Science Activity 2: Landing Site Topography

Educator Preview

Activity Overview

Youth interpret topographic maps created by LiDAR technologies and then use the maps to understand the landforms and to identify safe and interesting landing sites.

Timing		**Prep Snapshot**	**21st Century Skills Connection**
Introduction	20 min	Prep Time 10 min	• Critical Thinking
Investigate	15 min		
Understand LiDAR Data	10 min	Print resources for the Activity.	**Science Practices**
Analyze Landing Sites	15 min		• Analyzing & Interpreting Data
Reflect	10 min		• Planning Investigations
Total	**70 min**		

Guiding Question	**Youth Will *Do***	**Youth Will *Know***
How can topographic maps help us choose a safe and interesting landing site on Mars?	• Interpret data from topographic maps to identify safe locations to land and landforms that might indicate water was present on Mars.	• A topographic map represents the shape of land in an area. • NASA uses LiDAR to make topographic maps of Mars.

Connecting Across Activities

In Science Activity 1, youth learned about landforms on Earth and Mars. In this Activity, youth deepen their understanding of landforms by examining topography data. Next, in Science Activity 3, they will interpret mineral data collected by spectroscopy.

Educator Resources
Access Activity resources using link or QR code.

Activity Resources

QR code leads to resources available for this Activity.

https://planets-stem.org/**betars-activity-s2**/

Family Connection

If time permits, have youth ask the following question to their Elders, families, or mentors before the Activity:

Q: Can you tell me a story about our landscape or the land on which we live?

Materials and Preparation

Materials

For the whole group

- *Topography Chart* or shared document (save for use in Activity 4)

For each group of four

- *Science Activity 1 Data Packet*
- *Science Activity 2 Data Packet* in page protectors, if possible
- *Topography Template*
- 1 *Landing Site Oval* from *Science Activity 1*
- 1 sheet of foam, craft
- scissors
- tape, masking
- writing utensils (pencils), colored, shades of yellow, green, and blue if possible
- 1 glue stick (optional)
- 1 toy car, about the size of one *Landing Site Oval* (optional)

Supporting Learner Differences

Consider providing the cut foam pieces instead of having youth cut them using the *Topography Template* handout.

For each youth

- Science Notebook

Activity 2 Materials Preparation (10 min)

1. Make copies of the *Topography Template* and *Science Activity 2 Data Packet* for each group of four. Consider laminating the pages of *Science Activity 2 Data Packet* or placing them into plastic page protectors to prevent them from getting damaged.

Activity Guide

Guiding Question: How can topographic maps help us choose a safe and interesting landing site on Mars?

Post the question somewhere accessible, such as on chart paper or a shared document, so that youth can refer to it throughout the activity.

Introduction (20 min)

1. If you sent youth home with the Family Connection question, ask:

   Q: Did anyone talk with their families at home about their land? If so, is there anything you would like to share?
   A: Accept all responses.

   Youth may identify any number of landscapes, places, and land uses.

2. Ask the following questions to help youth think back to the previous activity:

   Q: As scientists, what are we trying to find out?
   A: We are trying to find the best location to land a rover on Mars to find evidence of past water.

   Q: Why are we trying to land a rover on Mars?
   A: We want to gather evidence to answer questions such as Could living things have been there once? Was water present on Mars?

   Q: What data have we examined so far and how does it help us answer our questions?
   A: We identified landforms at each of the four possible landing sites. Landforms that are shaped by water are evidence of past water on Mars.

   Q: What else might we need to know about the landforms before we send a rover to explore further?
   A: Responses will vary. Possible responses include the size and height of the landforms and the materials they are made from.

3. If time and weather permit, go outside and travel with youth across areas of varying height and slope. Ask:

   Q: What do you notice about the height of the land as we travel?

   A: Accept all responses. Possible responses include that it is going up or down; that it is steep, not steep, or flat; that it is difficult or easy to travel on; or that it is a landform such as a valley or hill.

   Q: When would it be good to know ahead of time if the land is steep or not? Why?

   A: Responses will vary. A possible response is we would want to know before travelling across the land so we know how difficult it will be and if we need special equipment to help us.

   If your environment allows, have youth spread out to areas of different height. Have youth observe each other spatially and ask:

   Q: How could we record these changes in height on a map?

   A: Accept all responses. Possible responses include using color, texture, measurement numbers, or lines to represent different heights.

   Explain that maps showing height usually use lines that trace places that are all the same height. If you walked one of these lines on the ground, you would never go up- or downhill. Different lines on the same map show different heights. These maps are called ***topographic maps***. The shape of land in an area is called that area's ***topography***.

