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Bruce Museum at Home
STEAM Activities for Children

Lesson # 7: ***Bridge Over Troubled Waters***
Week of May 4, 2020

This week's STEAM activity introduces a host of new concepts. Learners will tackle the principals of tension, compression, and torsion as they build bridges.

Your learner will need to use their science journal once again this week. If they haven't made one yet, or if their pages are full, go back to Week 1 for instructions on how to make a journal.

This week, we are happy to have an additional design-focused lesson, **Bridge Challenge**, from one of the Museum's educational partners, Engineering Tomorrow. Engineering Tomorrow's lesson utilizes many of the same materials and underlying scientific principles as this week's Bruce at Home STEAM lesson, **Bridge Over Troubled Waters**, but the Bridge Challenge is for an older learning audience. The Engineering Tomorrow lesson will help older learners connect project-based learning with essential engineering concepts. Older learners should follow this link to give it a try.

In order of appearance, this week's lesson contains: a materials list, a simple art activity, bridge vocabulary words and general instructions, ways to add on to the activity, open-ended question ideas, a brief art activity, and NGSS Performance Expectations.

A tip for adults: *This is a fun, open-ended lesson for your learner. They will need space to build, rebuild, and deal with collapse of their structure. Make sure they don't use anything for their bridge builds that is overly breakable.*

The **Materials List** for this activity has three sections, one for materials that can be found in many households, one for materials that you will be upcycling, or rescuing from being discarded, and one for an additional art activity. Consider limiting the amount of materials initially used so that your learner doesn't become overwhelmed.

Household Materials: science journals, pens and pencils, painter's tape, large books (encyclopedias, phone books, cook books, coffee table books), soup cans, tongue depressors, string, plastic straws.

Upcycled Materials: cardboard, empty vegetable bags, egg cartons, twine, paper towel and toilet paper tubes, plastic clamshell containers.

Art Materials: white paper, coloring tools (paint, markers, colored pencils, and crayons), scissors, and clear tape.

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Basic Bridge Vocabulary

Bridge: Traditionally, bridges are structures that go across/above something (a river, a railroad track, a ravine). Bridges not only span things, but they also connect points.

Foundation: The part of a bridge that holds it up; can be thought of as the bridge's legs.

Deck: The supported portion of a bridge on which cars, pedestrians, trains, etc. can move on.

Substructure: The part of a bridge that provides additional support. In the case of a homemade bridge, this could be reinforcements on either end of the deck.

Superstructure: Everything from the deck up.

Tension: Stretching force that pulls on a material.

Torsion: Twisting force on a material.

Compression: Pressing force that squeezes materials together.

Cable-stayed: A bridge in which the deck is suspended from cables anchored to one or more towers.

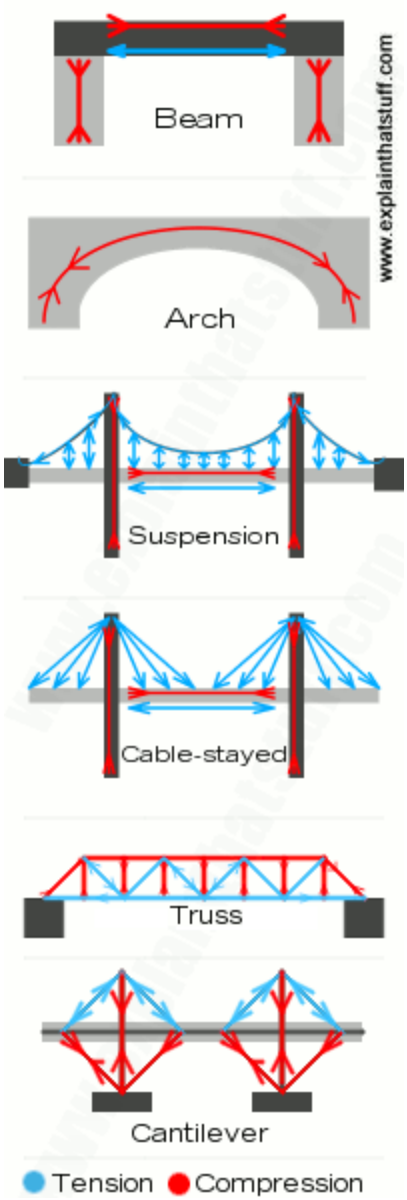
Beam: A simple type of bridge, composed of horizontal beams with vertical posts.

Arch: A curved structure that converts the downward force of its own weight, and any weight pressing down on top of it, into an outward force along its side and base.

Suspension: A bridge in which the deck is suspended from cables that pass over two towers; the cables are anchored in housings at either end of the bridge.

Truss: A rigid frame composed of short, straight pieces joined to form a series of triangles or other stable shapes.

Cantilever: A bridge built using cantilevers, structures that project horizontally into space, supported on only one end.



Bridge building is a fun and open-ended activity, which can be as complicated or easy as you and your learner want. Your learner may already engage in bridge building using blocks, Legos, or other building toys. If you'd like to incorporate those kinds of toys into

this activity, go for it! There are a few bridge options below that incorporate these materials.

