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DESIGN2LEARN

GEOLOGY & DYNAMIC EQUILIBRIUM: THE HUMAN ANIMAL

Zombie Apocalypse Design Challenge

Summary

This fun and silly design challenge is a good way to start the year! This challenge encourages teams to collaborate, think critically, and persevere – just like real engineers. Part of being a good engineer is learning how to work together to solve problems; in this fast-paced challenge, youth will have to work together to save themselves from a zombie apocalypse!

Content knowledge in this lesson is flexible. This activity can support learning in 7th grade Unit 3 (Dynamic Equilibrium: The Human Animal) that focuses on survival, environmental sensing, locomotion, and shelter. It can also support learning in 7th grade Unit 1 (Geology) if you add earthquakes to the apocalyptic scenario. Finally, as they build shelters out of dowels, youth will begin exploring strong shapes and structural design principles that will resurface in the Mineral Structures Design Challenge and Earthquake Bridge Design Challenge.

MATERIALS | HERE'S WHAT YOU NEED FOR THIS ACTIVITY!

- ☐ *Large dowels*
- ☐ Rubber bands
- ☐ Camera (cell phone camera works too)

VOCABULARY WORDS

SURVIVAL	The continued existence of organisms
LOCOMOTION	Movement. In humans, locomotion is necessary to escape danger, obtain food and shelter, and reproduce. It is accomplished by the interaction of the skeletal and muscular systems, and coordinated by the nervous system.
EARTHQUAKE	Shaking of the ground as a result of movement within the earth's crust or volcanic action.
PLATE TECTONICS	The theory that the lithosphere is divided into plates that collide, move apart, or slide past one another.

Preparation Before the Lesson

In this lesson, youth will be building shelters during an apocalyptic scenario. Decide if you want to incorporate zombies, earthquakes, or both into your apocalypse. For both scenarios, you'll need people who can push or shake youths' structures to test their functionality as shelters. This job is fun for learners, but also consider asking fellow school and afterschool staff to stay late and dress up as zombies. Getting some fellow staff members in on the action can be fun and surprising for youth. It can help build positive relationships and contribute to a sense of belonging to the group and a sense of excitement about the activity. Similarly, think about adding fun decorations to the room to give this design challenge a festive feeling.

Delivering the Lesson

1. HOOK THE YOUTH:

Think about how you're going to "hook" the youth, or get them excited about this activity. Can you think of a creative way to motivate youth, relate the activity to their lives, or pique their interest? If you're stuck, we've included some suggestions below:

- See "Preparation before the lesson" above. Decorating the classroom with zombie decorations, or having a few staff members already dressed up as zombies can get kids' attention right away!
- Have a "zombie off": who can do the most convincing/scary/silly zombie impression across the room?
- Do some visualizations. Ask youth to picture a "Zombie Apocalypse." What does it look like? What's happening? What would they do?

2. INTRODUCE THE CONTENT:

Start the session by introducing the scenario. Zombies have taken over the city and earthquakes are devastating buildings and other structures. Teams need to survive this attack by creating a safe shelter where they can wait out the damage. Get creative with your delivery! Embellish this story to include details about how the school and neighborhood to make it more fun.

Ask youth what they think they will need to do to survive this scenario.

POSSIBLE QUESTIONS TO ASK:

- How will you survive this zombie apocalypse scenario?
- What kinds of things will you depend on for your survival?
- What is "locomotion"? How is being able to move crucial for your survival in this scenario?
- What tools do you have to sense and respond to your environment? How do those help you survive?
- What causes earthquakes? How could you use this knowledge to help you survive this scenario?

3. ISSUE THE DESIGN CHALLENGE:

After youth have discussed the scenario, deliver the design challenge!

> Your team is in need of shelter to survive the zombie apocalypse! Remember, materials are limited in a zombie apocalypse, so you will only be given two materials to help you for this challenge: dowels and rubber bands. You must design a free-standing structure that is large enough to hold your entire team, as well as strong enough to withstand earthquakes and the zombie attack!

Have the group decide on fair testing rules and constraints for this engineering design challenge together. Use this discussion as an opportunity to incorporate youth voice as they decide what counts as "success" in this design challenge. Some suggestions are:

- The structure must be free-standing (your team cannot hold any parts)
- The structure must hold the entire team

- Must be stable and strong enough not to fall apart when the "zombies" attack and "earthquakes" hit
- The structure must be built within _____ minutes
- Zombies can attack the structures by _____ (shaking the structure, pushing the corners, etc.)
- Earthquakes can be simulated by_____ (shaking the structure, etc.)

4. PROVIDE TIME FOR PLANNING, BUILDING, AND TESTING:

Provide time for youth to brainstorm and make a plan for their structure. Provide paper for sketching if necessary. Pass out a few sample materials and allow youth to see and feel the dowels and rubber bands. They should become familiar with the properties and characteristics of each material to help them think about their design, but should not begin building yet.

Once youth have finalized their sketches, hand out the materials to each group. When everyone is ready to begin, start the timer for the amount of time your group decided on. Give youth a warning as the timer approaches zero.

POSSIBLE QUESTIONS TO ASK WHILE BUILDING:

- Can you tell me about your design?
- What made you decide to add this particular feature?
- How do you think your structure will stand up to the zombies? Earthquakes?
- What kinds of things are you thinking about for your design? (durability, strength, strong shapes, etc.)