Supporting Youth Thinking

To support student understanding of the word *topographic*, tell youth that it comes from the roots *topo*, meaning "place," and *graph*, meaning "to write or draw." Have youth think of other words they know that come from similar roots, such as *utopia* (a good or nonexistent place), *dystopia* (a bad place), *graph* (a drawing of data), *graphite* (a soft mineral that leaves a gray streak, used to make pencil "lead"), and *bolígrafo* (Spanish for *pen*).

You may want to allow youth to share stories about any previous experiences with topography, such as using depth finders for fishing. You can also prompt youth to consider the topography of indoor spaces, such as the height and arrangement of different items in a room.

4. Share this Activity’s Guiding Question with youth:

   Q: How can topographic maps help us choose a safe and interesting landing site on Mars?

Investigate: Build Topographic Models (15 min)

1. Organize youth, or have them organize themselves, into groups of four.

2. Provide the *Topography Template* Handout, a piece of craft foam, scissors, tape or glue stick, and colored writing utensils to each group.

3. Have youth color each shape in the *Topography Template* from darkest (shape 1, blue) to lightest (shape 7, yellow).

Supporting Learner Differences

Encourage youth to use patterns instead of colors to indicate the different layers.

4. Have youth cut out each of the seven layers on the template.

5. Have youth use each of these paper layers to outline and cut a shape from the craft foam. All shapes can be cut from one sheet of craft foam if youth plan ahead.

6. Have youth tape their craft-foam shapes together using tape loops on the back of each shape or a glue stick. They should begin with the largest shape and attach the next smallest shape to it, and then the next smallest, so that each shape is fully within the boundary of the one below it.

7. Have youth tape the layers of the paper templates in the same way as the foam pieces and then trace the outline of each layer. Explain that youth have created topographical maps from three-dimensional models.

8. While youth are working, help them understand their topographic maps by asking the following questions:

   Q: Since these layers are all flat, how can you tell which layer stands for the highest area and which stands for the lowest?

   A: Responses will vary. A possible response is that the lightest color layer is the highest area, and the darkest color is the lowest.

   Q: What does each line represent?

   A: Each line represents land at the same height.

   Q: What does it mean when the lines are close together? When they are far apart?

   A: Where there are a lot of lines close together, the slope is very steep. When the lines are far apart, it is not as steep.

   Q: Are there areas around here that have topography similar to what is represented by this map?

   A: Accept all responses. Possible responses are that local steep areas, such as hillsides and cliffs, could be represented by areas of the map where the lines are close together. Local flat areas, such as fields and plains, could be represented by areas on the map where the lines are far apart.

9. Provide each group with a landing site oval from Science Activity 1 or a toy car. Have each group place the oval (or toy car) on different parts of their craft-foam model. Ask:

   Q: If you want your oval/car to be stable and not tilt, where should you place it? Why?

   A: Responses will vary. A possible response is that you should place the oval/car on a single layer because it doesn't tilt there. If it is on multiple layers, it tilts.

The best landing site will tilt the oval or toy car the least.

Supporting Youth Thinking

If you are using the toy car, point out the scale of this model is not correct—the car would have to be <u>much</u> smaller (there are no 5-mile by 10-mile-long cars out there!). Encourage youth to notice where the lines on the 3D model appear closer together. Ensure youth understand that lines that are closer together indicate steeper lines.

10. Have each group place their oval/car on their paper map in various locations. Ask:

    Q: Using the information from the map, would your oval/car be level or tilted if it was really in this location?

    A: Responses will vary. Possible responses include that it would be tilted if it is sitting across lines and flat if it is not sitting across any lines.

11. Have each group share their topographic models and maps with another group. Have the groups discuss how the models and maps are similar and different.

Understand LiDAR Data (10 min)

1. Tell youth: Now that you understand how to read a topographic map, you are ready to explore topographic maps of Mars! Explain that, to help scientists study the topography of Mars, engineers developed an instrument that measured the height of millions of different points on the surface. By putting those measurements together, scientists know the topography of the entire surface of Mars.

2. Tell youth *Li*ght *D*etection *a*nd *R*anging*,* LiDAR, is how these maps were created. Remind youth what they learned from the *Special Report Video* (3:37 – 5:18) about this technology. LiDAR gathers information about the size and height of landforms by bouncing a laser off them and measuring how long it takes the light to come back. This approach is one way NASA learns about the surface of Mars.

Connecting Across Activities

The Engineering Series, *Worlds Apart: Engineering Remote Sensing Devices,* goes into detail on how LiDAR works and challenges youth to engineer a model LiDAR device to capture the topography of a surface.

