MISSION LUNAR TOPOGRAPHY: MAPPING THE MOON FOR OPTIMAL LANDING SITES

DURATION
1 Lesson
1-2 Class periods (50 min)

GRADE LEVELS
7-10

LESSON PLAN

OVERVIEW

In this engineering-focused lesson, students work in teams to design a lunar lander and identify its optimal landing site according to the specific requirements of the mission. Students will learn how topography provides information about the lunar surface and how topography has impacted historical lunar missions. Teams will use what they've learned to make observations about various possible landing sites based on a topography map. Students will catapult their lunar landers to a pre-selected landing zone, observe, discuss site pros and cons, reevaluate, and relaunch to determine the most successful landing.

LESSON OBJECTIVES

By the end of this lesson, students will be able to:

- Identify and distinguish between high and low elevation regions using a topographic map.
- Examine mission outcomes to make informed adjustments and enhancements between experiments.
- Explain the significance of topography in the design and success of space missions.
- Understand the difference between accuracy and precision.

STANDARDS

NEXT GENERATION SCIENCE STANDARDS (NGSS)

MS ETS 1-2

Evaluate competing design solutions based on jointly developed and agreed-upon design criteria using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS ETS 1-3

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

HS ETS 1-1

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS ETS 1-2

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS ETS 1-3

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

COMMON CORE: ELA

CCSS.ELA-LITERACY.W.6.2
Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.SL.6.5
Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

CCSS.ELA-LITERACY.L.6.1
Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCSS.ELA-LITERACY.L.6.2
Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

CCSS.ELA-LITERACY.L.6.3
Use knowledge of language and its conventions when writing, speaking, reading, or listening.

MATERIALS

- Topography map elevation replicators:
  - Indoor examples: chairs, textbooks, notebooks, backpacks
  - Outdoor examples: mulch, sand, sticks, rocks
- Lunar Topography Map with coordinates
- Meter sticks
- Tape
- Paper
- Club for the Future Lunar Topography Lesson

LESSON PLAN

INTRODUCTION (30 MINUTES)

1. Begin by introducing Blue Origin and the Blue Moon Mark 1 (MK1) lunar lander
   - Checkpoint: Identify the purpose of MK1 and lunar cargo.
     - » Why do we go to space? What is lunar permanence and its purpose?
2. Discuss historical moon landings and sites
   - Why was the Sea of Tranquility chosen as the landing site for Apollo 11?
3. Intro to topography map
   - What is a topography map? How do you read a topography map? What does a lunar topography map tell us about the lunar surface?

LUNAR LANDER CHALLENGE (35 MINUTES)

PART 1: LUNAR TOPOGRAPHY ANALYSIS (15 MINUTES)

1. Divide students into small groups.
2. Groups analyze a lunar topography map to identify high and low elevation points.
3. Groups make predictions about what sites and geographical phenomena would be ideal for landing.
   a. Discuss why and identify group's landing coordinates of choice.

PART 2: LUNAR LAUNCH AND LANDING EXPERIMENT (20 MINUTES)

1. Students craft a small lunar lander (could be as simple as a wad of paper or complex as an origami paper spacecraft).
2. During this time, instructors should replicate the lunar topography map given to each group using floorspace in the classroom or outdoors. Classroom example: high elevation zones represented by stacked books, desk chairs, notebooks. Outdoor example: low elevation zones represented by dug out patches of mulch or dirt, high elevation zones represented by large rocks or mounds of mulch. Recommendation: Build the map with the class.
3. Groups make predictions about what sites and geographical phenomena would be ideal for landing.

PART 3: ANALYZE RESULTS AND REITERATE (15 MINUTES)

1. Launch. Land. Repeat.
2. Teams discuss the pros and cons of their landing site. Did it go where they wanted? Was it easy or difficult to land in the site they chose? How does this relate to that site's topography? Example, observe that smoother landing sites (usually the base of craters such as the Sea of Tranquility) may allow for a more stable landing.
3. Relaunch, making any changes desired to landing site.
4. Students individually complete a written reflection, analyzing results of the mission. What are lessons learned from the changes in landing sites? How would they improve their chosen sites in the future?

