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Bridges: Joining Communities Together

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This unit has its foundation in the third grade curriculum utilized by the City of New Haven. The curriculum suggests that students in the third grade study their community. Usually our study covers topics like: What is a community? Why do people live in communities?, What kinds of communities are there?, Why do communities have a government?, and How do the government, schools, and services provided to the community help people to satisfy their needs and wants? For my third graders it is usually the first time they really learn about New Haven and its history. A few years ago I was privileged to be part of a seminar on the Symbolic Language of Architecture and Public Monuments. The seminar leader pointed out the basics of classical architecture and how its elements form a language we see in even some of the most contemporary buildings within the community. Decorative elements add to the beauty of a building or monument. When architecture utilizes these elements we usually recognize the building or monument as more than a building - rather a statement about us as human beings sometimes more specifically as Americans. In the past, I have used architecture as a way of presenting the past, present, and possible future of the community to my students. The seminar on bridges seemed a perfect continuation of that seminar and those ideas.

Bridges have a practical and aesthetic affect on the community. Recently the local newspaper printed a picture of a proposed bridge to be built over the Quinnipiac River. The now inadequate Q-bridge would have more lanes. The bridge would still connect New Haven with East Haven and points beyond. The picture in the newspaper showed a modern and dynamic bridge. Those proposing the bridge talked little of how it would carry more traffic over the Quinnipiac River. The article spent more time waxing poetic about how such a span would be unique and a landmark people would want to see. It would be an attraction for travelers to the northeast. Some may argue the wisdom of such a bridge but it seemed that there was a conscious effort to build something that went beyond a utilitarian purpose. There was an effort almost a need to build something memorable, something that would mark our community as special. Not only could the bridge literally unite us to other neighborhoods and communities, it would also give us an object of pride to share and enjoy.

I don't know if most people ever think about or appreciate the beauty that surrounds them in the buildings and architecture we take for granted every day on our travels to and from work. I know that that seminar heightened my awareness. I would like to bring both the practical and aesthetic of the bridge to my students. The unit is interdisciplinary in that it will encompass talking about other areas of the curriculum such as math, science, social studies, and art. In structuring a unit about communities and bridges I would like to use the following outline as a guide:

1. What are bridges?
2. What are the parts of a bridge?
3. Who makes up the team that builds a bridge?
4. How do we decide where to put a bridge?
5. What type of tools and machinery are used to make a bridge?
6. What makes a bridge stay up?
7. What are the basic types of bridges?
8. How do the materials used in constructing a bridge relate to its form and shape?
9. What makes a bridge special?
10. Make your own bridge.

Fellow participants in the seminar suggested that the unit should include a field trip or trips, to help the children sharpen their observation skills. Whether a trip begins the unit or comes in the middle or end is going to depend on the time of the year, availability of transportation and the purpose of the trip. Our seminar leader suggested a trip to the top of East Rock, which sits above New Haven and Hamden and offers a wide view of the city. At its' base is a park which also features a number of wooden bridges which might interest the children. Our school is near the Kimberly Avenue Bridge and there are also a number of railroad bridges close by. We can easily visit the Tomlinson Bridge that is being rebuilt, and see the Q-Bridge, which will be replaced in the future. Ideally we would take a trip early in the unit and toward its conclusion when students have hopefully increased their awareness of bridges.

What are bridges?

It may seem an obvious question but it is necessary to begin at the beginning with third graders. Its one of those things we know but try to explain it and the exact words seem hard to find. I might begin by giving the children a piece of paper and asking them to write down and draw what they think a bridge is and how they would describe it. We would review and share the ideas they present. I might even make a list of ideas they give. We might take their ideas and questions and construct a KWL chart (What I know, What I want to know, and What I want to learn about bridges?), which is a graphic organizer that will help us to organize their learning so that the unit centers on their needs. Hopefully, their questions would match most of the content I have suggested in the outline above.

