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DESIGN2LEARN

GEOLOGY

Spaghetti Marshmallow Design Challenge

Summary

Engineers need to consider strong shapes and geological processes when constructing bridges, buildings, and other structures. In this design challenge, youth, like engineers, will apply their knowledge of earth science to build structures on different types of terrain.

As some participants might already know from their science class, dynamic processes that wear away Earth's surface include weathering and erosion. Weathering breaks down rocks to form sediment. Erosion transports that sediment. Materials like sand and soil are the products of weathering and erosion. These forces are responsible for different earth materials, types of terrain and geological features. In this challenge, everyone will create free-standing structures on a variety of different types of terrain.

MATERIALS | HERE'S WHAT YOU NEED FOR THIS ACTIVITY!

- ☐ *Spaghetti-Marshmallow Team Worksheet*
- ☐ 20 uncooked spaghetti (per team)
- ☐ 3 feet of tape (per team)
- ☐ 1 marshmallow (per team)
- ☐ Scissors
- ☐ Ruler
- ☐ Measuring tape
- ☐ 4 aluminum foil trays (or more, depending on the size of your group)
- ☐ Soil and/or Sand
- ☐ Foam block, cut into slanted "hill" shape
- ☐ Pebbles/small rocks
- ☐ Scrap paper and pencils
- ☐ *Fun timer to project on screen*

VOCABULARY WORDS	
WEATHERING	The process that breaks down rocks to form sediment.
EROSION	The transport of sediment.
SOIL	A substance that consists of sediment, organic material, water and air.

Preparation Before the Lesson

1. Purchase and arrange your materials. Each group (~2 people per group) will need 20 uncooked spaghettis, three feet of tape and one marshmallow to make one structure.
2. Set up aluminum trays with four different terrain types: sand, soil, slanted hill, and bumpy rocks. Depending on the size of your group, you may want to make more than one tray of each type so there are enough for each group to try.

Delivering the Lesson

1. HOOK THE YOUTH:

Think about how you're going to "hook" the group, or get them excited about this activity. Can you think of a creative way to motivate everyone, relate the activity to their lives, or pique their interest? If you're stuck, we've included some suggestions below:

- Keep momentum high by getting to the initial round of building quickly. Do a quick introduction of content, but come back to it in more depth after participants have had a chance to jump right into the first round of the spaghetti marshmallow challenge.
- Do a virtual (or real-life) "tower tour." Check out pictures of various towers from all over the world on different terrains. If there are skyscrapers or other tall structures walking distance from your school, do a walking "tower tour" to gather inspiration for the challenge.

2. INTRODUCE THE CONTENT:

Explain to the group that all over the world, engineers have to build homes, buildings to work in, and structures of all kinds. Engineers have to take many elements into account, such as the building materials available, their budget, and the geology of the land where they're building. Ask everyone how different types of terrain or land might impact how and what engineers build.

POSSIBLE QUESTIONS TO ASK:

- What are different types of terrain that you know about?
- How do those different types of terrain come about? For example, why are there sometimes cliffs along the edge of the ocean?
- How do you think different types of terrain or land might impact how and what engineers can build in different parts of the world?

3. ISSUE THE DESIGN CHALLENGE:

After everyone have discussed how different types of terrain might impact what and how engineers build, deliver the design challenge!

> Create the tallest, free-standing structure you can on five different types of terrain: flat terrain, soil, sand, pebble stones, and a slanted hill.

Have the group decide on fair testing rules and constraints for this engineering design challenge together. Use this discussion as an opportunity to incorporate youth voice as they decide what counts as "success" in this design challenge. Some suggestions are:

- The structure has to be free-stranding. No one should hold any parts during testing
- You cannot alter the marshmallow. Eating it disqualifies your whole team
- You may alter other materials (the spaghetti and masking tape)
- The entire marshmallow must be at the top of the structure*
- The structure will be measured from the table surface to the top of the marshmallow
- You don't have to use all of the materials, except for the marshmallow
- You'll have _____ minutes (suggested: start off with 20 minutes and give extra time if need-be)

*Adding the marshmallow at the top of the structure makes this design challenge more difficult. By having to support the marshmallow at the top of the structure, each group will need to design a structure that can balance and support a (relatively) heavy load.

4. PROVIDE TIME FOR PLANNING, BUILDING, AND TESTING:

Hand out the *Spaghetti Marshmallow Team Worksheet*. Ask everyone to write the challenge in their own words in the first box: "Identify Problem". Have participants share out the challenge in their own words and check that each person understands the prompt.

Give each group five minutes for planning. Distribute scrap paper or index cards with pencils for sketching. Encourage teams to sketch their design ideas on the Spaghetti Marshmallow Team Worksheet in the space for question 2, "Brainstorm." Pass out a few sample materials and allow everyone to see and feel the spaghetti and marshmallows. They should become familiar with the properties and characteristics of each material to help them think about design, but should not begin building yet.

POSSIBLE QUESTIONS TO ASK:

- How do the different materials feel?
- What do you think will be the benefits of working with the spaghetti? Any drawbacks? What about working with the marshmallow?
- What type of design do you think will work best? Why?
- What are you using as inspiration for your design?