EXTENSION ACTIVITIES

- Research Apollo 11 moon landing.
- Design a moon lander from scratch.

ASSESSMENT

- Student Mission Packet is filled out and turned in.

ADDITIONAL ACCOMMODATIONS

1. **For Visual Learners:**
   - Provide any MK1 promotional videos discussing the mission objectives.
2. **For Auditory Learners:**
   - Include audio recordings of the first moon landing.
3. **For Kinesthetic Learners:**
   - Encourage these students to be the launchers in testing.
4. **For English Language Learners (ELL):**
   - Provide a word bank of moon-related vocabulary.
   - Allow reflections to be written in native language and translated.
5. **For Students with Learning Disabilities:**
   - Offer notes sheet with fill-in-the-blank spaces as a learning aid.
6. **For Gifted Students:**
   - Encourage research on moon landings throughout history.
   - Additional reflection on why lunar permanence is important.
7. **For Students with Physical Disabilities:**
   - Ensure all materials are accessible (ex. large print, digital formats).
   - Provide adaptations for launching (ex. brightly colored obstacles or lander, audio cues from teammates describing the launch, peer guidance, adaptive grips on catapult or electronic motor).
8. **Flexible Grouping:**
   - Form groups considering varied abilities to promote peer support.
9. **Tiered Assignments:**
   - Offer different levels of complexity in final reflection activity.
10. **Use of Technology:**
    - Use virtual reality for immersive moon experiences if available.

TIME	MATERIALS	ACTIVITY
30 min	Slides Student Mission Packet	1. (Slide 1) • Introduce the new unit to students. 2. (Slide 2) • Review the learning objectives. • Pass out the student mission packet. 3. (Slide 3) • **A little background information, anyone heard of Blue Origin?** • Wait for hands. • **Who knows what they do at Blue Origin?** • Take some answers. 4. (Slide 4) • **Well, Blue Origin is a space company that builds rockets that take people and things to space. Blue Origin's vision is millions of people living and working in space for the benefit of Earth.** • **What are ways we could utilize space to benefit Earth?** • Wait for hands. Take some answers. • **Those are great answers!** 5. (Slide 5) • **Let's watch a video about how they are doing this at Blue Origin.** • **As you saw in the video, Blue Origin is building rockets and flying people to space… all for the benefit of Earth.** 6. (Slide 6) • **Blue Origin has a 3-part mission, and as you can see, the third mission is "To inspire the Next Generation", that's where all of you come in.** • **If we want to see millions of people living and working in space, we'll have to solve some big challenges. It's going to take a lot of time and brain power and it's not going to happen in just my lifetime.** • **We need you to help us take on this mission and build this life in space.** 7. (Slide 7-9) • **So, let's talk about why we even go to space. What are some reasons we go to space? What is in space that might interest us? Take some hands and then go over slides 8 and 9.** 8. (Slide 10) • **Now for the main topic of the day, the Moon!** 9. (Slide 11) • **In the past, we have done a lot of research on the Moon's surface and the rocks on the Moon.** • Review definition of the moon. • **The powdery soil on the Moon's surface is what we call "lunar regolith"** • Go over definition. Give students time to take notes • **Scientists were able to study the Moon because we collected samples of lunar regolith many years ago when we went to the Moon.** • **Anyone know when we first landed on the moon?** • Take some answers. 10. (Slide 12) • Go over the slide. • Show video of the launch to the Moon. 11. (Slide 13) • Go over slide. • Let them know we will come back to the question in a bit.

