Western Engineering Outreach

Volcano Shelters

Grade 3-5

Meet Today's ENG HERO!

Elizabeth Gillies - Professor with Western Engineering

Elizabeth Gillies is a Professor in Chemical and Biochemical Engineering at Western University. Dr. Gillies leads a research program in smart materials and biomaterials spanning from fundamental discoveries to applications with a focus on polymer chemistry and the design synthesis of materials with new properties and functions. She is also exploring applications of her materials in drug delivery, regenerative medication and agriculture. To learn more about Dr. Gillies, please visit: https://www.eng.uwo.ca/chemical/faculty/gillies_e/index.html

Learning Goal:

- Students will apply the Engineering Design Process to ensure that they successfully built a shelter that will not collapse under the weight of more and more flour.
- Students will engage in multiple tests to make observations that can lead to the best possible final design for their structures.
- 3 to 5- Understanding Structures and Mechanisms, Strong and Stable Structures 1.1 Assess effects of strong and stable structures on society and the environment (e.g., reliable load bearing structures are essential in all areas of life for shelter)

Materials:

- A few large index cards
- Construction paper
- Masking tape
- Straws
- Scissors
- Flour
- Popsicle sticks
- Cardboard
- Plastic cup
- Water
- 3-4 Tbsp of baking soda at least
- 1 tsp of dish soap
- Food colouring
- 1 cup (8 oz) of Vinegar
- Large metal trays as building platforms

Engineering and Science Connections:

Background:

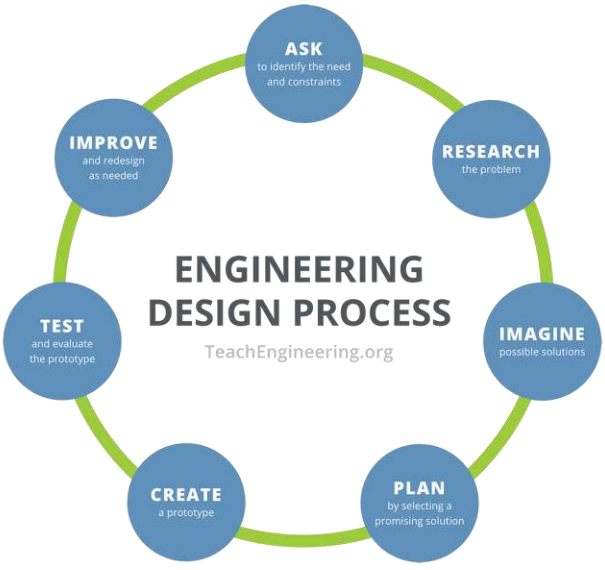
Explosive volcanic eruptions can result in large quantities of ash being shot into the sky and carried by wind up to thousands of miles away. This volcanic ash then falls from the sky in the areas surrounding the volcano and can result in build-up of several inches and even feet. Not only is theash hazardous to breathe, but it can challenge the structural integrity of homes and buildings.

Because the ash is dangerous to inhale, many people hide in their homes or nearby buildings until the ash stops falling. However, as the ash accumulates on buildings, it causes strain that can lead structures to collapse, which is an even great danger to those inside. Volcanic ash is not only heavier than snow, but it also does not melt and disappear as the weather gets better.

Many buildings that may be able to hold a great quantity of snow are unable to remain standing under the pressure of large quantities of ash. It is recommended that any homes built in an area at risk of being involved in a volcanic eruption be built to withstand a large amount of ash fall. In general, flat roofs are more prone to collapse than roofs with a steep slope. Steep-pitched roofs will allow the ash to fall away from the roof instead of accumulating. Adding reinforcements to a house to make the walls and roof stronger may also help protect against collapse.

Engineering Design Process:

The Engineering Design Process is a problem solving system used by engineers to develop the best solution possible for every problem that they solve. Here is a chart explaining this system:



Activity :

Challenge 1: Students will design and build a model shelter that will not collapse during a volcanic eruption. The first test will be to withstand the baking soda volcano. To be successful in this task, we want to ensure that there is no liquid getting into the floor of the shelter the students have created. Students must:

1. Minimize the amount of liquid within their shelter once the eruption occurs
2. Have an easily accessible way to open and close shelters (needs a door)

Challenge 2: Once students have successfully completed the first component of the challenge, cups of flour, representing the ash from a volcanic eruption, are poured onto the structure. The structure needs to:

1. Not cave as more and more ash (flour) is poured on top of it.
2. Prevent ash (flour) from accumulating inside the shelter

STEP 1:

You have been tasked with constructing a model shelter that could withstand the pressure of the accumulated ash that results after a volcanic eruption.

STEP 2:

Use these materials to construct a shelter that:

1. Will not cave as more and more ash (flour) is poured on top of it.
2. Will prevent ash (flour) from accumulating inside the shelter.
3. Prevent lava (baking soda, vinegar + water) from entering the shelter.

Ensure that you are building on a large metal tray as a base. It is recommended that you use the Engineering Design Cycle to construct the best possible shelter that can meet these specifications.

STEP 3:

Brainstorm what type of roof would best withstand volcanic ash build-up and ways to prevent lava from entering the structure. Create diagrams showing the different types of roofs or shelters to test. Make adjustments to your diagrams as you think through any potential problems that may arise with that design solution.

STEP 4:

Test your designs with flour throughout the design process, see which designs work and which ones fail. Try to only use a limited amount of materials and repurpose materials to fit in different roles if they don't meet the requirements of the initial role.

Volcano Shelters

STEP 5:

Once you have completed building your shelter, test it to see how well it would withstand the lava eruption.
To make Lava:

- Start off by combining the "base ingredients." Put the water inside of the plastic cup. Fill it about 2/3 full. Add the baking soda, dish soap, and food colouring.
- We give it a good stir just before adding the last ingredient using a popsicle stick. Now it's time for the eruption! Pour in the vinegar until it starts foaming over, pouring it's lava all over.

STEP 7:

We can now test for the structure's ability to withstand the ash following the eruption. Test your prototype using a measuring cup to pour a consistent amount of flour on top of the roof. Count how many cups of flour your shelter is able to hold before collapsing or filling. You may use a scale to weigh the amount of flour needed for collapse.

STEP 8:

Once you have observed how your shelter withstands the eruption and ash, make improvements based on the results.

Examples:

What Did You Learn?

- Which design solutions worked best for your shelter? Which ones didn't work? Why?
- What changes did you have to make to your shelter based on your testing observations?
- It is not uncommon for falling ash to be accompanied by rain due to the weather changes that can occur after a volcanic eruption.

Future Learning

- What effect do you think adding water to this activity would have on your results?
- How would you need to change your design if water were added to the flour before it was poured onto your house?
- What other types of natural phenomena might impact the way roofs are constructed?

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

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Thanks for discovering with us!