Once each group has finalized their sketches, hand out the materials to each group. When everyone is ready to begin, start the timer for 20 minutes (or whatever time your group decided on). Give everyone a warning as the timer approaches zero and give them additional time, if needed.

POSSIBLE QUESTIONS TO ASK WHILE BUILDING:

- Can you tell me about your design?
- What made you decide to add this particular feature?
- Is it challenging or easy to build on flat terrain?
- What kinds of things are you thinking about for your design? (strength, flexibility, strong shapes, etc.)

Once everyone has completed their structures and time is up, use a ruler or measuring tape to measure the towers' heights and see which was the highest. Individuals can record the heights on their worksheets in question #3, "Build/ Test."

POSSIBLE QUESTIONS TO ASK WHILE TESTING:

- What are some of your observations?
- Are there any changes you want to make to your design? How come?
- What happened when you added the marshmallow?

5. LEAD THE GROUP IN A REFLECTION ACTIVITY:

Once all everyone has measured their towers, facilitate a reflection discussion to prepare groups for the next rounds of building. You can ask the questions below, or incorporate your own.

- What inspired your tower design?
- What were some challenges you had in initially constructing your tower?
- What improvements would you make to improve their tower design?

- How do you think flat terrain helped or hurt your design?
- Do you think your design will need to change on other terrain types? How so?

Give teams time to sketch an improved design idea on the team worksheet in question #4, "Evaluate/Improve."

6. PROVIDE TIME FOR NEW ROUND OF PLANNING, BUILDING, AND TESTING:

Explain that teams will now have a chance to use what they learned while building on flat terrain to try and engineer an improved tower on a new terrain type. You can decide how you want to structure this round: each group can choose the terrain type they're interested in building on, you can do multiple rounds so each group builds on each terrain type, or you can come up with something else.

Give everyon five minutes for planning. Distribute scrap paper or index cards with pencils for sketching.

POSSIBLE QUESTIONS TO ASK:

- How are you using what you learned from the last round of testing to inform your new design?
- Do you think it will be more or less challenging to build on this new terrain type? Why?
- What are you using as inspiration for your new sketch?

Once everyone have finalized their sketches, hand out the materials to each group. When everyone is ready to begin, start the timer for 20 minutes (or whatever time your group decided on). Give teams a warning as the timer approaches zero and give them additional time, if needed.

POSSIBLE QUESTIONS TO ASK WHILE BUILDING:

- Can you tell me about your design?
- What made you decide to add this particular feature?
- How is it going building on this new terrain type? What are you noticing?
- What kinds of things are you thinking about for your design? (strength, flexibility, strong shapes, etc.)

Once everyone has completed their structures and time is up, use a ruler or measuring tape to measure the towers' heights and see which was the highest.

Depending on how you've structured this portion of the activity, repeat this process with the different terrain types so that everyone has the opportunity to try and build on the different materials.

7. LEAD THE GROUP IN A REFLECTION ACTIVITY:

Conduct a brief "gallery walk" if the groups have not seen every team's final structure and especially if they did not get to build on each terrain type. Have a brief discussion, using the questions #5 on the worksheet, "Share Solutions."

- How do you think your team's design did?
- What do you like about your team's design? What do you like about other designs?
- What would you change about your design to make it even better next time? Why?

Possible Timeline

You can divide this activity into more than one hour-long session and use different pre- and post- activities to highlight different science concepts. See below for some possibilities, combine them as you like, or come up with your own!

TIMELINE 1	
SESSION 1 (1 HOUR)	Introduce the challenge. Build and test. Reflect on the first round of building.
SESSION 2 (1 HOUR)	Build and test with two new terrain types. Reflect and share solutions.
SESSION 3 (1 HOUR)	Build and test with remaining two terrain types. Reflect and share solutions. Alternatively, let youth choose the terrain types and challenge each other to build on materials like marshland or others.

Additional Background Information

The rock at Earth's surface forms a nearly continuous shell around Earth called the lithosphere. There are dynamic processes that wear away at the Earth's surface. These processes are called weathering and erosion. Weathering breaks down rocks to form sediment. These sediments make up earth materials like sand and soil. (Soil also includes organic material, water, and air.) Erosion is the process transports sediment. Gravity is the driving force behind erosion. Gravity can act directly to move sediment, or move sediment through water, wind, and glaciers. Together, these forces are responsible for different earth materials, as well as types of terrain and geological features. Overtime, sediment gets deposited during erosion. These deposits can result in changing landforms, changing soil composition, and new types of terrain. In this challenge, participants create free-standing structures on a variety of different types of terrain. They get to explore the properties of different materials and explore what modifications are necessary for structures to stand on different types of terrain.

Scope and Sequence Major Understandings

- The dynamic processes that wear away Earth's surface include weathering and erosion. (2.1g)
- Erosion is the transport of sediment. Gravity is the driving force behind erosion. Gravity can act directly or through agents such as moving water, wind, and glaciers. (2.1i)
- The process of weathering breaks down rocks to form sediment. Soil consists of sediment, organic material, water and air. (2.1h)

NGSS Science and Engineering Practices

- Collect data about the performance of a proposed object, tool, process, or system under a range of conditions.
- Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process, or system.