In truth no one really knows when the first bridge was made. Most of the literature assumes that the idea for a bridge occurred after early man saw a fallen tree crossing a small stream and the idea seemed to click. There are numerous examples of early bridges from China to Africa and even in the ancient cultures of middle and South America.

Often teachers use some piece of literature as a way to segue into a unit, or to help tie it together. There are a couple of bridge related poems and stories which the teacher may want to consider using throughout the unit. As an opening piece I have included a Jack Prelutsky poem: *I'm Building a Bridge of Bananas* (see Appendix A). You might also consider using William Wordsworth's *Composed upon Westminster Bridge, September 3, 1802* . This poem is a reflective piece about the joy that the bridge gives the writer as he looks at the bridge. This poem may be used further into the unit to lead students into writing their own poem to a bridge that they may visit as part of the unit.

There is also the classic children's tale: *Three Billy Goats Gruff* , retold by Janet Stevens (there are other versions) in which the bridge is the main setting for the action. Three clever goats outwit a mean troll that lives under they must cross to go to the mountains. Students might build dioramas of the bridge and or act out the story with stick puppets. In researching literature for the unit, I also came across the story by Natalie Savage Carlson called *The Family Under the Bridge* . In this story a hobo who lives under a bridge crossing the Seine River in Paris finds a mother and her children have moved there because of bad times. At first the hobo, Armand, decides to move, but then he comes to care for the children and helps the family to find a home. This chapter book could help focus children on thinking about the bridge and how it influences the life around it. There are numerous possibilities for writing and art activities that can accompany this particular story.

Teachers may want to use the poem: *Concord Hymn* by Ralph Waldo Emerson, which commemorates a monument being placed where the original bridge was at the sight of the battle of Concord. Here the colonists first engaged the British in battle, thus beginning the revolutionary war. This poem is well known for one line: *Here embattled farmers stood / And fired the shot heard round the world* . Discussing this bridge and what happened could lead into many areas depending on the teacher's goals and the sophistication of the students.

Finally I offer the well-known rhyme: *London Bridge* . It was thought that the poem refers back over a thousand years when the English and Norwegians were fighting against the Danish Vikings. The bridge was in the middle of the two warring sides. The English couldn't get across or get by in boats to attack so they tied ropes to the wooden piers and rowed downstream as hard as they could. The bridge tumbled down. Some other historians think the rhyme was started in 1281 when ice knocked down five of the bridge's arches.1

I'm sure that there are probably a number of other possible pieces of literature that could compliment this study; I have named only a few.

What are the parts of a bridge?

While there are many different kinds of bridges there are certain parts that are part of each bridge (see Appendix B). Every bridge has a deck, which is where you walk or drive cars on. They also have supports that help hold them in place. The supports of a bridge all rest on a foundation in the ground. The road leading up to a bridge is called the approach.

In a beam bridge and arch bridge the supports at the end are called abutments and the supports in the middle are called piers. In a suspension bridge towers provide support. The long cables that are strung over the towers are called cables and they are tied down in anchors on land. Hangers run from the cables and hold the deck up.

Who is part of the team that makes a bridge?

As with the last section of the unit, I see the importance of using the jargon of building as a way to increase the vocabulary of my students, and help them put a name to objects and people they know but whose correct name they are unfamiliar. Often in conversation even the most articulate of my students will describe by action or definition what they mean to say but the word escapes them. They have seen cement mixers but most will not know it by name. They will describe it as " that truck that has the part in the back that turns and it carries cement." They know what they want to say but can't. From my perspective, if they remember only a few words it will be an accomplishment.

