Lunar Reconnaissance Orbiter: (LRO)

Audience
Grades 6-8

Time Recommended
1-2 Hours

AAAS STANDARDS

- 1B/1: Scientific investigations usually involve the collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected evidence.
- 3A/M2: Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information
- 11B/M3: Different models can be used to represent the same thing. What model to use depends on its purpose.

NSES STANDARDS

Content Standard A (5-8): Abilities necessary to do scientific inquiry:

c. Use appropriate tools to gather, analyze and interpret data.

d. Develop descriptions and explanations using evidence.

e. Think critically and logically to make relationships between evidence and explanations.

Content Standard E (5-8): Understandings about Science and Technology:

b. Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed. Technology also provides tools for investigations, inquiry, and analysis.

MATERIALS

- Student science notebooks
- Computer and projector
- Modeling clay or Play-Doh
- Construction paper
- Cardboard
- Ruler
- Dental floss or string
- Scotch tape

Making a Model: Mapping the Moon

Learning Objectives:

- To build a topographic map of a "Moon mountain."
- To use a topographic map to determine a safe landing place for a Moon mission

Students will learn about NASA's mission to find safe landing sites on the surface of the Moon. After seeing a visualization of surface mapping, students will create a topographic map and use this map to consider questions about landing sites on the surface of the Moon.

Preparation:

1. Preview the LRO visualization before viewing with students.
2. Prepare a computer with projector for students to be able to view the visualization.

Background Information:

At the core of NASA's future in human space exploration is the potential return to the Moon. Once there, we would build a sustainable, long-term human presence with new spacecraft, robotics and life-sustaining technologies. In order to accomplish these goals, the Lunar Reconnaissance Orbiter (LRO) is an unmanned mission tasked with creating a comprehensive atlas of the Moon's features, searching for safe and engaging landing sites, identifying important lunar resources, and characterizing how the lunar radiation environment will affect humans long-term.

Building safe lunar land sites requires detailed topographic data, which LRO is currently gathering as it orbits around the Moon. This will better aid the continued quest for human space exploration.

Procedure:

1. Have students begin the lesson by setting up their science notebooks for the day. Instruct the students to write the focus question in their science notebooks. **What kind of surface is necessary for a spacecraft to land safely on the Moon?**
2. Share the student information sheet about the mapping of the Moon with students. Have students record notes in the observations/data section of their science notebook.
3. Watch the visualization of the Moon mapping that LRO will do. See the supplemental resources section for the link to this visualization. Have the students record notes in the observations/ data section of their notebooks.

4. Lead a discussion with students about why it is important to map the surface of the Moon. See background information for assistance.

5. Tell students they will be making their own model and map of an area of the Moon.

6. Give each pair of students a large ball of modeling clay—about the size of a softball.

7. Have the students mold the clay into a large mountain about 4 to 5 inches tall. Instruct them to make the mountain oddly shaped (but flat on the bottom), as this will make their maps more interesting. They can also put a small crater in the top of their mountain shape if they wish.

8. Using their pencil and a ruler, have the students make ½-inch pencil marks starting from the top of the mountain.

9. Have the students use a pencil to make two holes through the middle of the mountain, from the top of the mountain to the cardboard underneath. Make sure the pencil holes go all the way through the mountain.

10. Ask the students to take the string, wrap it around their fingers, and hold it tight. Use the string to cut the top ½-inch of the mountain.

11. Have the students place the slice of mountain on the white construction paper and trace around it. Have them put the pencil through the holes in the slice to make marks on the paper to help them line up the slices of clay. Put the slice to the side.

12. Ask them to cut a second slice and line up the holes with the marks on the paper. Lay the slice on top of the first slice tracing. Trace around the second slice. Again, put this slice to the side.

13. Continue tracing each slice of the mountain until all slices have been traced. After all the slices have been traced, have the students color each slice a different color.

14. Have students place their slices of mountain back together, lining up the slices using the pencil holes.

15. Have the students tape their maps into their science notebooks. Then have them answer the discussion questions listed below before making their claims/ evidence charts.

    a. Why are some of the traced lines closer together than others?
    b. What kind of mountain slope makes lines that are closer together?
    c. What kind of mountain slope makes lines that are far apart?
    d. Where are the steepest slopes on your mountain?

16. Have students make a claims/ evidence chart for the focus question. Have them use the article (see worksheet section), the visualization (see supplemental resources sections), and their topographic maps to make claims.

17. Using the claims/evidence chart, have students consider the following questions to make a conclusion about the focus question.

    a. Looking at your map, where would be the best place to land a spacecraft?
    b. Why is this location an ideal spot to land a spacecraft? Use your claims/evidence chart to make this claim.

