W 1045

DESIGN CHALLENGE — FLOOD BARRIERS

Can You Keep Your House Dry?

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Design Challenge – Flood Barriers

Can You Keep Your House Dry?

Skill Level
Beginner – Advanced

Learner Outcomes
The learner will be able to:
Understand causes of flooding
Develop and test an engineering design

Educational Standard(s) Supported
ETS1 (any grade level)
MS-ESS3-2, MS-ESS3-3

Success Indicator
Learners will be successful if they:
Design a flood barrier that meets the challenge requirements

Time Needed
30-40 minutes

Materials List
- *Paper and pencil*
- *Dishpan or 9-by-13-inch aluminum tray (one per group)*
- *2 cup measuring cup (one per group)*
- *Small cardboard box or empty Kleenex boxes to serve as a house*
- *Various barrier materials: Styrofoam, cotton balls, fiberfill (pillow stuffing), plastic, paper towels, microfiber towels, modelling clay, sponges, straws, popsicle sticks, waxed cups or plates, plastic wrap*
- *Attachment materials: tape, paper clips, rubber bands etc.*
- *Kitchen scale (if weighing designs)*
- *STEM Challenge worksheet (one per student)*

Introduction to Content

In this lesson, students will participate in a design challenge where they have to build a barrier that will keep a small cardboard house dry from flood water.

Introduction to Methodology

In this design challenge, students will be challenged to use absorbent and impervious materials to make a flood barrier that keeps a house dry while minimizing material weight.

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Terms and Concepts Introduction

Flood – An overflowing of a large amount of water beyond its normal confines.
Absorbent – Absorbent materials are able to easily soak up liquids.
Impermeable – Impermeable materials do not allow liquids to pass through.

Setting the Stage and Opening Questions

What is a flood? Have you ever experienced a flood?
A flood is an overflow of water to an area that is normally dry. A flood happens when rainfall exceeds the drainage rate for a particular area. This could be due to a river overflow, dam or levee break, hurricanes causing heavy rain or storm surge, or rapid snow melts.

Flooding is predicted to increase in the future. Can you guess why?
Scientists predicted that rainfall during heavy precipitation events will increase due to climate change. We also have more people living near bodies of water. More urban development also means more impervious/impermeable surfaces so rainfall has no place to soak in.

How do we protect our homes and buildings from floods?
One way people protect buildings from damaging floods is to build flood barriers that keep the water out. A great example of this are the levees built around New Orleans.

Can you build an effective flood barrier?
Today we are going to give you a house and challenge you to keep it dry from flood waters! But remember – engineers not only need to design a working solution, they also are constrained by materials available or material costs, so that must be taken into consideration.

Tips for Engagement

Watch:
SciShow Kids "Why Do Floods Happen"
https://youtu.be/Qe350nm_odA

Experience

1. Divide students into teams, and provide each group with a tray and cardboard house or Kleenex box.
2. Explain the **Challenge Goal** and **Rules**:
   a. **Challenge Goal**: To design a flood barrier that will keep their house dry from 2 cups of water poured on the outside of the barrier for at least one minute. The design must minimize material costs.
   b. **Rules**:
      - Teams must start with a planning drawing.
      - House must be on the bottom of the container (i.e. not on the side, not propped up on anything)
      - You cannot modify the house or the tray in any way.
      - House cannot be covered with materials and flood barrier must not touch house.
      - Barrier cannot be more than half the height of the house,
      - Water must be able to infiltrate into the ground, so it must touch the bottom of the pan (i.e. do not simply build a lined retention pond).
   c. Designs must minimize materials used (i.e. keep costs low). Options:
      i. Give teams a limited amount of materials to work with.
      ii. Allow teams to choose materials but set a price on each material and give teams a budget.
      iii. Allow teams to choose materials but have them use the least amount of weight (if doing this, teams should weigh their trays prior to testing).

Experience continued

3. Set a time limit for the challenge (recommend 20-30 minutes). Test designs by slowly pouring 2 cups of water into their yard. Wait one minute, then see if house is dry, damp or flooded.

4. Have students re-think their design, create a new plan and try again.
    a. If they were unsuccessful, have them re-think their design to make it work.
    b. If they were successful in keeping their house dry the first time, challenge them to do it again with fewer/lighter materials.

Life Skill(s)

Learn to form ideas, make decisions and think critically. (HEAD)

Demonstrate the characteristics of teamwork. (HEART)

Use skill, effort or ability to accomplish a goal. (HANDS)

Wisely use resources to achieve a purpose. (HEART)

Share

Which designs were the most successful? Why?
Which designs were least successful? Why?

Process

What do the most successful designs have in common?
What do the least successful designs have in common?
If we removed the budget/weight constraints, what would you change?

Remember that engineers continuously design, test and re-test over and over again to optimize, so they don't expect to get it perfect the first time!

Generalize

What characteristics of the materials used were most important? Did you use both absorbent and impermeable materials?

Apply

If you needed to design a flood barrier for your house or school, how would you do it?

STEM
CHALLENGE

Ask

Problem:

Criteria:

Constraints:

Imagine

Ideas:

Best Idea:

Pros:

Cons:

Plan

Plan:

Materials Needed:

Create

Prototype:

Test Results:

What do we need to change?

Improve

Modify:

Retest:

ETS1: Engineering Design

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. 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.

MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]