Earthquake IN THE CLASSROOM

CLASSROOM ACTIVITY FOR TEACHERS

Students learn how engineers construct buildings to withstand damage from earthquakes by building their own structures with toothpicks and marshmallows. Students test how earthquake-proof their buildings are by testing them on an earthquake simulated in a pan of Jelly.

Introduction:

Read out loud to students before starting the experiment

Earthquakes can cause much loss of life and millions of dollars worth of damage to cities. Surface waves and body waves from earthquakes can cause walls to crack, foundations to move and even entire buildings to crumble.

Engineers continually strive to make buildings stronger to resist the forces of earthquakes.

Engineers face the challenge of designing more robust buildings to withstand earthquakes.

Earthquake-proof buildings are intended to bend and sway with the motion of earthquakes, instead of cracking and breaking under the pressure.

Have you ever looked at a really tall building, such as a skyscraper?

What does it look like?

Does it appear fragile and unstable?

It might, but it is most probably quite sturdy and can withstand wind, rain and other natural elements and phenomena.

Earthquake-proof buildings typically have cross bracing that forms triangles in its design geometry (like a bridge).

Such buildings also typically have a large “footprint,” or base, and a tapered shape, decreasing in size as the building gets taller (or simply, smaller at the top).

Short buildings are more earthquake proof than tall ones. Why do you think that is?

Have you ever climbed up a tree or been on top of a playground jungle gym in the wind?

Do you sway more when you are up high than when on the ground?

All buildings shake at the same frequency as the shaking of the Earth, but the movement is magnified as the building gets taller.

Sometimes, as can be the case during earthquakes, buildings sway too much, crack and crumble and fall.

Experiment:

Allow 50 minutes for the activity

Materials:

Each student needs:

- 30 toothpicks
- 30 miniature marshmallows
- Earthquake Journal

For the class to share:

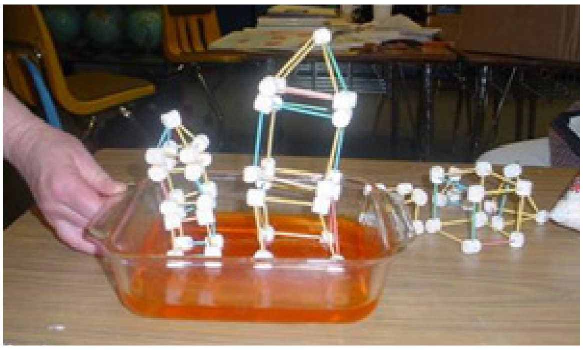
- eight 20-cm square disposable baking dishes, or one 20 x 30-cm disposable roasting or baking pan
- 8 boxes jelly crystals (plus a stove, water and pan to make the jelly in advance)

Preparation:

Prepare the jelly the night before the activity so that it is fully set when students begin the activity.

Pour the jelly into eight 20-cm square pans to be shared by four students, or in one large pan for the entire class to share.

Make one marshmallow-toothpick structure as a display example for students.



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Classroom resources provided by Cairns Regional Council

CLASS ROOM ACTIVITY FOR TEACHERS

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With the students:

1. Hand out student journals.Have students fill in the top left section of the journal with vocabulary terms. Direct students to record their activity observations as they work.
2. Tell students that today they are acting as if they are engineers. They will make models of buildings and conduct an experiment to test how well their structures stand up under the stress of an earthquake. Explain to them that this is similar to what some civil engineers do as their jobs.
3. Show students the display model of a structure.
4. Illustrate how to make cubes and triangles using toothpicks and marshmallows.
5. Show students how to break a toothpick approximately in half. Explain that cubes and triangles are like building blocks that may be stacked to make towers. The towers can have small or large "footprints" (or bases).
6. Distribute 30 toothpicks and 30 marshmallows to each student. Explain that Earth has limited resources, so therefore engineers also have limited resources when building structures.

   For this engineering challenge, students are limited to using only the materials they have been given to make structures.

   They may make large or small cubes or triangles by using full-size or broken toothpicks. They may use cross bracing to reinforce their structures.

   Note: for higher grade levels, give students more rules for their buildings.

   You can use one or more of the following rules or create your own.

   Buildings must be:

   - at least two toothpick levels high,
   - contain at least one triangle,
   - contain at least one square,
   - or buildings must contain one triangle and square.
7. Place the structures on the pans of jelly.

If aluminium pans are used, tap the pans on the bottom to simulate compression or primary waves. If glass baking dishes are used, shake them back and forth in a shearing motion to simulate S or secondary waves.

After students have tested their structures, have them redesign and rebuild them and finally test them again.