18. Have a discussion with students. Make a claims/ evidence chart with students and discuss the conclusions students made. (See sample claims/ evidence chart below)

Claims	**Evidence**
• I claim inside the crater will be the safest landing spot on our piece of the moon. • I claim that the flat base of our mountain is the safest landing spot.	• I claim this because there are no large rocks and the surface is flat and not sloped. • I claim this because it is flat and the spacecraft would not land on a steep surface.

worksheet

MAPPING THE MOON

Student Information Sheet

When Buzz Aldrin and Neil Armstrong were just seconds from landing on the Moon, they realized their landing was in danger. Only 400 feet from the surface of the Moon, they saw that their ship, Apollo 11, was on course to land in a crater full of SUV-sized boulders. They averted danger by taking control of their ship's computer and landing in a smoother area beyond the crater's rim.

Image 1: Buzz Aldrin and the U.S. Flag on the Moon, 1969. Photo courtesy of NASA Image Database, http://www.nasaimages.org/luna

Part of the challenge of landing on the Moon is finding a surface safe enough to land upon. Generally, a good landing site is level and free from large objects that could damage the spacecraft as it lands.

In order to help get astronauts back on the Moon by 2020, part of the Lunar Reconnaissance Orbiter's (LRO) mission is to find safe landing spots on the surface. One of the instruments designed to help in achieving this goal is the Lunar Orbiter Laser Altimeter (LOLA). LOLA was created to calculate the height of lunar terrain. It is a laser ranging system that records the time it takes for a pulse to travel from the spacecraft to the surface and back. After orbiting the Moon for a year, LOLA will create an elevation map of the Moon's polar regions.

A second instrument, named Diviner, will measure temperatures in LOLA's mapping area to analyze potential landing sites. Because temperatures change more quickly in areas with lots of rocks, Diviner can analyze temperature change to determine areas on the surface that appear to be smooth but are more likely rocky.

Finally, the LRO also will carry a pair of cameras called the Narrow Angle Cameras (NAC's). These eagle-eyed cameras will work together to take images of the lunar surface that can show details of the Moon as small as a half-meter. As the LRO orbits, the

Moon rotates beneath it and the NAC's will take pictures to build a detailed view of the lunar poles. This information will be used to identify landing zones that are safe for spacecraft and free of large boulders and craters (unlike the technology available during the Apollo missions).

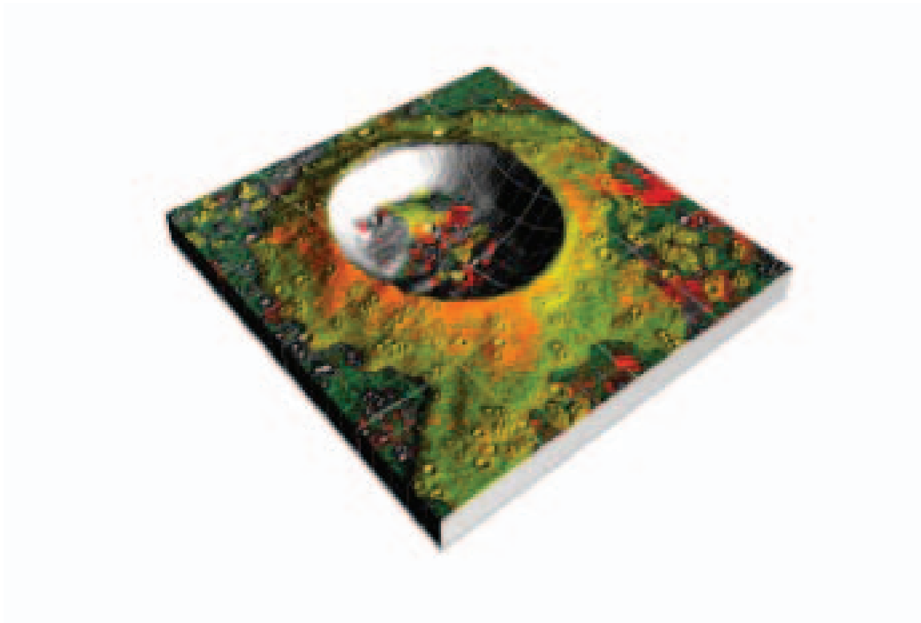

Image 2: The LRO's imaging cameras will provide highly detailed images of the lunar surface. From these images, scientists can determine where large rock hazards exist. Large rock hazards found in or near level surfaces will make landing in those areas unsafe. Artist depiction above from NASA's Scientific Visualization Studio, http://svs.gsfc.nasa.gov/vis/a000000/a003500/a003533

SUPPLEMENTAL IMAGES/ MATERIALS/ RESOURCES:

Resources:

Visualization: Friedlander, J. (2008). How will LRO find safe landing sites on the moon? Retrieved September 13, 2008, from http://svs.gsfc.nasa.gov/vis/a000000/a003500/a003533