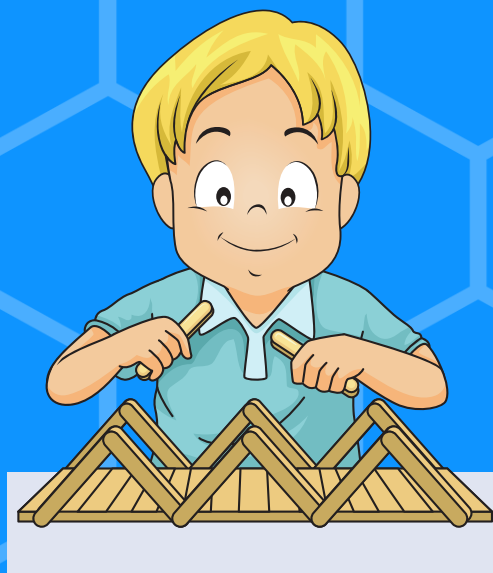


Science Technology Engineering Math

STEM CHALLENGE

Elementary and Middle School



HOW DO BRIDGES WORK

*Aligned with Next Generation Science Standards

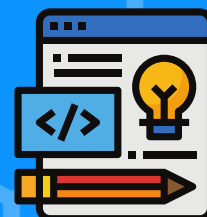
Included in this Activity:



KNOWLEDGE
BUILDER



CHECKING FOR
UNDERSTANDING



DESIGN
CHALLENGE

CREATED BY ALICIA ROBERTS

HOW DO BRIDGES WORK



Essential Questions: How do bridges work? Can bridges shape society? What type of impact does a bridge have on the environment?

Grade Level: Elementary / Middle School
Subject: Science, Math, Physics, STEM
Themes: Forces, Gravity, Engineering
Crosscutting Concepts: Cause and Effect, Scale and Proportion, Structure and Function

Length: 2 class periods (45 min)

Assessments Included:
Formative Assessment

Vocabulary Builder

Beam

Arch

Truss

Suspension

Tension

Compression

Set Up

What you will need:

Skewers

Popsicle sticks

Glue (Wood glue or Hot glue works best)

String

Pipe cleaners

Exacto knife or shears to cut wood sticks

Objective: Understand why tension (pulling apart) and compression (pushing together) are the two important forces of bridge design.

Standard - NGSS:MS-ETS1-2

Students will demonstrate understanding by: Evaluating competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Activities

Day 1

Knowledge Builder

Begin with discussion of Essential Questions. In small groups have students complete Knowledge Builder using the internet or resource page. Students should collaborate on selecting a bridge type to build based on their research completed for Knowledge Builder.

Day 2

Checking for Understanding

Formative Assessment

Use Checking for Understanding:
10 ASSESSMENTS TO PROVIDE SNAPSHOTS
OF STUDENT UNDERSTANDING
(in less than 10 minutes)

Design Challenge

Students will propose, discuss and collaborate to generate ideas and understanding of how to build a bridge based upon their understanding of bridge designs covered in this unit of study.

Big Ideas Explained



Big Idea:

Civil engineers shape our lives by the things they design and build. One of the greatest inventions for society has been the bridge. In this lesson students will use geometry and measurement to create a bridge of their own. Students should understand that gravity, compression and tension and weathering are forces that determine the safety and longevity of a bridge. Students will learn how bridges influence society and the environment.

Essential Questiond

How do bridges work?

Bridges are designed to balance two types of forces: compression and tension. The load of these forces are channeled onto supports at each end of the bridge called abutments and piers.

Can bridges shape society?

Bridges are a critical component of a nation's infrastructure, making it possible to ship materials to consumers and allow people to travel beyond their communités. Bridges also allow people to connect together and explore different beliefs and cultures.

What type of impact does a bridge have on the environment?

Bridges can be very heavy pieces of construction, with large foundations, huge supports and long wide spans. Because of their size bridges are always going to have a large impact against the surrounding environment. Changes made to river channels, damage to vegetation, increase in traffic and population, and fish migration are all impacted by bridge design and construction.