		12. (Slide 14) • **We are working to go back to the Moon.** • **NASA's Artemis missions are set to take people back to the Moon in the near future.** • **Blue Origin is also working on landing on the Moon.** • **Let's take a look at what they are planning.** • Show the video. 13. (Slide 15-16) • Go over slides 15 and 16. • Leave time for students to take notes on the student worksheet. • Note that the pictures of the moon landers are different from the one in the Blue Moon video. This is because the video was of an early mockup, whereas the pictures are the most up to date models. 14. (Slide 17) • **Why do we care about the Moon's surface? It tells us about the history of the Moon and what it is made of. It also tells us about the resources that we could use from the Moon.** • **Utilizing space resources is one way we can make space more sustainable.** • Go over the definition of space sustainability. Allow students to take notes. 15. (Slide 18) • **Now let's look at how they are doing this at Blue Origin.** • Show video.
30 -40 min	Student Mission Packet Materials to simulate moon's surface.	1. (Slide 19) • **So now that you've seen why we want to study the Moon, you are going to look at some of the challenges we face with landing on the Moon.** 2. (Slide 20) • **What do you notice about these pictures of the Moon?** • Take some observations. • **What do you think these bumps are or what do you think is creating this texture on the surface of the Moon?** • Go over the slide. 3. (Slide 21) • **Who has heard of the word "topography"** • **Anyone know what it means?** • Go over slide and definitions. 4. (Slide 22) • Each group works on answering these questions. • Review answers as a group. • At this point, students will need the Moon map field that they will be testing on. If you are pressed for time, you can build this on your own and have it ready, or you can build it as a class (recommended). This lesson will be proceeding with students building the testing field. 5. (Slide 23) • Review the slide. • At this point, you could either build it as a class by looking at the different elevations and stacking items to represent those elevations and area accordingly, or you can break it up into different grids and have each group build out those sections. • Think about how you'll build out the elevations so that it matches the positive and negative elevations. • By building this with students, you are helping them understand how to read and interpret the map. 6. (Slide 24) • **Now that we have built our testing area, you will choose a site and complete your testing.** • Go over the slide.

		7. (Slide 25) • Go over slide. • If you have gone over accuracy and precision, this should be a review. If you have not gone over accuracy and precision, this would be a good opportunity to have students come up with definitions for each based on the pictures. 8. (Slide 26) • Go over slide. • Students will mark their site with a piece of tape and launch from a set distance away. You can decide on the distance based on your students. • They will test by launching three times and then will take the average distance achieved from their site. They might need to test their launch systems. • For added engineering challenge, they can build catapults to launch their rovers. • Otherwise, students will toss their rovers onto their launch sites. 9. (Slide 27) • Optional: make this a challenge with a winner, the team that has the lowest average distance from site would be the winner. • Have students complete their reflections and turn in the packets. 10. (Slide 28) • Go over slide for final answer to why the Sea of Tranquility was the site chosen. • The site was chosen because it was low elevation and a relatively large smooth surface.

STUDENT MISSION PACKET

MISSION LUNAR TOPOGRAPHY STUDENT MISSION PACKET

1. Why do we go to Space?
    a. ___________________________________
    b. ___________________________________
    c. ___________________________________
    d. ___________________________________
2. Lunar Regolith:____

    ____
3. Lunar Permanence:____

    ____
4. Space Sustainability:____

    ____
5. Topography:____

    ____

MISSION OVERVIEW:

In this mission, you'll become lunar explorers and take on the challenge of choosing the perfect landing site for your rover on the Moon.

DIRECTIONS:

1. Choose a landing site for your rover and mark it with a piece of tape.
2. Make your rover (this could be as simple as a wad of paper, you can search origami vehicles and fold one, or you can build your own out of paper).
3. Once you have your vehicle, you will test. You must launch one meter away from the edge of the Moon field and always launch from the same spot.
4. Measure the distance from your chosen landing site (tape) to where your rover landed.
5. Calculate the average distance from the rover.
6. Answer the conclusion questions.

DATA

	Launch 1	Launch 2	Launch 3	Average Distance
Distance in cm				

CONCLUSION

Answer the following conclusion questions.

1. *Where was your landing site and why did your team choose it?*

2. *Would you say your team was accurate in your launches? Why or why not?*

3. *Would you say your team was precise in your launches? Why or why not?*

4. *Do you think you chose the best landing site? If you could do it again, would you choose a different landing site? Why or why not?*

5. *What did your team find challenging?*

6. *What was successful?*

7. *Return to the initial question, why do you think Apollo 11 landed in the Sea of Tranquility?*