



# 3,2,1...Natural Disaster

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**Target Grade:** 6<sup>th</sup> Science

**Time Required:** 9 days

## Standards:

NGSS Standards:

- 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 - ETS1 - 4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

CCSS Standard:

- CCSS.ELA-LITERACY.W.6.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

## Lesson Objectives:

Students will:

- Design and construct model shelters built to withstand six natural disasters after defining the criteria and constraints of the design problem based on text evidence and the rules for building set by the teacher.
- Assess student shelters through a series of tests to evaluate the shelter's durability, focusing on its ability to withstand each natural disaster and rating it using a set of defined rubric standards.
- Identify strengths and weaknesses of their shelters in an organized report, sequence ideas logically, and provide descriptive detail before presenting detailed findings to the class.



- Evaluate competing designs by identifying strengths and weaknesses of each, as well as similarities and differences between structures.
- Identify the best design based on specific criteria.
- Engage in scientific discourse, answering and asking questions pertaining to the topic of discussion.

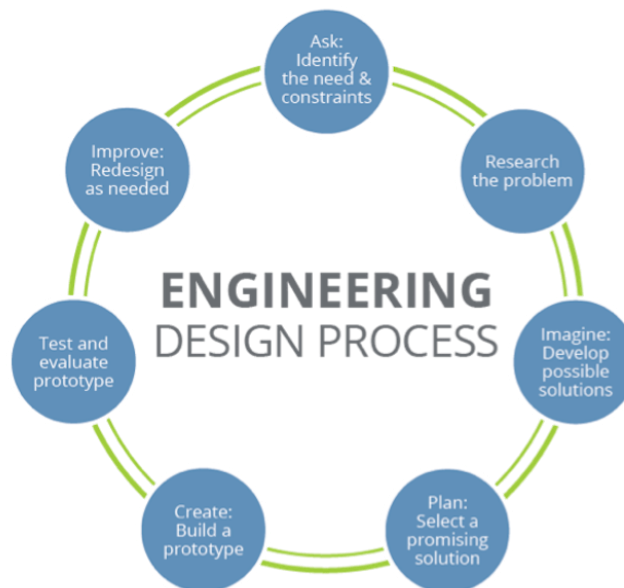
### Central Focus:

This engaging lesson gives students a chance at an authentic use of engineering design. Students are tasked to build a house that is able to withstand six different natural disasters. Students engage in designing, building, testing, data collection, and improvement of the homes. Students not only use engineering practices, but learn about natural disasters as well.

Key words: science, engineer, test, disaster, weather, shelter, revise, brainstorm, solution, prototype, process, present

### Background Information:

Students should be aware of the engineering design cycle prior to this lesson. These steps include the following; Define the Problem, Collect Information, Brainstorm Solutions, Develop a Solution, Build a Prototype, Present Your Ideas to Others for Feedback, Test and Redesign. The process is never really complete, as there can always be additional redesign. Students also need to be aware of the safety precautions in using some of the makerspace materials. It is advisable that the teacher does not introduce new tools in this lesson, but instead uses only the tools students are familiar with already, as a safety precaution.



<https://i2.wp.com/media.premiumtimesng.com/wp-content/files/sites/2/2017/02/Engineering-Design-Process.png>



## Materials

### Reproducibles: 1 per student

- Natural Disaster Radio Announcement Transcript
- Natural Disaster Fact Finding Cause and Effect Worksheet
- Shelter Blueprint Worksheet
- Problem Solving and Adjustment Form
- Materials List
- Observation, Reflection, and Shelter Evaluation Packet
- Criteria and Constraints for Building Shelters
- Shelter Grading Rubric
- Design Process

### Other Supplies

- Highlighters - 1 per student
- Pencils - 1 per student
- 150 ml beaker
- Gallon size plastic container
- 3 cups of muddy water with gravel - 1 per team
- One 1 foot x 1 foot piece of cardboard
- 1 Vacuum Cleaner
- ¼ cup glitter - 1 per team
- Small Paintbrush - 1 per team
- Tsp. or Tbs. measuring spoon - 1 per team
- Six inch by six inch piece of cardboard - 1 per team