There are many different options for bridge builds, ranging from easy to complicated. Choose one that's right for you and your learners, or choose several!

Bridge Projects

For learners in Kindergarten through Second Grade

Popsicle Stick Truss Bridge

Book Beam/Arch Bridge

Cardstock and Block Bridges

For Learners in Second through Sixth Grade

Straw Bridge Beam vs. Suspension Challenge

Egg Carton Suspension Bridge

Lego Bridge Challenge

List of Famous Bridges

Let's make some bridges!

- Collect your materials for bridge building.
    - While there are lots of materials in the list above, consider limiting your learners' choices to encourage creativity.
- Whichever project you choose, review the applicable bridge vocabulary with your learner and ask them to use their science journal to draw a plan for their bridge.
    - Things their bridge plan should have:
        - Basic design
            - Look through the types of bridge designs listed above. Which look the most interesting to you and your learner?
            - Which do you think will be the easiest or hardest to make?
            - Which do you think are the strongest?
        - Proposed use for their bridge
            - Who or what is this bridge for?
            - What would the purpose of this bridge be in the "real world"?
        - Materials choices
            - What materials do you have available?
            - What are the strengths and weaknesses of the materials you have?

    - Some building plans don't work; science journals are a great place to record successes and failures.
- Bridges face many challenges in real life. Your learner should test their bridges in various ways to see if their creation stands up.
    - Learners should use their journals to list all the challenges they think a bridge might face in real life.
        - Learners can also use their journals to list all the bridges they know in their area.
            - You might be surprised at how many bridges you cross on a regular basis.

Possible Bridge Challenges

- Can your learner's bridge support a specific weight? (100 pennies is a good starting point, but use what's available to you and your learner.)
    - Weight can be placed on top of the bridge or suspended from the bridge. Creating a container to suspend the weight in can be its own project.
- Can the bridge survive a hard wind? (Use a fan to test.)
    - What can we do to our structures to help them stand up to wind?
- Can a person pass underneath the bridge? (Only for large bridges.)
- Can a component of the bridge be removed without the bridge becoming unstable?

As your learner tries the various challenges, they should use their science journal to track their successes and failures.

Art Project: Troubled Waters

This week's art project is all about giving your bridge a purpose. As mentioned earlier, bridges serve to connect locations and to create a path over unpassable obstacles. In this week's project, we will be creating the unpassable obstacles beneath the bridge.

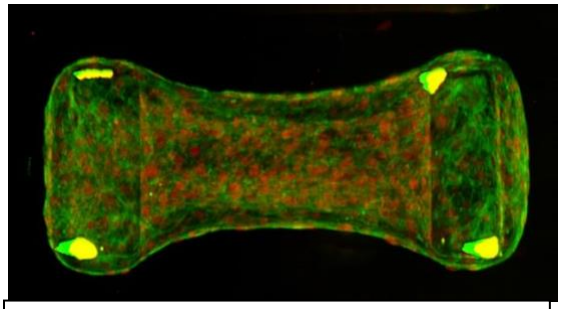
- Ask your learner what the purpose of their bridge is.
- Ask them to create a visual representation of that purpose using paper, coloring tools, and scissors.
    - Learners can create a raging river, a busy highway, a deep chasm, a pit of monsters, or anything that their bridge needs to travel across.
    - This can be a great chance for imaginative play! Learners can incorporate a drawn background with toys and objects from around the house.
        - In the example shown below, the drawing is of a river that is teaming with creatures. Some of the creatures are toys and knick-knacks from the artists' own collection while some are drawings.
    - Learners can make as many drawings to use under their bridge as they want and can swap them in and out as they desire.
- An alternative to this project is to create users for the bridge itself, or a reason to cross to the other side.

- This could mean creating two figures that want to meet each other, making a destination on one side of the bridge, or making cars that want to cross the bridge itself.

Two different types of bridges, providing safe passage to pedestrians.

Suspension bridge whisking away dragon treasure (100 pennies!)

Want to dive in even deeper?



Lab grown heart cell between two man-made pillars.

The Bruce Museum is thrilled to be part of the larger science and research community. Last year Cell-Met invited Corinne Flax to participate in a training focusing on the engineering of man-made heart cells. What does this have to do with bridges, you may be wondering? The answer is more than you might think!

Heart cells pulse in time with one another, which is what creates the beating of our heart and what moves blood throughout our circulatory system. When scientists grow heart cells in labs they create a structure, much like the towers of a bridge but on a microscopic level, to attach the baby heart cells to. The cells have to grow and beat, without tearing themselves in two, or ripping free from the towers. Think of each heart cell as a tiny bridge, being subjected to tension and compression with each beat.

This video from Cell-Met educational partners suggests a different take on bridge exploration that has learners building their own heart cells and exercising them. If you are up for the challenge, build your own heart-cell towers and create a heart cell to connect them. Then, test out your heart cell. Can it survive 10 consecutive compressions?

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NGSS Performance Expectations

2-PS-2 Matter and It Interactions Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

K-2-ETS1-2 Engineering Design
Develop a simple sketch, drawing or physical model to illustrate how the shape of an object helps its function as needed to solve a given problem.

K-2-ETS1-3 Engineering Design
Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

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