There are many people who work on a bridge. That includes:

1. Client - community people / officials who commission the bridge.
2. Bridge Designer - works on the design of the bridge.
3. Structural Engineer helps to make sure that the bridge is correctly designed.
4. Contractor - the person hired to be in charge of building the bridge. He works with the designer and engineer to make sure the correct plans are followed.
5. Project superintendent- hired by the contractor to hire workers and keep track of materials and equipment that will be used. Usually it is their job to schedule the work to be done.
6. Foremen (men and women can have this job) help the project superintendent with specific jobs. One might be in charge of carpenters, one in charge of masons and another in charge of steel workers.
7. Builders - include the people who actually build the bridge: cement masons, steelworkers, carpenters, truck drivers, electricians, and equipment operators.
8. Suppliers - people and businesses that furnish materials, fabricate pieces, and provide services while the bridge is being constructed.
9. Inspectors - they visit the bridge as it is being built and make sure that all the people are doing their job correctly and that all the safety codes are being followed.
10. Safety Consultants who checkout and approve the bridge upon completion.

How do we decide where to put a bridge?

Simply put every bridge is the solution to a problem of getting from one place to another. The people from the community who propose the construction of a bridge usually have some economic or social problem, which makes building a bridge a necessity. Perhaps two communities are cut off and a bridge will mean better communication. One thing most communities know is that stores need people. If a community project does not get the flow of traffic it needs economic problems will happen. When discussing this idea, I would like to hand each child the map of a fictional community with roadways and a river. The map would show the population on both sides cut off from areas in the community. Perhaps there are businesses or places people would not be able to visit without a bridge. Students would have to figure out where it should go and how write a few sentences on how it would help the community.

- Is the bridge going to go over water or land?
- If it's over water how deep is it?
- How high are the banks of the river and are they rocky or soft?
- Is it a busy waterway? Do tall ships go by?
- What is the weather like? Is it extremely hot or cold? Is it very windy?
- Does the area experience earthquakes?
- Will the bridge have any affect on the land or animal life in the area?
- Is the bridge for pedestrians, trains, cars, or a combination of groups?
- How wide is the space to be covered?
- What kind of bridge will work best?
- What materials will be used?
- How much money is there to spend on the bridge?
- How will the areas around the bridge be developed?

What types of tools and machinery are used to build a bridge?

As I previously stated, most of my students do not have a very rich vocabulary. While they may have seen a lot of building tools and vehicles they will have limited knowledge of their names or what they do. I hope to provide a chance to explore the builder's tools. I have found a series of books (see Bibliography) that describe the types of trucks from cement mixers to cranes and dump trucks that would be used in building bridges. I would also like to show them the video on building bridges that not only shows some of the equipment used but also reviews a lot of the information already covered about the types of bridges. I located the video *How Do They Build Bridges?* in my local library. It is by *Popular Mechanics for Kids* (see Resources).

What makes a bridge stay up?

A bridge's job is to keep its weight up and to carry the weight of people and vehicles crossing it. The bridges' weight is referred to as a dead load, while the traffic from pedestrians and vehicles is referred to as the live load. The goal in this section will be to talk about the two main forces involved in bridge construction: compression (pushing) and tension (pulling).

Demonstration: Pushing and Pulling.

One way to see if the forces working on something are pushing or pulling is by seeing what happens to its length. You can demonstrate push and pull by the use of a piece foam rubber or sponge. Draw lines about an inch apart on one long edge of the foam or dampened sponge. Bend the foam or sponge into a U.2The lines on the inside will squeeze close together to simulate pushing. The lines on the outside will stretch apart to simulate pulling. Students should notice that pushing or compression makes things shorter, while pulling or tension makes things longer.

Students can experience these forces for themselves if they stand and do a side bend.

Stand up and bring your right arm over your head stretching to the side and bending the torso to the left. They will feel the stretching of their right side of the body as they pull toward the left. Meanwhile they will also experience pushing or squeezing as the left side of their body especially around the waste squeezes or pushes together on the side.

Trusses are often used to strengthen a bridge. This is a design, which relies on the triangulation of steel and wood segments that give amazing strength by reason of their shape. Demonstrate the strength of the triangle by having students make a square out of straws and a square or Popsicle sticks. Students can take these shapes and exert pressure on each. They should see the square give way and collapse. The triangle will be superior in strength. This principle is used to form trusses that are used in beam bridges to add to their durability and strength. You can follow the illustrations in Appendix B and have students put together their own truss structure for a bridge. They can hang the bridge between two desks and try adding small loads from the bridge. How much weight can you add before the bridge squeaks, sags, or wiggles? If your bridge passes this test try adding books to the top. If it collapses or breaks why did it?