### From Makerspace

- Duct Tape
- Rubber bands
- Pom Poms
- Paper Clips
- String
- Rulers
- Circuit Batteries
- Cardboard
- Plastic Cups
- Plastic Wrap
- Hot Glue Gun
- Clay
- Construction Paper
- Circuit Write



- Cardboard
- Plastic Straws
- Masking Tape
- Bubble wrap
- Liquid Glue
- Felt
- Popsicle Sticks
- Scale
- Circuit LED Lights

## Instruction

### Day 1:

Hook (5 minutes): Start class by role playing the following scenario to begin student engagement: The Earth as we know it is out of control. Tectonic plates are moving in unpredictable patterns, and the weather is outrageous with a huge storm headed their way. No one can predict exactly how severe the aftermath will be!

Build Background (25 minutes): Provide students with a transcript of the radio announcement that describes six different natural disasters predicted to take place over the next week; flood, blizzard, mudslide, tornado, earthquake, and volcanic eruption.

Read the radio announcement aloud to the class. Then, instruct students to re-read the radio announcement themselves and annotate as they read. Students should highlight the information in the articles pertaining to the impact these disasters have on shelters, focusing on cause (quantitative facts related to the disasters speed, size, and duration) and effect (impact on shelters).

Class Discussion (15 minutes): As a group, discuss the cause and effect information the students identified in the radio announcement. Students should complete the fact finding handout during whole group discussion. Students should write facts about each natural disaster in the **cause** column and its effect on shelters in the **effect** column.

### Day 2:

Task Explanation (10 minutes): Explain to students that it is their job to work as engineers and architects to build a shelter that can withstand the six impending natural disasters; flood, blizzard, mudslide, tornado, earthquake, and volcanic eruption. The shelter that provides the most protection will win! Each shelter must have a working circuit for power and heat, this will help keep inhabitants safe during the forecasted blizzard.



Instructions (10 minutes): Provide students with the criteria for building their shelter and the grading rubric. As a class, discuss the constraints and criteria for the structures. Then review the engineering design process using the design process hand out.

Discussion and Brainstorm (30 minutes): Put students into groups of 4 - 6, or allow them to choose their own groups. Provide each 'team' with a blueprint worksheet to begin their planning. Student groups must create a diagram of their shelter with labels, and a materials list. Remind students the base for their structure will be a 6 inch by 6 inch piece of cardboard.

Once students have finished drawing and labeling their diagram, ask them to highlight each design element in their plan, in relation to each disaster. Have the students create a key explaining which disaster each color highlight represents.

### **Days 3-4:**

Active Learning (2 hours): Provide students with their base, a 6 inch by 6 inch piece of cardboard. Allow students to build their shelter using the MakerSpace, problem solving as they proceed. Students should check throughout the process for needed adjustments. Have students take notes on their problem solving worksheet, detailing what adjustments are needed, if any, and explaining how they problem solved.

### **Days 5-7**

Test Preparation (10 minutes): Before testing begins, have each group measure and weigh their shelter and record the data on the testing form. Have students multiply the data by 75 to get the 'real world' dimensions of the shelter.

Sound the alarm and test each structure against each natural disaster. Use the makerspace for testing each structure.

Testing (30 minutes per test= 3 hours):

#1 Flood: Place each shelter inside a gallon sized plastic container. Use 150 mL of water to flood a small container, pouring water near the side of the shelter, thus flooding the plastic container. Have each team make observations and evaluate how their structure held up against the flood using the observations, reflections, and evaluation packet.

#2 Earthquake: Place each shelter between two desks and shake them for 30 seconds, moving the desks apart and back together a bit. Have each team make observations and rate how their structure held up against the earthquake using the observations, reflections, and evaluation packet.

#3 Tornado: Use a vacuum cleaner 'arm' to simulate a tornado. Hold the vacuum cleaner 6 inches above each structure and circle around the structure five times. Have each team make



observations and rate how their structure held up against the tornado using the observations, reflections, and evaluation packet.

**#4 Mudslide:** Use 3 cups of runny mud and gravel, and a 1 foot x 1 foot piece of cardboard. Place the piece of cardboard at an angle against an outside wall. Put each structure at the bottom of the piece of cardboard on the ground. Spill the mud onto the cardboard and let it roll down to the structure hitting its side. Make sure your mud is thick enough to have an impact, but thin enough to slide down the cardboard incline. Have each team make observations and rate how their structure held up against the mudslide using the observations, reflections, and evaluation packet.

**#5 Volcanic Eruption:** Put each shelter into a gallon sized plastic container. Use ¼ cup of glitter and sprinkle it on top of each shelter. Have the students use a paint brush to sweep the dust out and measure how much glitter (“volcanic ash”) made it inside their shelter, using a teaspoon or tablespoon. Have each team make observations and rate how their structure held up against the volcanic eruption using the observations, reflections, and evaluation packet.

**#6 Blizzard:** Test students’ circuits to see if they will provide electricity to the shelter to keep the inhabitants from freezing. Have each team make observations and rate how their structure held up against the flood using the observations, reflections, and evaluation packet.

### **Days 8-9**

**Closing** (2 hours): Have students reflect on the process using the observations, reflections, and evaluation packet. Display the shelters in front of the class once all tests have been completed. Have students make observations and comparisons of each shelter’s durability. Ask teams to give an informative presentation about their observations, problems faced, surprises, and future directions. As a group, compare how each shelter held up against the natural disasters. Discuss how differing weights and sizes may have impacted overall success. Complete the lesson by discussing how each simulated test differed from a real natural disaster in severity and process.

### **Differentiation**

Structure groups so that students who have difficulty building are with students who excel in that area. Create group jobs as necessary (ex: builder, tester, data recorder). The activity is designed to have differentiation built in as students can use their individual strengths when brainstorming and building. English language learners may use a bilingual dictionary or translator to communicate with group members or work on documentation, as appropriate.

### **Assessment**

Formative:

- Annotated radio transcript



- Participation in class and small group discussions
- Nature Disaster Cause and Effect Fact Finding worksheet
- Shelter Blueprint worksheet
- Problem solving and Adjustment Form

Summative:

- Observations, Reflections, and Evaluation Packet
- Student Reflection at the conclusion

## Radio Transcript

Breaking News! The Earth's weather patterns have gone mad. Meteorologist across the country have reported that the Northwestern United States should brace themselves for the worst.

It is expected that there will be 14 inches of rain in just three hours starting next Wednesday. Locals should prepare for flooding, as water will surely overtake riverbanks and submerge the streets. This flooding can cause irreversible water damage to structures and foundations. Flooding will inevitably lead to serious mudslides, which, depending on their severity, can cause hundreds of pounds of mud, rock, and even boulders to come crashing down the sides of mountains and hills. Anyone near any type of natural incline should begin assembling a plan as mudslides have been known to flatten houses.

The rain, although severe, will lead to even worse conditions as the week progresses. The temperature is expected to drop quickly by Wednesday and turn the flood water to ice, and the rain to snow. A severe blizzard will turn the skies white causing what is known as a whiteout and leaving up to 4 feet of snow on the ground. Often in a blizzard the power will go out and freezing temperatures put everyone at risk.

That's not all, and here is where things begin to get really crazy folks, tornadoes, which are usually found in the midwest part of the country, are expected to touch down within the next week in the Northwest as well. These twisters can have devastating effects, ripping houses off the ground and destroying everything in their path with winds up to 300 miles per hour.

Last but not least, it isn't just the weather that seems to be out of control. Tectonic shifts of the earth's plates are predicted to cause both volcanic eruptions and earthquakes. Being in the ring of fire poses a grave danger to those in the Northwest as they have quite a few active volcanoes nearby. While lava flow from these volcanic eruptions might not endanger many, for hundreds of miles the sky will turn black and ash will fall creating hazy skies and endangering the health of those breathing in the tainted air. The earthquakes that are predicted could reach up to a 7 on the Richter scale. Seismic activity is rated on a 7 point scale, so faults are expected.

Ladies and gentlemen, this is truly unbelievable news but I assure you, this is no joke. Inhabitants who call the Northwest home should begin preparations immediately.



Name: \_\_\_\_\_

## Natural Disaster - Fact Finding - Cause and Effect

Natural Disaster	Cause	Effect
Flood		
Blizzard		
Mudslide		
Tornado		
Earthquake		
Volcanic Eruption		

Name: \_\_\_\_\_

## Shelter Blueprint

Draw your shelter as you plan to build it. Label each design element you will include and the materials you will use when constructing your shelter.

Designate which design element is to protect against which natural disaster. Complete the key below before highlighting each element in the corresponding color.

### Key

- |                                     |                                   |  |                                  |
|-------------------------------------|-----------------------------------|--|----------------------------------|
| <input type="checkbox"/> Flood      | <input type="checkbox"/> Blizzard | <input type="checkbox"/> Mudslide          | <input type="checkbox"/> Tornado |
| <input type="checkbox"/> Earthquake |                                   | <input type="checkbox"/> Volcanic Eruption |                                  |

Name: \_\_\_\_\_

## Problem Solving and Adjustments Form

Record at least four problems you faced while building your shelter.  
Explain the problem, what you adjusted to address the problem, and the  
result of your adjustments.

Problem	Adjustment	Result

Name: \_\_\_\_\_

## Observations, Reflections and Evaluation

Before testing your shelter, record the information below.

Measurements	Prototype	x75 for real world scale dimensions
Height		
Length		
Width		
Volume		
Weight		

What elements did you include in your shelter design to protect against each of the following Natural Disasters?

Natural Disaster	Element Included in Design
Flood	
Blizzard	
Mudslide	
Tornado	
Earthquake	
Volcanic Eruption	

### Testing Results

<b>Test</b>	<b>Natural Disaster Impact Description</b>	<b>Sketch</b>	<b>Possible Improvement</b>
Flood			
Blizzard			
Mudslide			
Tornado			

<b>Test</b>	<b>Natural Disaster Impact Description</b>	<b>Sketch</b>	<b>Possible Improvement</b>
Earthquake			
Volcanic Eruption			

What was the strongest element of your shelter design? Explain.

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**What was the weakest element of your shelter design? Explain.**

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**What natural disaster had the most severe impact on your shelter?  
Describe.**

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**What natural disaster did your shelter withstand best?**

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## Final Reflection

What did the strongest shelters have in common?

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What did the 'weakest' shelters have in common?

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What most impacted survival of the shelters, and thus the people inside, during a natural disaster?

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## Constraints for Building Your Structure

\*Your shelter must be attached to the 6 inch by 6 inch base and the shelter base can not exceed this 6 inch by 6 inch area.

\*Your shelter must be free standing.

\*Your shelter must not exceed 1 pound in weight.

\*Your shelter must not measure higher than 10 inches or shorter than 4 inches.

\*Your shelter must have an entrance/exit and some type of ventilation.

\*Your shelter must have an electrical circuit to provide 'power'.

## Rating Your Structure During Testing

	3	2	1
Shelter Impact	There was significant, noticeable damage to the structure. The damage changed the shelters overall appearance or stability and can be easily identified. The structure in some way was bent, or dented.	There was slight damage to the outside of the shelter that is noticable but the overall appearance and stability of the structure is the same. The shelter was scratched or slightly dented.	The test had little to no impact on the shelter. The shelter may have a small scratch but no dents.

## Shelter Grading Rubric

	3	2	1
Followed Criteria	Structure followed all of the defined criteria for building	Structure followed only five out of six of the defined criteria for building	Structure followed four or fewer of the defined criteria for building
Design Elements	Shelter had at least one element included in its design to help protect against each of the six natural disaster	Shelter had at least one element included in its design to help protect against five natural disaster	Shelter had at least one element included in its design to help protect against four or fewer natural disaster
Strength	Shelter held up long enough to be put through all six tests	Shelter made it through five tests before collapsing or being too damaged to continue testing	Shelter made it through four or fewer tests before collapsing or being too damaged to continue testing

# Engineer's Design Process

- ☆ Define the Problem
- ☆ Collect Information
- ☆ Brainstorm Ideas
- ☆ Develop Solutions and Build a Model
- ☆ Present Your Ideas for Others To Give Feedback
- ☆ Improve Your Design