SUBJECT: ***BRIDGE TYPES & SIMPLE MACHINES***

GRADE LEVEL: *Kindergarten – 3rd Grade*

OBJECTIVES/GOALS: Introduce the basic concepts (fixed vs. moveable bridges), uses, and benefits of bridges, and the variety of bridges used around the world and everywhere in between.

LESSON & BACKGROUND (20-25 minutes):
A bridge is any structure spanning a space, chasm, body of water, or other obstacle. Bridges are of great value and use because they make the movement and transportation of people, animals, vehicles, and things much easier, faster, and safe.

There are two basic types of bridges – fixed and moveable.

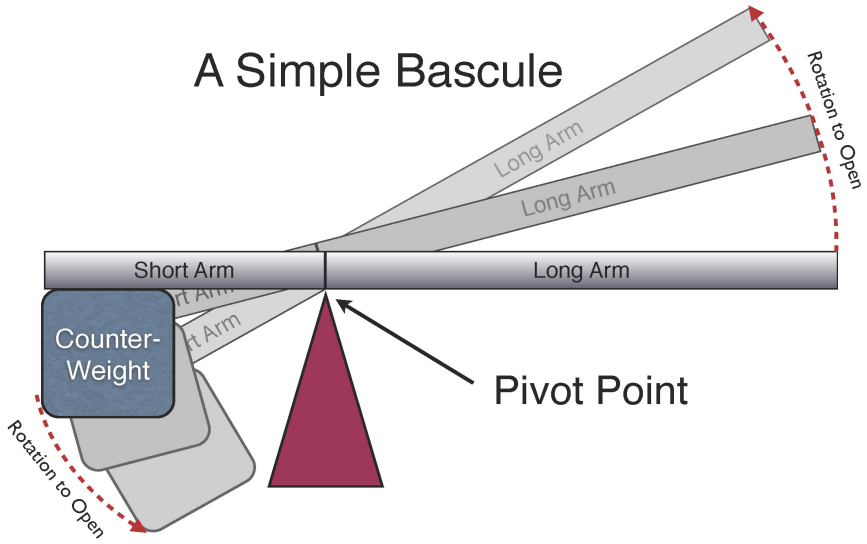
- A fixed bridge is a permanent structure usually carrying street and/or railroad traffic back and forth over some obstacle or body of water. Moveable bridges are fixed in place, but move to open and close a waterway for ships.
- Moveable bridges, often called drawbridges, when closed are used to carry street or railroad traffic over a waterway. Drawbridges open to allow large ships or boats to pass along the waterway. Drawbridges force land traffic (pedestrians, cars, trucks and trains) and water traffic (sailboats, barges, ships) to take turns and share use of the bridge.
- It should be noted that there is a small third category of portable bridges. These bridges are used occasionally to cross a stream or river and then moved to different locations as needed. Most common use of these bridges is during military campaigns such as the Bailey bridge invented for use during WWII.

Read aloud of *Drawbridges Open and Close* to explore the steps of opening and closing a drawbridge.

- Ask or discuss why a drawbridge needs to open. By opening these bridges allow the ships and boats that can't fit under the bridge to pass.
- Traditionally ships and navigation of the waterway has right of way over street and rail traffic and often drawbridges are required to open on demand for water traffic. That is less common now as ships are no longer the primary means of transportation to move people, materials, and products.
- Ask or discuss why a drawbridge is locked. Is that to stop burglars from stealing the bridge? No, that is silly!
    - Locks make the bridge stronger by connecting the two parts (or bridge leaves) together to help support and carry street or railroad traffic crossing the bridge.

- Locks also help protect the bridge by making it stronger to resist impacts from the side such as if it were hit on the side by a ship accidentally running into the bridge.
- Locks help prevent someone (say Ponticat) from accidental opening of the bridge.
  - Did you know Ponti is Latin for "bridge"?

