

Lesson Plan: Flood Barrier Design Challenge

Adapted from STEM Flood Control Challenge by *Teachers are Terrific*

Target Grade: 3rd

Teacher Prep Time: 30 minutes

Lesson Time: 3 days/180 min. total

Learning Goals:

- Students will work as a team to design and build a flood barrier for their doghouse made from their choice of materials.

NGSS

- 3-ESS3-1. Make a claim about the merit of a design solution that reduces the impact of a weather-related hazard. (Clarification Statement: Examples of design solutions could include barriers to prevent flooding, wind resistant roofs, and lightning rods).*
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- Disciplinary Core Ideas
 - ESS3.B Natural Hazards
 - A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.
- Cross Cutting Concepts
 - Cause and Effect
 - Cause and effect relationships are routinely identified, tested, and used to explain change.
- Science and Engineering Practice
 - Constructing explanations (science) and designing solutions (engineering)

Where this lesson fits in:

- Prior to this lesson, students will have researched weather conditions such as major rainstorms and hurricanes. Students should have also been exposed to images of various types of flood barriers.

Materials Needed:

Per Individual:

Pencil

Saving the Doghouse worksheet packet

Small food container (Smart & Final FoLo Pak 16)

Per Class:

Design Rules poster

Masking Tape (1 roll)

Paper Towels (1 roll)

Water Soluble Markers

Per Group of 2-3 students

9x13 aluminum tray or plastic container

4 -12 oz. Styrofoam cups

1 - 2 cup measuring cup

1 - 6 oz. plastic cup for Part 1 (reused in Part 2)

1 -graduated cylinder to measure 50 ml of water

1 - 1 cup of polyester fiberfill (Polyfill) for pillows

1 kitchen sponge piece (Cut per Teacher Prep)

1 microfiber towel piece (Smart & Final, 18 Large

towel bag size, cut per Teacher Prep)

4 plastic straws

2 toilet paper rolls

Videos: *Flooding Video: 02-17-2017 Santa Barbara-Los Angeles Major Flooding and*

Mudslides <https://www.youtube.com/watch?v=5NNr6D03nik>

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Teacher Preparation:

1. Prepare 1 Styrofoam cup per group for absorbency testing by making a pencil-sized hole in the bottom of the Styrofoam cup.
2. Make copies of *Saving the Doghouse* Worksheet for each student.
3. Measure out polyester fiberfill into one cup quantities.
4. Cut masking tape into 12 in. strips.
5. Cut large kitchen sponges in fourths.
6. Cut microfiber towel in half.

Engage: (10 min.)

Ask students to pair/share what they know about floods and storm surges. Allow students to share out.

Show the video of actual floods. Ask students to describe the effects of the floods. Discuss what causes floods. Then ask students to define the term “flood.” (ESR (Expected Student Response): A flood is a natural event that occurs where an area of land that is usually dry, suddenly gets submerged under water. It can be due to large amounts of rain falling in a short period of time. It can happen quickly and cause a lot of damage.)

Ask students if people can prevent these natural weather conditions?

Explain that although we can't stop heavy rainfall or overflowing waterways, there are steps we can take to help protect our homes and the homes of our pets.

Explain to students that they will be engineers tasked with designing a way to keep their dog's house in their yard from being flooded.

Distribute the *Save the Doghouse* worksheet to each student. Have students record their definition of a flood.

Lab: Part 1 (50 min.)

Ask students what kinds of materials might be helpful to keep water away from the doghouse. (ESR: materials that soak up or block the water.) Discuss the terms, “absorb” and “absorbency”. Have students record the definition for the term, “absorb” on their worksheet.)

Ask, “How you can tell what materials absorb water?” (ESR: Measure how much water the materials soak up.)

Explain that students will have the chance to select different materials and test their absorbency.

Absorbent materials:

- Polyester fiberfill (1 cup)
- Sponge piece (1)
- Paper towel sheet (1)
- Microfiber towel piece (1)

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Show students the materials to test for absorbency. Read through the procedure together, and then have the students select one of the materials that you can use to demonstrate the following steps. Students will then conduct the procedure for the remaining absorbent materials.