Resources on Bridge Design:

The Hook

6 Facts Shaping Bridge Design and Construction
<https://www.youtube.com/watch?v=GUISPIHQxXw>

The Research

Explain That Stuff
<https://www.explainthatstuff.com/bridges.html>

The Additional Information

The Bridge Site
<https://www.bridgesite.com/funand.htm>

KNOWLEDGE BUILDER

Developing students capacity to research and investigate. Students will propose, discuss and collaborate to improve ideas and understanding.



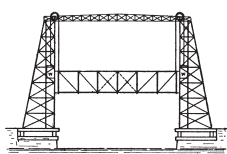
How Do Bridges Work

What type of bridge have you traveled on in your community?

DIRECTIONS Research and create a definition for the following types of bridges. Include a description of the design and function, and the greatest length the bridge can cross in a single span (the distance between two bridge supports.):



BEAM



TRUSS



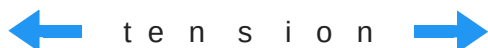
ARCH



SUSPENSION

Illustrate and describe two opposing forces

TENSION & COMPRESSION



KNOWLEDGE BUILDER

ANSWER KEY

Beam bridges are made of horizontal beams supported by piers at each end. These two components support the downward weight of the bridge and the traffic that moves across it. The greatest length a Beam bridge can span is 250 feet.

Truss bridges are a combination of triangles made of steel. A truss is rigid and has the ability to spread the compression and tension of the load from a single point to a wider area across the bridge. The greatest length a Truss bridge can span is 360 feet.

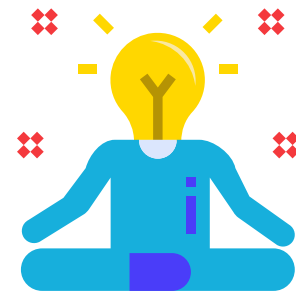
Arch bridges are made up of arches supporting the bridge and are naturally strong. The curve of the arch spreads out the forces of tension and compression onto the abutments. The greatest length an Arch bridge can span is 800 feet.

Suspension bridges are made up of towers and cables constructed in a way that will support the weight of the deck. Vertical cables are suspended from larger cables that run between towers. The cables are anchored in abutments at each end. The greatest length a Suspension bridge can span is 7,000 feet.

Tension and Compression are two forces that are at work in bridges. Compression is a pushing force. Tension is a pulling force. The biggest difference in these two forces is that tension is a force that stretches something to make it longer, whereas compression is a force that shortens the body of the object absorbing its force.

CHECKING FOR UNDERSTANDING

Connecting the dots! Making sure that what students are learning is what is being taught while it is being taught.



How Do Bridges Work

10 ASSESSMENTS TO PROVIDE SNAPSHOTS OF STUDENT UNDERSTANDING (in less than 10 minutes)

1. Connecting to the Community

Describe how bridges connect people or communities geographically, socially or economically.

2. What's the Positive Impact of Bridges

Explain how bridges can help the economy and connect communities to the world.

3. Common Misunderstandings

List 3 misunderstandings about bridges and their design.

4. Yes/No Chart

Create a series of yes or no questions that are specific to each type of bridge using the Knowledge Builder worksheet.

5. Rate It

List in order the 3 most important ideas discovered in the lesson. Put a star next to the most interesting thing you learned.

6. Explain What Matters

Describe how tension and compression are critical to bridge design.

7. Compare Contrast

List 3 things that are the same or 3 things that are different in each bridge design.

8. Draw What You Know Create an infographic of the different types of bridges: Beam, Truss, Arch and Suspension

9. Rank It

List in order 5 important considerations bridge builders must take into consideration for the design and construction of a bridge.

10. 10 Second Expert

Write, draw or diagram a bridge design in a way a stranger would understand. Present it to your partner, small group or class.