- The Narrows Drawbridge in the book opens like a seesaw or teeter-totter and is called a bascule bridge. Bascule is a French word meaning "seesaw" and implies the use of a counterweight.
- Bascule bridges work easily and smoothly because they are balanced. The counterweight attached to the short arm of each leaf of the bridge balances against the long arm over the waterway to bring the center of gravity to or very near the point of rotation. This balances the bridge so less effort (or energy) is used to open and close the bridge.



ADVANCED LESSON (15-25 minutes):
A drawbridge is full of simple machines and *Drawbridges Open and Close* shows many of these machines and can be used to point out the uses and application of simple machines.

- Each leaf of the bridge acts like a giant lever and by balancing it with a counterweight very little energy is required to open or close the bridge.
- The gears are wheels and axles that turn and mesh to take the electric power of a spinning motor and through reducing gears slow down the speed of rotation and in so doing increase the power of the gears to mesh with a rack on the bridge.

- The rack and pinion (or drive gear) transfers the rotation of the gears into a lateral movement to drive the back end of the bridge down to lift the roadway over the waterway.
- The big lever in the control room controls the motors to open and close the bridge.
- The lock uses a screw gear to lock and unlock the bridge.
- The open bridge becomes two inclined planes.
- The cord in the wheel house of the tugboat may runs through one or more pulleys (though they are not shown) to activate the steam whistle or electric horn on the tugboat.

Further experimentation or a math problem may also be added to determine the weight necessary to balance a board or ruler resting on a round object and calculate the weight ratios for off center balance points and counterweights used to bring the system into balance.

QUESTIONS TO PROMPT DISCUSSION & FURTHER EXPLORATION:

- Who crossed a bridge on the way to school today? Was it fixed or movable? What was it made out of?
- Is a table or chair a bridge? (Yes.)
- Is a ceiling or roof a bridge? (Yes, and yes.) Does that mean we all sleep under bridges? (Yes, unless we are sleeping under the stars)
- So is a parking garage or a building a series of bridges stacked one on top of the other? (Yes, bridges are everywhere and all around us!)
- What kind of materials are bridges made out of? (stone, brick, concrete, wood, iron, steel, wire, rope, popsicle sticks, cardboard, paper, pipe cleaners, glue, tape, or just about any solid material)
- Who builds bridges? (engineers, masons, construction workers, cities, framers, kids, and almost anyone can build a bridge)
- How else would you cross a river or lake if there were no bridge? (by boat, airplane, swim.)
- What if there were no bridges, would going places be harder or easier? (It would mean traveling more distance up and down or around an obstacle and might mean getting wet or the need for a canoe, boat, or barge to cross water.)

HANDS-ON ACTIVITY (25-30 minutes):
Materials: A mix of the following – tape or glue, cardboard pieces, tongue depressors, toilet paper rolls, paper cups, construction paper, bobby pins, or other household materials.

Activity: Ask students build or draw their own bridges to provide hands-on creating, designing, and working with different materials. This is a great opportunity for

individual interaction and discussion about their ideas, trials, and errors in building bridges and what they have learned.

Advanced Activity: Ask students to draw and design their own bridges and to incorporate as many simple machines as possible and to show in one or more pictures the use of levers, wheels & axle, pulleys, inclined planes, wedges, or screws.

LINKS & ADDITIONAL MATERIALS:
Bridges of All Kinds: https://www.youtube.com/watch?v=hhhdW35J6fQ
Bridges video: https://www.youtube.com/watch?v=oVOnRPefcno
25 Most Impressive Bridges: https://www.youtube.com/watch?v=4nR71DW91uQ
25 Most Unique Bridges:
https://www.youtube.com/watch?annotation_id=annotation_1173850997&feature=iv&index=22&list=PL3Ikn3SKdJHh3ydUUZpusjBVgt3PTPmeH&src_vid=4nR71DW91uQ&v=MFXKi7xI9xw
Rack & Pinion: https://www.youtube.com/watch?v=nSdjaM1dkKk