympus Mons using cash register tape.</p> <p>Standards Addressed:</p> <p>Science: MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.</p> <p>Math: MP.4 Model with mathematics</p> <p>Materials & Resources</p> <ul style="list-style-type: none"> • Station_Mars_Trek • 1 Cash register tape per group of 2 • 1 Ruler per student • 1 Calculator per student • 1Pencil per student <p>Procedure: In this phase, students are developing their comparative models.</p> <p>The teacher distributes a zip-top bag kit (consisting of 1 roll of cash register tape, 2 rulers, 2 calculators, and 2 pencils) per group of two.</p> <p>Using the LMS, the teacher distributes the Station_Mars_Trek to each student.</p>

	<p>In a tool talk demo, the teacher uses a sample diameter for Olympus Mons to determine the amount of tape needed in centimeters.</p> <p>In each group of two, one student works on data for Olympus Mons and the other on Yellowstone Caldera.</p> <p>Each student should be setting up a proportion to determine the quantity of tape needed in centimeters.</p> <p>Each student should measure how much tape is needed and cut and label their respective volcano.</p> <p>Students should check their partner’s model using the MARK (M=what should be modified? A=what should be added? R=what should be removed? K=and what should be kept?) protocol</p> <p>Formative Assessments: In small group conferences, the teacher “looks for” <i>accuracy of the numerical setup of proportion and accuracy of measuring the quantity of tape needed using the ruler</i> in each student’s response.</p> <p>Modifications: Students are provided the ratio of 1km =1cm which is mathematically achievable for all students. In addition, the teacher demonstrates via tool talk how to approach the numerical setup.</p>
<p><u>Explain</u></p>	<p>Lesson Objective: Students will be able to write an evidence-based claim about which volcano is larger.</p> <p>Standards Addressed: Science: MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. Math: MP.4 Model with mathematics ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest E5. Read, write, and speak grounded in evidence E3. Obtain, synthesize, and report findings clearly and effectively, in response to task and purpose</p> <p>Materials & Resources</p> <ul style="list-style-type: none"> • <u>Station_Mars Trek</u>: Section on Evidence-Based Claim <p>Procedure:</p>

	<p>The teacher should ask students, what does it mean when textbook authors write that two objects in a diagram are drawn to scale.</p> <p>For the evidence based graphic organizer, the teacher should review what counts as evidence from the previous explore phase.</p> <p>Students are selecting the claim that they agree with and providing two pieces of evidence in support of their claim. Evidence must be quantitative and comes from the explore it phase.</p> <p>Formative/Summative Assessments</p> <p>On students claim, the teacher “looks for” a claim that is accurate and is supported with quantitative evidence. The claim that students record that they agree with Student#2. Acceptable evidence includes but not limited to: (1) From the scale models, Olympus Mons is approximately 9.4x bigger than the Yellowstone Crater. (2) From the scale model, the ratio of Olympus Mons and Yellowstone Crater is 9 to 1.</p> <p>Modifications</p> <p>The discussion addressing what counts as evidence and the graphic organizer for documenting students’ responses ensures the engagement of students.</p>
<p><u>Elaborate</u></p>	<p>Lesson Objective Students will be able to use given data on the diameter of New York State and use quantitative analyses to compare Olympus Mons and their state.</p> <p>Standards Addressed</p> <p>Science: MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.</p> <p>Math: MP.4 Model with mathematics</p> <p>Materials & Resources</p> <ul style="list-style-type: none"> • 1 Calculator per student • 1 Ruler per student • 1Pencil per student • Station Mars Trek: Section on New York State vs. Olympus Mons

	<p>Procedure: In this section, students are gaining additional practice.</p> <p>The teacher provides data on the diameter of New York State and explain that it will be compared to the diameter of Olympus Mons.</p> <p>Students calculate how many times smaller is New York State compared to Olympus Mons. Given a model (i.e. graph paper) that represents Olympus Mons, students will then shade in the portion that represents New York State.</p> <p>Formative/Summative Assessments The teacher “looks for” ratio of $530\text{km}/600\text{km} = \sim 0.9/1$ The teacher “looks for” correct proportion (approximately 90%) of the graph is shaded for New York State.</p> <p>Modifications In a tool talk, demonstrate using the measurement of New York State for North to South, how to set up the ratio and shade the correct proportion.</p>
<p><u>Evaluate</u></p>	<p>Lesson Objective Students will be able to obtain data on the diameter of Yonkers and use quantitative analyses to compare Olympus Mons and their city.</p> <p>Standards Addressed Science: MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. Math: MP.4 Model with mathematics ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest E5. Read, write, and speak grounded in evidence E3. Obtain, synthesize, and report findings clearly and effectively, in response to task and purpose</p> <p>Materials & Resources</p> <ul style="list-style-type: none"> • 1 Calculator per student • Computer for researching diameter of Yonkers • 1Pencil per student • Station_Mars Trek: Section on Yonkers vs. Olympus Mons <p>Procedure: In this phase, students are demonstrating mastery of the</p>

	<p>standard.</p> <p>The teacher provides the students with the quiz in which they must research the diameter of Yonkers and use the data to compare to Olympus Mons both quantitatively and visually.</p> <p>Students calculate how many times smaller the City of Yonkers is compared to Olympus Mons.</p> <p>Given a map of the City of Yonkers, students duplicate the map to show how many Yonkers are needed to visually represent Olympus Mons.</p> <p>Summative Assessments The teacher “looks for” ratio of $4.2\text{km}/600\text{km} = \sim 0.007/1$ The teacher “looks for” approximately 143 images/maps of Yonkers</p> <p>Modifications A map of Yonkers is provided for students to duplicate in order to visually represent Olympus Mons from the perspective of Yonkers. In addition, a link to the needed evidence on the length of Yonkers is also provided.</p>
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