3. Provide the *Science Activity 2 Data Packet* to each group. Give groups several minutes to examine the data and compare it to previous images. Ask:

   Q: What do you notice about this data?

   A: Accept all responses. Youth may notice that the images are topographic maps with lines. The images have colors matching the color scale on the topographic maps they made earlier.

   Q: What locations do these images show?

   A: Responses will vary. A possible response is that the images show the same locations that youth have already examined: Gale Crater, Iani Chaos, Jezero Crater, and Nili Fossae. Specifically, they show the same area of interest in each location as the Context Camera images.

4. Use *Jezero Crater: Topography*, pages 38 – 39 in the *Science Activity 2 Data Packet,* to guide youth through the following prompts:

   Q: What do you think the color scale means?

   A: The colors represent height. Yellow represents high areas and blue represents low areas. (If printed in grayscale, brighter represents high areas and darker represents low areas.) The color scale shows the direction of the slope.

   Q: What do you think the lines mean?

   A: As on the topographic maps earlier, each line represents a particular height.

   Indicate different parts of the crater. Ask:

   Q: How steep is this area?

   A: Responses will vary. Where lines are close together and color varies quickly, the slope is steep, such as on a hill or mountain. Where lines are far apart and color varies slowly, the slope is shallower, such as on a flat plain or field.

   Q: What makes a good landing site, and which areas of the map are good landing sites?

   A: Responses will vary. A possible response is that a landing site should be in a flat area, not a steep area. Interesting landing sites will include landforms that may have formed in water. Scientists also often like to explore areas with steep slopes or rugged topography, where layers of rock might be exposed.

Analyze Landing Sites (15 min)

1. Give youth time to examine and describe the topography of each site with their groups. Remind them to refer to the data from Science Activity 1, Landforms, as well.

2. Have youth record their observations of the topography of each site in the table on *Safe and Interesting Landing Sites*, pages 11 – 14 of their Science Notebooks.

3. Have groups share their ideas with the class.

4. Ask youth:

   Q: Why do you think NASA scientists are interested in topographic maps?
   A: Responses will vary. A possible response is that topographic maps can show the shape of landforms, which can tell scientists more about how those landforms formed, how much water might have been involved, how long they took to form, etc.

5. Have youth select safe places to land for each of the possible landing sites. Say: "At each of the four possible landing sites in the *Data Packet*, trace one oval (10 miles by 5 miles; 16 kilometers by 8 kilometers) showing where you think it might be safe and scientifically interesting to land."

   Remind youth that a safe landing site should be as flat as possible, while a scientifically interesting landing site should be on or near landforms that indicate past water.

Supporting Learner Differences
If youth need a bonus challenge, groups can choose landing sites that also have evidence of volcanic activity.

6. Have youth rank the sites from safest to least safe on *Safe and Interesting Landing Sites*, page 15 in their Science Notebooks. If necessary, suggest roles that group members can fill, such as referring to observations, moderating discussion, and recording the group's choices.

Reflect (10 min)

1. Discuss the topography and landforms at the four sites. Record youth ideas on the *Topography Chart* or a shared document that is accessible to the whole group. Ask:

   Q: After analyzing the data, do you have a better sense of where the best landing site might be?
   A: Accept all responses. A possible response is that we have a better sense of the best site because we have information about landform types and topography.

   Q: Did your rankings change when you got topographic maps?
   A: Accept all responses.

   Q: How or why did the topographic maps change your decision about the best places to land?
   A: Accept all responses. A possible response is that we rated flat areas that are safe to land more highly than before.

2. Rephrase and repeat the Guiding Question. Ask:

   Q: How did topographic maps help us choose a safe and interesting landing site on Mars?
   A: Accept all responses. A possible response is that topographic maps of the landing sites are data that helped us to locate a safe, level landing site.

3. Reinforce the connection between evidence for past water on Mars and the possibility of past life so that youth can use this information later in the activities. Ask:

   Q: What questions do you still have?
   A: What other remote sensing data do we have to help us choose a landing site?

4. Wrap up for the day by congratulating youth on their scientific work and remind them they are following a site selection process that is very similar to the process NASA has used in past, present and future missions. Let youth know that next time, they will explore yet another type of remote sensing data about sites on Mars.

After the Activity

1. Plan ahead for Science Activity 3. See Activity 3 Materials Preparation on page 58.

2. Take time to reflect on the following educator prompt:

   Q: How did you help youth understand the concept of a topographic map? How could you use similar strategies during future activities?

Remote Sensing Unit Resources

QR code leads to resources available for this unit.

https://planets-stem.org/**betars-unit-landing-page**/