Absorbency Test Procedure:

1. Measure 50 mL of water into a graduated cylinder
2. Cover the hole in the Styrofoam cup with the absorbent material to be tested.
3. Place that cup into the second Styrofoam cup
4. Using a second hand or timer, pour the 50 mL of water into the top Styrofoam cup, and wait for exactly 15 seconds.
5. Lift the top Styrofoam cup and place into the plastic cup/container to catch any excess water.
6. Measure the amount of water in the bottom Styrofoam cup by pouring it into the graduated cylinder and record this amount on the worksheet along with any observations.
7. Remove the tested material and repeat for each of the other absorbent materials.

Gather students back together and discuss the results. Students will record the class range of water absorbed for each material. Have students record which material(s) were the most absorbent based upon the class results.

Distribute doghouse containers and allow students to decorate using water-soluble markers in preparation for Part 2. Use of the markers will allow students to see where water touched the doghouse.

Lab: Part 2 (1 day/60 min)

Tell students that now they will use what they have learned about the absorbency of materials to help them design a way to keep their doghouse dry in a "flood".

Show students the container that will represent their backyard. Explain that engineers are limited or constrained by the building restrictions and/or materials that are available to use. Sometime the materials are in limited supply, and material costs must also be considered. Engineers must also follow design rules.

Requirement: The doghouse must not be wet 10 seconds after 2 cups of water are poured rapidly into the container outside of the barrier.

Project the **Design Rules** sheet and review with the class.

1. The house must be placed on the bottom and in the center of the container.
2. The materials cannot be more than half the height of the doghouse.
3. You may choose only **one** of the absorbent materials we tested.

Material Constraints: Review the materials that will be available for use:

Absorbent Materials: Students may choose **one** of the absorbent materials tested in the quantities shown below:

Polyester fiberfill (1 cup)

Sponge pieces (2)

Paper towel sheets (2)

Microfiber towel piece (1)

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Other building materials choices and quantities available:

2 toilet paper rolls, 12 in. masking tape strip, 4 plastic straws, 2 Styrofoam cups

Direct groups to work together to design their flood barrier and record the materials to be used on their *Save the Doghouse* worksheet. Students should make a drawing of their design and label each component.

Allow students time to gather the materials and build their flood barrier. Check to be sure teams have documented their design and explained their thinking on their worksheet.

Divide the design teams into equal groups. For example if there are 9 groups, have them gather into 3 equal groups. Each team in the group will explain their design and will then test their design per the procedure below, while the other teams observe.

Flood Barrier Testing Procedure:

1. Fill measuring cup with 2 cups of water
2. Pour the 2 cups along one end of the pan outside the barrier as quickly as possible
3. Leave the set-up undisturbed for 10 seconds
4. Remove the doghouse from the container and check to see if wet
5. Record results and observations on worksheet

Example Set-ups:



Discussion and Extension:

Gather the class together and review the results.

Have each successful group draw their design on the whiteboard or place worksheet under doc camera to aid discussion. Ask the following questions emphasizing cause and effect relationships.

Discussion Questions

- What do the designs that worked have in common?
- What characteristics of the materials used were the most important? Why?
- Do the designs that didn't work have anything in common?
- Why do you think these designs were not successful?
- If the constraints were removed, would you change any materials?
- Would you change the design?

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Part 3: Redesign

Allow all teams to redesign their flood barriers. Challenge teams that were initially successful to redesign their flood barrier using less material than in Trial 1. Explain that less material will likely equate to less expensive flood barriers. Remind them that engineers also face cost constraints.

Check to be sure teams have documented their design and explained their thinking on their worksheet.

Teams regroup and repeat the Flood Barrier Testing Procedure. Then gather the class together and again review results and revisit the discussion questions. Allow time for the students to complete the questions on their *Saving the Doghouse* worksheet.