DESIGN CHALLENGE

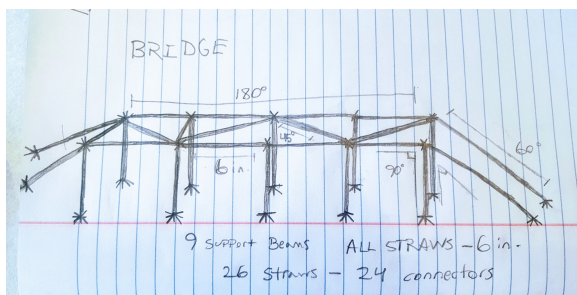
Ask students to apply knowledge in a creative, innovative way using the design process. Experiment. Fail. Learn. Repeat.



How Do Bridges Work

Directions: In small groups or pairs brainstorm ideas on how to build a bridge using Big Ideas from the Knowledge Builder worksheet. Compare and contrast ideas, draw a prototype and build a bridge.

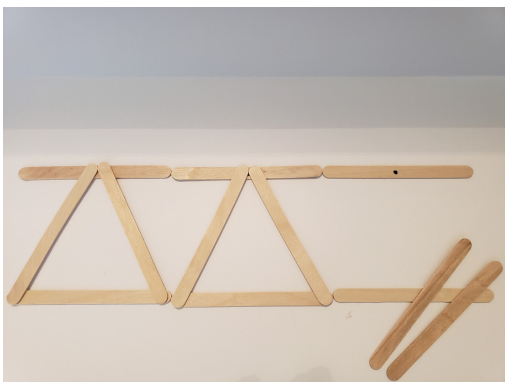
Decide on Bridge Type and Sketch It



Identify and Measure Resources Needed

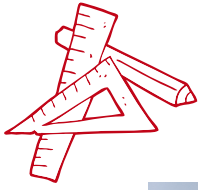


Lay Out Materials and cut to size

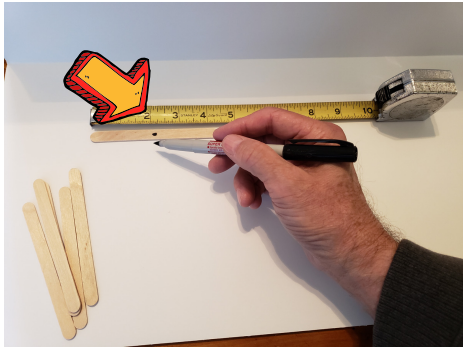


Assemble Bridge and Test Stability

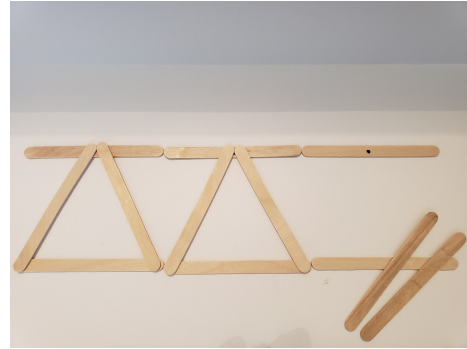




7 Helpful Tips for Bridge Building



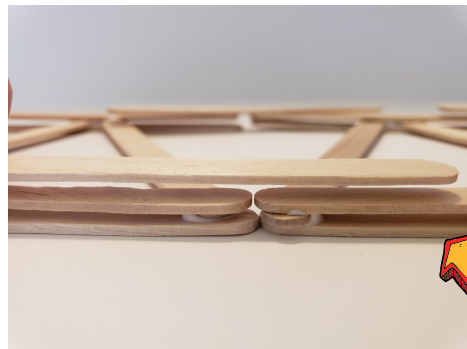
1. Measure and mark center point



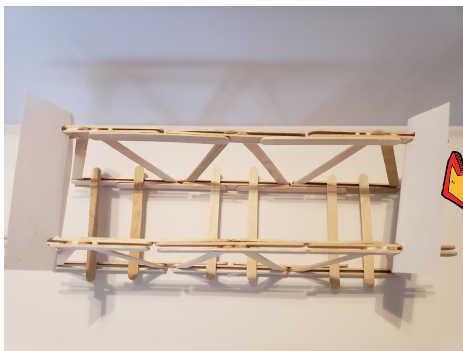
2. Lay out the design



3. Glue one layer at a time



4. Think about the support needed



5. Use index card as support while building and as glue dries



6. Use beams to support deck



7. Use Truss framework to increase strength and support