The teaching point here is that the main weakness in a beam bridge is going to be in the middle where the weight has a tendency to sag or in the connections. This is why an unsupported beam bridge that is too long will sag, as it gets wider between piers.

The arch has its weakness in the curve, which is pushing out, but the bottom of the arch where it reaches the ground keeps it from collapsing outward. In a suspension bridge the cables are tied to abutments on either end of the bridge and then they cross over the towers, which support the cables as they stretch over the water. The weight of the cables then transfers the loads to the towers, which transfer them to the ground.

What are the basic types of bridges?

Because my students are third graders, I would like to keep things simple, so I decided to talk about three main bridge types: beam, arch, and suspension. I will also add on movable bridges as a fourth category. The beam bridge is the simplest bridge to make and usually the cheapest. It is a simple structure that carries usually one road or pedestrian path over it. The beam bridge is the extension of that bridge I alluded to earlier, which first sparked the idea of a bridge in humans. At first it might have been a simple log going across a small stream but soon the builders realized it could be made longer if some kind of pier were out into the water. At first piers were made of piled rocks and later they were made of wood, iron, and steel. As with most things the advancement to other bridge types was born from a necessity to cross spaces the beam bridge could not handle. These bridges are rarely longer than 250 feet. The beam bridge is the most common bridge seen on highways in the United States.

The students will have already built a beam type bridge in building the truss bridge. They can take the truss bridge design and turn it into a covered bridge like those found throughout the United States by adding a fence of popsicle sticks on either side of the bridge and then adding a tag board or cardboard roof. The bridge can then be painted. Many of the covered bridges are red in color. It must be noted that a system of trusses is often incorporated into an arch or suspension bridge design. In fact many bridges use a combination of design techniques.

Most modern arch bridges can be up to 1800 feet. The arch is used most successfully where the two legs or sides of the arch can be stood on either side of a riverbank or area to be crossed. Sometimes the bridge can be a series of arches across a river if necessary. When there is a need to span a longer length a suspension bridge is used. Suspension bridges cover the longest distances from 2,000 to 8,000 feet in length. The uniqueness of a suspension bridge is that it eliminates the need for numerous piers. In a suspension bridge, cables tied to a few widely placed towers hold up the deck. Often digging piers is time consuming and expensive. Over long spans the suspension bridge is a better use of money and materials, and the results are visually spectacular.

Demonstration: Making a Suspension Bridge

Students can work in pairs to make these suspension bridges. First they can put their desk chairs back to back about three feet away from each other. The backs of the chairs will be the towers of the bridge. Then place a large book on the seat of both chairs. Tie a string to one side of one of the books and then loop it around and across to the other chair where you should tie it to the other book. Put another string around the other side of the book and attach it onto the other book so that there are now two strings going from one chair to the other. Make sure that the strings are tight. Then make a cardboard deck a bit wider than the distance to the cables and able to reach from one chair to the other. Put the deck down and cover it with a book on either chair. Then tie a series of strings from the main cables. Punch holes in the sides of the deck where the pieces of string are hanging. Tie the strings to the deck making sure they are tight and that the deck is even.3 Place a

load on the bridge to see what it can handle. If it sags, how can you fix it by using more cable? Try seeing how your bridge handles wind by having a fan blow across the bridge. What can you do with the cables to help stabilize the deck? The last category of bridge is that of the movable bridges. In Medieval times the drawbridge was used as part of the castle to help protect the town and its people. The castle was usually built surrounded by a moat or body of water. When the drawbridge was down the people could come and go. In times of trouble the drawbridge would be raised, making it difficult for invaders to successfully attack the town.

