

Bridge Building


Age Range:

9+ years old

**National Science
Education
Standards:**
Unifying Concepts
and Processes:

 K-12: Form and
function

 K-12: Evidence,
models, and
explanation

Science and
Technology:

 K-12: Abilities of
technological
design

 K-12:
Understanding
about science and
technology

Physical Science:

 K-4: Properties of
objects and
materials

 5-8: Motions and
forces

Approximate Time Required for Session:

1.5 hours

Purpose:

- To work as a team to design and construct a bridge that meets the requirements (e.g., spans a 15 inch gap and supports 10 pounds) using available materials.
- To learn the different types of bridges.
- To understand important features of the design process.

Overview of Activities:

This session requires campers to study the barrier facing them, an open gap which must be spanned. They must work as a team to design a basic blueprint for the construction of a bridge. After the team has designed and sketched their bridge, they will use the material and implements provided to physically build it. The bridge must span the gap and support a weight of 10 pounds.

Background Information for Facilitator:

A bridge is a structure erected to span a physical obstacle such as a depression or a body of water. Often it serves as a pathway for pedestrians or vehicles. Bridge designs vary depending upon the function of the bridge and the nature of the terrain near its location. There are seven main types of bridges: truss, girder, beam, slab, arch, suspension, and floating. Other types include cantilever, swing, lift, bascule, etc. However, the aforementioned seven varieties are encountered most often.

See below image for reference to bridge types.

- 1) The truss bridge has a truss for a superstructure. The span rests on one support at each end. These supports may

Background Information Continued:

- include abutments, piers, bents, towers, or any combination of these.
- 2) The girder bridge has two or more girders supporting a separate floor system of slab and floor beams.
 - 3) The beam bridge is the simplest bridge, consisting of one or more horizontal beams with a support on each end.
 - 4) The slab bridge is composed of a reinforced concrete slab that is either singular or in a series of narrow, pre-cast slabs. This slab is parallel with the roadway alignment and spans the space between the supporting abutments or other substructure parts.
 - 5) The arch bridge has abutments at each end shaped as a curved arch. Arch bridges work by transferring the weight of the bridge and its loads partially into a horizontal thrust restrained by abutments at each end.
 - 6) The suspension bridge has its floor system and its incidental parts suspended on cables supported at two or more locations on towers and anchored at their extreme ends.
 - 7) The floating bridge has substructure parts which provide buoyancy such as logs or timbers held in position under a plank deck.

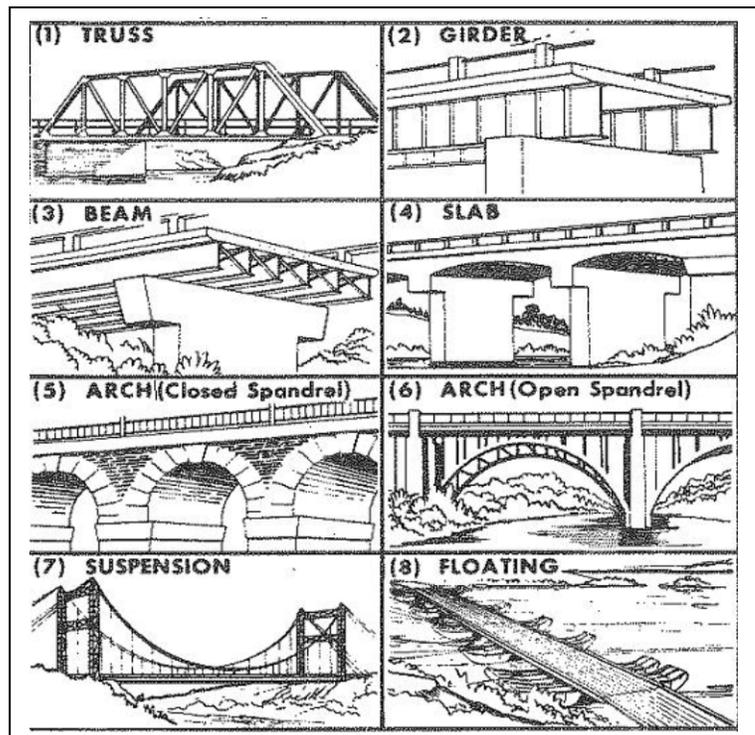
Concepts and vocabulary:

Abutment - the supports at either end of a bridge.

Deck - the roadway portion of the bridge.

Span - the distance between abutments of a bridge.

Superstructure - the upper structure or edifice built over the bridge to aid in its support.





Activity A: Bridge Building

Approximate Time Required for Activity:

1.5 hours

Suggested Groupings:

Large groups of up to 20
Smaller groups of 3-5 youth

Introduction:

In this activity, campers will design and build a working bridge that spans a 15-inch gap and supports a weight of 10 pounds. They will work as a team to design and construct the bridge within the allotted time.

Materials Needed:

- Pencils
- Sheets/tablets of paper
- Rulers
- Craft popsicle sticks
- Glue sticks
- Glue guns
- String
- 10 pound weight for each large group
- Easel for each large group
- Flip chart paper and markers for each large group

4-H SET Abilities:

- Draw/Design
- Build/
Construct
- Use Tools
- Measure
- Communicate

Tips!

Use low temperature glue guns for this activity. The hot glue guns can be a safety hazard, particularly for younger campers.

White glue can be used in lieu of glue guns. However, you must allow a considerable amount of time for it to dry.

Remember to encourage lots of exploration.

Avoid answering questions. Ask questions to help campers discover their own answers.

Preparation:

- 1) Make sure you have adequately prepared for the activity. Read the background information and activity. Practice building a bridge that spans a 15-inch gap and supports a 10 pound weight.
- 2) Determine the size and number of large and small groups. Have a plan for dividing the large group into smaller groups of 3 to 5 youth. Assign at least one trained facilitator to each large group and if possible each small group.
- 3) Prepare a packet for each small group that consists of a pad of writing paper, pencil, string, a ruler, a glue gun, 10 glue sticks, and 100 craft popsicle sticks.
- 4) Create a 15-inch gap that must be spanned. This activity can be done outdoors over a natural setting. It can also be done indoors by using the ends of two tables of equal height or by placing two stacks of books of equal height on a table with a 15-inch gap between them.

Introduction and Opening Questions (10 minutes):

- Gather campers. Explain that they will design and construct a working bridge which spans a 15-inch gap and supports a 10 pound weight.
- Divide campers into groups of about 20 people. Each group should have at least one trained facilitator.
- In large groups, facilitate a discussion with campers about the various types of bridges they have seen in their travels.
 - Discuss the different sizes.
 - Discuss and evaluate the different shapes of bridges and how they are designed.
 - Explore the purpose that different types of bridges serve.
 - Compare the different types of material you've seen used for bridge construction.
 - Compare the various support systems of bridges.
 - Engage the group in evaluating what keeps a bridge

Introduction and Opening Questions Continued:

- from collapsing.
- Discuss the various types of obstacles bridges span.
- Brainstorm and discuss with the campers what they might need to consider if they were architects in charge of designing a bridge or engineers in charge of building it. Remind them to keep these thoughts in mind, as they will be useful during this project.

Experiencing I (15 minutes):

- 1) Show them the area you have established to be spanned.
- 2) Divide campers into teams of 3-5 participants.
- 3) Provide each team with a tablet of paper, pencils, a ruler, and two craft sticks.
- 4) Show campers all the materials they will have to construct their bridge.
- 5) Have campers study the area to be spanned, and design the type of bridge they will build.
- 6) Prepare a sketch of your bridge. They will need to keep in mind the materials they have available to them for construction. They are not required to use all the materials, but cannot use more than what they have been provided.

Sharing, Processing, & Generalizing I (10 minutes):

Bring small groups together to form the larger group of 20.

- Ask the teams to share their experience in the design process:
 - Share the sketch of your bridge and explain how you came up with the design.
 - What were the group dynamics like? How did you work as a team?
 - Is there any additional information you'd like to share?
- Do any of you want to change or adapt your design based on your observations of other groups?

Tips!

In the design phase of the activity, give the teams only two craft sticks as reference. This requires them to sketch the plan on paper.

The gap to be spanned is 15 inches, so the bridge needs to be *longer* than 15 inches.

Tips!

As they begin the process of construction, they may realize that they will need to make corrections or adaptations to their original design. They may do so.

If you have more than one large group consider making as many 15-inch gaps to span as the number of large groups you have. This will speed up the testing process.

Experiencing II (45 minutes):

- 1) Give each team 100 craft sticks, 1 glue gun, and 10 glue sticks.
- 2) Allow the participants approximately 40 minutes to construct their bridge.
- 3) When all teams have completed their structures, allow a few minutes for all groups to visually examine each other's creations.
- 4) Begin the process of placing a bridge, one at a time, over the area to be spanned and place the 10 pound weight upon it.
- 5) Repeat until each bridge has been tested. Record the results on the flip chart paper.

Sharing, Processing, & Generalizing II (10 minutes):

Gather all the small groups together to form the larger group of 20 for the rest of the activity. Ask each small team to share their experience in the construction process:

- Tell us about any anxieties you had regarding your bridge and its design.
- Share with us any surprises you had in this activity.
- Did some bridges work when it looked as if they would not and vice versa, and if so why was that?
- Compare the principles you have learned in math or science at school and their application to this project?
- Explain how you can apply some of the things you did here today to evaluate the next bridge you see in regards to how it was designed and constructed.
- Is there any additional information you would like to share?

Taking it One Step Further:

- 1) You can adapt this activity to see which bridge can support the heaviest load by increasing the poundage to the breaking point of each structure and recording the results.
- 2) You can make this activity more challenging by doubling or tripling the size of the gap to be spanned. Be sure to increase the amount of material you provide to the design/building teams accordingly. Ask campers if and how they altered their design to accommodate the extra gap to be spanned. Explain your reasoning.



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