Once the time goes off, have teams enter their structures. Test the structures by having a few "zombie" volunteers walk around and tapping and pushing the corners of the structures. The more enthusiastic your zombie actors are, the better!

While the zombie apocalypse is going on, take a few pictures of the learners' designs, zooming in on shapes that youth incorporated in their designs.

After a few fun, high-energy minutes of testing, pause and ask youth to evaluate their designs. Set aside time so they can make modifications for stability and strength before retesting.

POSSIBLE QUESTIONS TO ASK WHILE EVALUATING AND IMPROVING:

- What were some of your observations from the testing scenario?
- Are there any changes you want to make to your design? How come?
- What happened when zombies attacked your structure?

5. LEAD THE GROUP IN A REFLECTION ACTIVITY:

Once all of the youth have made their initial tests, revisions, and re-tests, facilitate a reflection discussion. It may be helpful to do a "gallery walk" or project the pictures you took during the challenge. You can ask the questions below, or incorporate your own.

- What were some challenges you came across while designing and building your structure?
- How did you overcome those challenges?
- What shapes did you incorporate into your designs? What did you notice about those shapes?
- How can you or did you improve your design?

- How did your ability to sense your environment help you survive in this scenario?
- What do structures meant to survive a zombie apocalypse and an earthquake have in common? How are they different?

Possible Timelines

You can divide this activity into more than one hour-long session and use different pre- and post- activities to highlight different science concepts. See below for some possibilities, combine them as you like, or come up with your own!

TIMELINE 1	
SESSION 1 (1 HOUR)	Zombie Apocalypse Design Challenge
SESSION 2 (1 HOUR)	Host an open-ended session with gumdrops, marshmallows, and toothpicks where youth can build whatever structures they want. Do a "shapes scavenger hunt": what shapes did youth naturally include in their structures? Call back to the shapes youth included in the Zombie Apocalypse Design Challenge; did they learn anything about strong shapes during that activity?
SESSION 3 (1 HOUR)	Explore the popsicle stick and fastener shapes from Mineral Structures Design Challenge. Build the straw and pipe-cleaner models.
SESSION 4 (1-1.5 HOURS)	Do the Mineral Structures Design Challenge.

TIMELINE 2	
SESSION 1 (1 HOUR)	Zombie Apocalypse Design Challenge
SESSION 2 (1-1.5 HOURS)	Watch San Francisco earthquake footage. Introduce the challenge. Build and test.
SESSION 3 (1-1.5 HOURS)	Reflect. Ask youth what other disasters (natural or otherwise) city bridges might need to survive. Re-design bridges to withstand these additional challenges. Test again.

Additional Background Information

If you include earthquakes in this apocalyptic scenario, remember that planet Earth is a layered planet, with a dense, metallic core; a layer of hot, liquid rock (mantle); and a cold, brittle surface (crust or lithosphere). The lithosphere is broken up into several pieces, known as plates. Convection currents in the liquid mantle pull the plates, causing them to move against one another (plate tectonics). Most earthquakes occur where plates come together (plate boundaries).

Earthquakes are measured by the Richter Scale, a logarithmic measurement system. In this scale, an earthquake of 5.0 represents a tenfold increase in amplitude (and about 31 times more energy released) than a 4.0 earthquake. An earthquake measuring 5.3 would be considered moderate, a 6.3 would be considered strong, and 7.0 or higher is usually considered severe. Injuries and deaths during earthquakes generally occur because of building or structure collapse or by unsecured objects falling from shelves.

Engineers consider strong shapes when constructing bridges, buildings, and other structures. Triangles are the strongest of shapes because they have three sides and three angles, which become fixed when a force is applied to any of the sides or angles. By contrast, squares will buckle when a force is applied to an angle or side. We can see this difference in the Mineral Structures Design Challenge. We can find triangles in many structures such as bridges and buildings. Triangles make structures more stable and rigid, making them ideal for designing infrastructure. In this activity, you're likely to see many youth structures that incorporate triangles in walls and roofs.

Finally, this survival design challenge offers an opportunity to discuss the survival strategies of humans and other animals. The survival of an organism depends on its ability to sense and respond to its external environment: how do humans sense and respond to their environment for survival? An everyday example for New York City residents is using our eyes, ears, and sense of touch to decide when (or when not) to cross the street. Locomotion, or movement, is one strategic we rely on to escape danger, obtain food and shelter, and reproduce. Locomotion, which is necessary in this challenge for escaping zombies and building a structure, is accomplished by the interaction of our skeleton and muscles, which is coordinated by the nervous system.

Scope and Sequence Major Understandings

- Plates may collide, move apart, or slide past one another. Most volcanic activity and mountain building occur at the boundaries of these plates, often resulting in earthquakes. (2.2f)
- The survival of an organism depends on its ability to sense and respond to its external environment. (5.1g)
- Locomotion, necessary to escape danger, obtain food and shelter, and reproduce, is accomplished by the interaction of the skeletal and muscular systems, and coordinated by the nervous system. (1.2g)

NGSS Science and Engineering Practices

- Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process, or system.
- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.
- Optimize performance of a design by prioritizing criteria, making trade-offs, testing, revising, and retesting.