Demonstration: Making a Movable Bridge

An easy way for students to make a drawbridge model its by using a cereal box. The box top is cut off. The front of the box is cut and allowed to fall like the drawbridge. The students then punch a hole in the top of the front panel and in the top of the back of the box. A string is drawn between each side of the drawbridge and the top of the deck and then it can be drawn up or let down by the student pulling the cables (see illustration in Appendix B).4 There are also bridges in which the deck of the bridge moves up and down to allow trains to pass and then retreat so that water traffic can get by. The process for making a model of this bridge is similar to the first. This time you need two cereal boxes. Cut the tops off and put a whole in each corner of the boxes both back and front. Then cut a square piece of stiff cardboard to be the deck. Put a whole in each corner. You will need about 5 feet of string run it from the box to the deck (see illustration in Appendix B).5

Finally there is the swing bridge. To make a model of this bridge you will need a rectangular baking pan, the lid of a margarine container or coffee tin, a paper fastener and some cardboard. Cut two ramps for the side of the bridge and lean them over the edge of the baking dish. Cut another piece of cardboard long enough to cover the span and fasten it to the plastic lid. Put water in the pan, making sure that the cardboard does not get wet. Then you can float boats in the pan and the bridge can open to let them by (see illustration in Appendix B).6

How do the materials used in constructing a bridge relate to its form and shape?

The different designs of bridges have to take into account the load that they have to carry. One of the fundamental things students should understand is that the design of a bridge is usually built around certain shapes that are known to have great strength. Materials also influence the finished design. Over the years bridge building went from wood to iron and steel. Now cement and aluminum are also used. One of the best ways to demonstrate this is to do the following demonstration:

Demonstration: Shape Matters

You will need about eight thick books all about the same size. Take two of the books and put them on a table about 6 inches apart from each other. Place a piece of paper between the two books and begin to place paperclips in the middle of the paper. See how many clips the simple paper bridge can hold. With the next two books set them up 6 inches apart but this time curve the paper between the two books like an arch. Begin to add paper clips at the middle of the curve.7 How many clips can it hold? Now we want to combine shapes. Put up two more books. Put a paper in between curved and then lay another paper on top of the books. Add paper clips. Does it hold more than the other two bridges?

Finally, take a piece of paper and fold it like an accordion, and put it on the 4th pair of books. Take another paper, fold it into an accordion pleat, and then glue a piece of paper to the top and bottom without squishing the folds of the middle paper. Which of these last three bridges will be strongest. Keep adding a load until one falls. Which is strongest? How could you improve on the strongest to make it even better?

Perhaps some of the greatest bridge builders were the Romans. They ruled throughout Europe and over five hundred years. They are the first great arch builders. The arch is considered to be both beautiful and one of the strongest shapes in construction. The Romans used the stones that were around them to construct these arches. Before the arch beam bridges over water were impossible without piers out in the water. This often disrupted ship traffic. The advent of the arch allowed builders to span greater distances without the need of piers and so larger ships were able to go underneath.

The arch works because the curve carries the weight outward from the top down to the abutments at the end. All sides are being compressed and since stone works well when compressed the arches have superior strength. The most important part of the arch is the keystone or top piece. The two sides of the arch are weak until the keystone is added. Then the arch can support itself.

Challenge: building an arch

Students will need to collect a number of stones about the same size and they can use clay or clay dough or the recipe for mortar given below. The Romans knew that the arch could not stand until the keystone was put in so they supported the bridge with a frame called centering. For this activity students can use a cylindrical shaped container like an oatmeal box or a block that is the correct shape. To make homemade concrete you will need:

Spoons

Spatula or wide craft sticks

Double boiler (you can use a smaller pan in a larger pan)

Pan or kettle to boil water

1 cup of sand

1/2-cup cornstarch

cookie sheet

handful of pebbles or gravel

The recipe is as follows:

1. Boil water in the double boiler and kettle.
2. Take the small pan and mix sand and cornstarch
3. When both pans of water are boiling add ½ cup of the boiling water in the pan to the mixture in the top of the double boiler. Put the pan in the top of the double boiler. Stir the mixture, as it gets thick. If it seems to thick add a little more hot water. Let the mortar cool till you can touch it.