What can they do to make it stronger? Did it topple? Should they make the base bigger? Make the structure taller or shorter? Let students design and rebuild as many times as the class period allows.

8. Have students draw and label the shapes in their designs (cube, triangle, etc).
9. Have students pretend that they are engineers who work for a civil engineering company designing buildings for Cairns.
10. Instruct them to make a flyer to convince their company to let them design a better building or structure.

Safety issues:

Inform students that in a science lab or during science experiments, nothing should ever be put into their mouths. The marshmallows and jelly are not for eating! Instead, set some aside for a treat after the activity.

Troubleshooting tips:

The activity works best with fresh (soft) marshmallows. As the marshmallows sit and dry out, they and the structures become stable and rigid.

Do not leave the Jelly uncovered too long, as it dries out and becomes less fluid, which affects the activity results

Assessment

Pre-activity assessment

Journal: Use the attached Earthquake Journal page or have students make their own by doing the following:

1. Put a title on the page: Measuring Earthquakes.
2. Divide the page into four quadrants labelled:
   - VocabularY
   - What I've Learned
   - What I Observed
   - Questions I Have.
3. Have students enter the new vocabulary words for the lesson (such as: tectonic plates, Ring of Fire, focus, epicentre, surface waves, body waves, P waves, S waves, aftershocks, seismograph, Richter scale, Mercalli scale) in the vocabulary section.

Activity embedded assessment

Journal: Have students record their own observations in the section titled, "What I've observed."

Measurement: Have students measure the length, width, and height of their structures and calculate the volume using the equation V=L x W x H.

Post-activity assessment

Journal: Have students fill in the final sections of the journal labelled, "What I've Learned," and "Questions I Have." Solicit questions from the students and let other students answer.

Re-Engineering: After students have tested their structures, they should redesign and rebuild them, then test again. What can they do to make it stronger? Did it topple? Should they make a bigger base? Make it taller or shorter? Let students design and rebuild as often as time allows.

Drawing the Geometry: Have students make drawings and label the shapes in their designs (cube, pyramid, triangle, etc.).

Make a Pitch! Have students pretend to be engineers and make flyers to convince a LOCAL company to let them design a better building or structure.

News Broadcast: Have student teams write news broadcasts about an earthquake that has hit Cairns. Have the broadcast begin with something exciting to catch the listener's attention. Then tell the facts of the event. Have the teams share their news broadcasts with the class.

Activity extensions

Have students examine the school for earthquake engineering. Does the school building encompass some of the principles of earthquake proofing?

Observe buildings in the community or city. What do students observe about the structure of the buildings?

Can you obtain fault maps of the area by searching the Internet? Try Geoscience Australia and your regional council website. Is this area in a zone at risk for earthquakes?   How far is it from an area with a volcanic history? Does the local architecture plan for this? How would you find out?

Activity scaling

For higher grades, give students more requirements and constraints for their buildings.

Curriculum links

F	Science	ACSSU004: Science as a Human Endeavour Earth and space sciences	Daily and seasonal changes in our environment, inlcluding the weather, affect everyday life
1	Science	ACSSU019: Earth and Space Science Science Understanding	Observable changes occur in the sky and landscape
		ACSHE021: Science as a Human Endeavour Nature and development of science	Science involves asking questions about, and describing changes in, objects and events
		ACSIS024: Questioning and predicting	Respond to an post questions, and make predictions about familiar objects and events
2	Science	ACSSU032: Science Understanding Earth and space science	Earth's resources, including water, are used in a variety of ways
		ACSHE034: Science as a Human Endeavour	Science involves asking questions about, and describing changes in, objects and events
		ACSHE035: Science as a Human Endeavour	Science involves asking questions about, and describing changes in, objects and events
3	Science	ACSHE050: Science as a Human Endeavour: Nature and development of science	Science involves making predictions and describing patterns and relationships
4	Science	ACSSU075: Earth and Space Sciences Nature and development of science	Science involves making predic tions and describing patterns and relationships
		ACSHE062: Science as a Human Endeavour; Use and influence of science	Science knowledge helps people to understand the effect of their actions
5	Geography	ACHGK030: Geographical Knowledge and Understanding	The impact of wildfires or floods on environments and communities and how people can respond
6	Science	ACSSU096: Science Understanding; Earth and Space Sciences	Sudden geological changes or extreme weather conditions can affect Earth's surface
		ACSHE098: Science as a Human Endeavour; Nature and development of science	Science involves testing predictions by gathering data and using evidence to develop explanations or events and phenomena
		ASHE099: Science as a Human Endeavour; Nature and development of science	Important contributions to the advancement of science have been made by people from a range of cultures
		ACSHE100: Science as a Human Endeavour. Use and influence of science	Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives