Assignment Discovery Online Curriculum

Lesson title:
Famous Bridges

Grade level:
6-8, with adaptation for older students

Subject area:
Physical Science, Technology

Duration:
Two class periods

Objectives:
Students will:
1. Understand the benefits and drawbacks of different types of bridges.
2. Investigate the history and structural challenges of a prominent bridge.
3. Think about the challenges involved in building bridges.

Materials:

The class will need the following:
· Computers with Internet access (optional but very helpful)
· Reference materials on bridges

Each group of three or four students will need the following:
· Research material about a particular bridge (Web sites and books suggested below)
· One long piece of butcher block paper
· Pencils, colored markers, and crayons

Each student will need the following:
· One copy of the Classroom Activity Sheet: Bridge Research and
· One copy of the Take-Home Sheet: Longest Suspension Bridges in the United States

This lesson plan can be enhanced by purchasing a copy of the documentary *Bridges: Design and Function* at our School Store. The program airs on the Discovery Channel February 12, March 19, April 23, and May 28, 2001.

Procedures:

1. Introduce the lesson by showing the class a picture of a popular bridge, such the Golden Gate Bridge (San Francisco) or the Brooklyn Bridge (New York City). Ask students to imagine what might happen if all the bridges in New York City or San Francisco were suddenly shut down. Then help the class brainstorm some ways that bridges affect our lives. For example,

you could remind students that food and other essential supplies are often transported across bridges.

2. Gather an assortment of bridge photos from library books and Web sites. Ask students to look at some pictures and discuss ways in which the bridges are similar. Then ask the class to speculate on why many bridges are shaped differently and made of different materials. Finally, help students make a list of some of the challenges that successful bridge designers must overcome. Some possible answers include earthquakes, strong winds, and changes in temperature. For this step and the group activity that follows, see Resources to find Web sites and books about bridges, including famous bridges. .

3. Divide students into small groups of three or four. Ask each group to select a photograph and research the bridge. Students can write their findings on the Classroom Activity Sheet: Bridge Research. Each group should try to find the following information:

   - When and where was the bridge built?
   - What type of architecture characterizes the bridge?Is the architecture consistent with an arch, beam, suspension, cable-stayed, cantilever, or moveable design?
   - What were some special challenges that the bridge architects and engineers faced? How did they overcome those challenges?
   - How much time did construction crews need to complete the bridge?
   - Approximately how many cars use this bridge each week (or year)?
   - What interesting stories can be found about this bridge? For example, are any fun facts associated with its design, construction, name, or use?

4. Have students in each group draw the bridge on butcher block paper. Specify a scale, such as 1 inch = 1,000 feet, and ask students to write the scale in a corner of the illustration. To demonstrate the scale, instruct students to draw a stick figure that represents a person 5 feet tall. Note: The scale may depend on the available wall space in the classroom or school hallway.

As a concluding activity, have the groups imagine that they are bridge tour guides. Ask each group write a short tour script and then select one person to present the tour to the class. Make sure that each group has a turn giving a tour.

5. For homework, assign the Take-Home Sheet: Longest Suspension Bridges in the United States. The assignment will give students understanding of nationwide bridge locations.

Resources

Web Sites: Famous Bridges

Akashi Kaikyo Bridge
http://www.hsba.go.jp/bridge/e-akasi.htm
http://www.pbs.org/wgbh/buildingbig/wonder/structure/akashi_kaikyo.html

Brooklyn Bridge
http://www.nycroads.com/crossings/brooklyn/
http://www.discovery.com/stories/technology/buildings/panoramas/brdg_java1.html
http://www.pbs.org/wgbh/buildingbig/wonder/structure/brooklyn.html

Chesapeake Bay Bridge-Tunnel
http://www.cbbt.com/
http://www.pbs.org/wgbh/buildingbig/wonder/structure/chesapeake_bay_brdg.html

Frth of Forth Bridge
http://www.pbs.org/wgbh/buildingbig/wonder/structure/firth_of_forth.html

Gorge P. Coleman Bridge
http://www.pbs.org/wgbh/buildingbig/wonder/structure/george_p_coleman.html

Golden Gate Bridge
http://www.goldengate.org
http://www.pbs.org/wgbh/buildingbig/wonder/structure/golden_gate.html

Iron Bridge
http://www.pbs.org/wgbh/buildingbig/wonder/structure/iron.html

Sunshine Skyway (Florida)
http://www.pbs.org/wgbh/buildingbig/wonder/structure/sunshine_skyway.html

Tacoma Narrows Bridge
http://www.me.utexas.edu/~uer/papers/paper_jk.html
http://www.pbs.org/wgbh/buildingbig/wonder/structure/tacoma_narrows.html
http://instruction.ferris.edu/loub/media/BRIDGE/Bridge.htm

Tower Bridge
http://www.pbs.org/wgbh/buildingbig/wonder/structure/tower.html
http://www.discovery.com/stories/technology/buildings/panoramas/brdg_ipix2.html

Web Sites: General Bridge Information
All about Bridges
http://www.pbs.org/wgbh/buildingbig/bridge/index.html

Bridge Trivia
http://www.bridgebuildermagazine.com/trivia.html

Bridge Builder Magazine
http://www.bridgebuildermagazine.com

IPIX Gallery of Famous Bridges
http://www.discovery.com/stories/technology/buildings/brdg_explore.html#ipix

Books on Bridges

Bridges: Amazing Structures to Design, Build & Test
Carol A. Johmann and Elizabeth Rieth. Williamson Publishing, 1999.

Bridges
Etta Kaner. Kids Can Press, 1997.

Building Big
David Macaulay. Houghton Mifflin Co., 2000.

Engineers of Dreams: Great Bridge Builders and the Spanning of America
Henry Petroski. Vintage Books, 1996.

Adaptation for older students:
To help older students delve further into bridge architecture, have them conduct research on bridges of the future. What kinds of materials will be used to build future bridges? Will bridges take on new shapes? This Discovery.com Web site can serve as a springboard for their research: http://www.discovery.com/stories/technology/buildings/brdg_next.html. Based on the research, ask students to use butcher paper and markers or 3-D manipulatives such as K'nex to show an example of future bridge design.

Discussion Questions:

1. Thousands of cars drive over bridges each day. What are some techniques used to enable bridges to withstand this level of wear and tear? What keeps the bridges from falling down?

2. In October 1989, a strong earthquake in the San Francisco Bay Area caused tremendous structural damage to many bridges. What are some ways that such bridge damage might be avoided in the future?

3. What is the longest bridge in your area? Why was it built? What factors determined the materials used to design and build it? Did the builders face any special challenges?

4. Does a career as a bridge builder or engineer sound interesting to you? Why or why not? What challenges do you think would be particularly frustrating?

5. The U.S. government requires states to inspect and evaluate all bridges at least once every two years. What are some ways that technology can be used to make the inspection of bridges more efficient and effective?

6. In addition to being functional, bridges frequently become attractive landmarks for a town or region. Which bridges do you think are most visually appealing? Why?

Evaluation:
Use the following three-point rubric to evaluate students' work during this lesson. Students should be able to work cooperatively in their groups, answer the research questions, complete their drawings of the bridge, write tour scripts, and present their tour to the class.'

> Three points: students worked well in their groups; answered all the research questions; completed an accurate illustration of a bridge drawn to scale; wrote a creative and interesting tour script; made a clear presentation to the class
>
> Two points: students worked somewhat well in their groups, answered most of the research questions; completed an illustration of a bridge drawn to scale; completed their tour script; presented the information to the class in a straightforward fashion
>
> One point: students completed some of the group work; answered two or three research questions; completed a not-to-scale illustration of a bridge; wrote most of their tour script; presented some information to the class

Extensions:

Build It and They Will Come
Divide the class into small groups. Give each group a small collection of materials, such as drinking straws, rubber bands, paper clips, and tape, to use to build a model bridge. Ask students to construct a bridge between the backs of two chairs that are approximately 2 feet apart. The bridge must be able to handle the weight of a model car or a tennis ball rolling across it. If their bridge cannot meet the load criterion, have them make adjustments until it can support the weight.

You're the Engineer!
Two online challenges will help students improve their understanding of different kinds of bridges. On each Web site listed below, students will find several scenarios that conclude with a question about the best kind of bridge to build. Students must figure out how to resolve the problem.

> The Bridge Challenge
> <http://www.pbs.org/wgbh/buildingbig/bridge/challenge/index.html>
>
> NOVA Online Bridge Activity
> <http://www.pbs.org/wgbh/nova/bridge/build.html>

Suggested Readings:

Bridges
Steven A. Ostrow, MetroBooks, 1997.
The history of bridges and bridge-making is presented through color photographs and explanatory text, from the earliest Roman bridges to the most recent suspension types, from covered bridges on back-country roads to huge iron railroad trestles. The book shows how engineering and aesthetics can merge and create something both beautiful and useful.

Bridgescape: The Art of Designing Bridges
Frederick Gottemoeller, John Wiley & Sons, 1998.
This book offers an in-depth look at all the decisions that must be made while a bridge is bein designed. The text stresses the integration of the aesthetic dimension of design with its engineering aspects and provides examples through hundreds of photographs and illustrations.

Web Links:

Bridges: Reaching Out
At Discovery Online's "Bridges: Reaching Out," explore the world's longest suspension bridge, learn about future bridges, and take a tour of the greatest and grandest bridges on planet Earth..
http://www.discovery.com/stories/technology/buildings/bridges.html

Technology & Bridge Design
Using internet resources suggested at this web page, students working in teams will prepare preliminary designs and prototypes (on paper) for a model bridge that could be built for a science fair.
http://projects.edtech.sandi.net/pbmiddle/bridges-tech/

How Bridges Work
From the ever-popular "How Stuff Works" web page, learn the basics of building beam, arch, and suspension bridges.
http://www.howstuffworks.com/bridge.htm

Bridge Building-Art and Science
Everything you always wanted to know about bridges, from the structural analysis of bridge stress to the soothing poetry and music inspired by by the world's great bridges.
http://www.brantacan.co.uk/bridges.htm

West Point Bridge Designer
West Point provides FREE downloadable bridge design software. Design your bridge and test it in a virtual simulation. You might even be able to encourage a few of your students to enter West Point's "Bicentennial Engineering Design Contest."
http://bridgecontest.usma.edu/download.htm

Vocabulary:

arch bridge
Definition: A type of bridge in which its weight is carried outward along the curve to supports at each end.
Context: One of the oldest connecting structures, arch bridges can have a span of up to 1,700 feet. The Iron Bridge, located in England, is an example of a well-known arch bridge.

beam bridge
Definition: A simple type of bridge composed of horizontal beams supported by vertical posts.
Context: Hundreds of workers helped build vertical supports for the beam bridge.

cable-stayed bridge
Definition: A bridge in which the roadway deck is suspended from cables anchored to one or more towers.
Context: Unlike suspension bridges, cable-stayed bridges do not block a driver's view of the water.

cantilever bridge
Definition: A projecting structure supported only at one end, much like a shelf bracket or a diving board.
Context: A cantilever bridge has two towers located on opposite sides of a body of water.

span
Definition: The distance between two supports of a bridge.
Context: The Verrazano-Narrows Bridge has a span of 4,260 feet, the longest of any bridge in the United States.

stay
Definition: A long, strong wire rope that supports a mast.
Context: One of the steel stays that supported the bridge snapped, but fortunately, the structure didn't collapse.

suspension bridge
Definition: A bridge in which the roadway is hung from strong cables that pass over two towers.
Context: The George Washington Bridge is the second longest suspension bridge in New York City.

tension
Definition: A force that stretches a material apart, often making the material longer.
Context: When cars travel on a suspension bridge, they put tension on the vertical cables.

truss
Definition: A rigid frame composed of short, straight pieces joined to form a series of triangles or other stable shapes.
Context: Many suspension bridges have a series of trusses beneath the roadway to prevent the bridge from twisting.

Academic standards:

Grade level:
6-8
Subject area:
Physical Science
Standard: Understands motion and the principles that explain it.
Benchmark: Understands the effects of balanced and unbalanced forces on an object's motion (e.g., if more than one force acts on an object traveling along a straight line, the forces will reinforce or cancel one another, depending on their direction and magnitude; unbalanced forces, such as friction, will cause changes in the speed or direction on an object's motion).

Grade level:
6-8
Subject area:
Technology
Standard: Understands the relationships among science, technology, society, and the individual.
Benchmark: Knows ways in which technology has influenced the course of history (e.g., revolutions in agriculture, manufacturing, sanitation, medicine, warfare, transportation, information processing, communication).

Grade level:
6-8
Subject area:
Scientific Processes
Standard: Understands the scientific enterprise.

Benchmark: Knows that the work of science requires a variety of human abilities, qualities, and habits of mind (e.g., reasoning, insight, energy, skill, creativity, intellectual honesty, tolerance of ambiguity, skepticism, openness to new ideas).

Credit:
Jordan D. Brown, a freelance author specializing in materials for kids and teachers

DiscoverySchool.com
http://www.discoveryschool.com

Classroom Activity Sheet: **Famous Bridges**

Name: _____

Bridge Research

Bridge: _____

Use the questions below to guide your research on the bridge your group selected.

1. When and where was the bridge built?

_____

_____

2. What type of bridge is it (arch, beam, suspension, cable-stayed, cantilever, moveable)?

_____

_____

_____

3. What were some special challenges that the architects and engineers of this bridge faced? How did they overcome those challenges?

_____

_____

_____

4. How long did it take to complete construction of the bridge?

_____

_____

_____

5. Approximately how many cars use this bridge each week (or year)?

_____

_____

_____

6. Did you find any interesting stories about this bridge? Any fun facts?

_____

_____

_____

Take-Home Sheet: **Famous Bridges**

Name: _____

Longest Suspension Bridges in the United States

Some of the most famous bridges in the United States are suspension bridges. On a *suspension **bridge***, the roadway is hung from strong cables that pass over two towers. The *span* of the bridge is the distance between the two towers. The five longest suspension bridges in the U.S. are listed below.

1.
Verrazano-Narrows Bridge
New York, NY
Built: 1964
Span: 4,260 feet

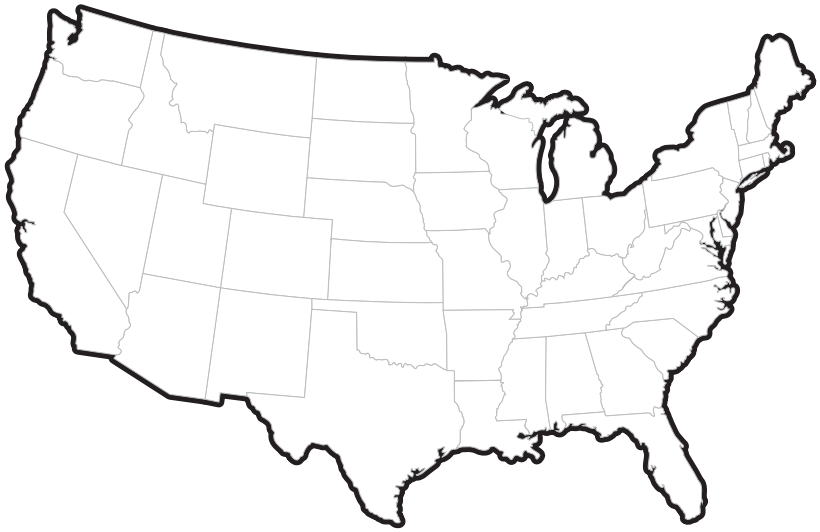
2.
Golden Gate Bridge
San Francisco, CA
Built: 1937
Span: 4,200 feet

3.
Mackinac Bridge
Mackinaw City, MI
Built: 1957
Span: 3,800 feet

4.
George Washington Bridge
New York, NY
Built: 1931
Span: 3,500 feet

5.
Tacoma Narrows Bridge
Tacoma, WA
Built: 1950
Span 2,800 feet

On the map below, mark where each bridge is located. Next to each bridge, name the body of water that the bridge crosses.



Draw a bar graph showing the length of each suspension bridge listed below. Include a bar for the world's longest suspension bridge, the Akashi-Kaiko, in Kobe-Naruto, Japan. It spans 6,529 feet.

Akashi-Kaiko

Verrazano-Narrows

Golden Gate

Mackinac

George Washington

Tacoma Narrows

Length in feet	0	500	1000	1500	2000	2500	3000	3500	4000	4500