4. Now you can try to make something like the arch
5. If there is any left add pebbles and turn the mixture into concrete.
6. You can place whatever objects you make on a cookie sheet and set the oven to 275°. Let them stay there until they dry.8

Which arch is stronger?

In this demonstration students will test the strength of two different arch bridges. One will have vertical supports like some steel arch bridges. You will need the following materials:

Arches: 2 poster board strips 2" X 14"

Decks: 2 poster board strips 2" X 11"

Piers: 4 poster board strips 2"X 4"

2 heavy books or bricks to use as abutments

1. First tape the center of one deck strip to the center of one arch strip. Tape a pier between the ends of the deck and arch at both sides. Be sure not to bend any of the strips.
2. Make another bridge like the first.
3. Add supports to this bridge by taping between the deck and the arch.
4. Put the books on the table about 11inches apart. Put the bridges in between them, one behind the other. Now test their strength by adding similar coins to each bridge one at a time. Which bridge can hold the heaviest load before sagging? Are the arches retaining their shapes?9

What makes a bridge special?

I suggested at the beginning of this unit that bridges are the kind of structures that often make us gasp at the engineering and daring that built them. Many seem to have risen from nowhere and defy nature. Every bridge that has been built has a story and indeed there are many fantastic stories about bridges that would be of interest to my students. One of the most famous stories concerns the building of the Brooklyn Bridge. John Roebling came up with the design for a bridge that would solve the problem of people wanting to get from

Brooklyn to Manhattan. After much haggling the Government had decided to give him a chance to build the bridge. 'While doing preliminary work on where to site the bridge, John Roebling was the victim of a bizarre accident that caused his foot to be crushed. He lost for toes as a result of the accident but more importantly he developed Tetanus which caused his death on July 22,1869 before the bridge was ever begun. The project fell to his son, Washington Roebling to complete. While construction was under way Washington Roebling was injured when he along with other men were stricken with the bends as they worked in a caisson being lowered into the East River to anchor the bridge. For years Roebling suffered the affects of this experience. In order not to give up the project his father had begun, Roebling rented an apartment from which he could see the construction site with binoculars. His wife, Emily, who had a mind for mathematics and engineering, became his link to the bridge and so the project was completed. The bridge opened on May 24, 1883.10

There are many interesting people and interesting bridges such as the story of the Tacoma Narrows Bridge or Galloping Gertie as it was known. The bridge was known to ripple like a roller coaster and many people drove over it for fun. The bridge was only four months old on November 7, 1940, when it collapsed after a 40 mile an hour wind made the deck begin to twist more violently than usual. The traffic was stopped and soon after the bridge ripped apart. Amazingly no one was hurt.11 There are pictures and film of the disaster on the web which students will find interesting (see Resources).

There is also the story of the Golden Gate Bridge that was designed by Joseph Strauss. Strauss was not a trained engineer. He was a dreamer and a poet. He argued that a bridge could be built between the Pacific Ocean and San Francisco Bay. Strauss is a study in perseverance. When his original design for the foundation did not work he tried another way and changed his idea.12

There are many different people involved in the history of bridge building and many bridges worth talking about. Students can be assigned to research some of these many names. There is not room here to mention them all.

Make your own bridge.

Throughout the unit there has been an attempt to model the construction of the basic bridge types. By the end of the unit I would like to have students take on a bridge building project of their own. Hopefully, by the time we reach the conclusion of the unit the students would have built up some confidence in using materials and be undaunted by a building project. After going through numerous ideas the advice of seminar participants seemed to be the best choice. They suggested that the building project should be somewhere in the neighborhood so the students could relate to the idea. I decided that the project would entail designing and building a bridge that would go from Long Wharf to Lighthouse. Both are prominent places in the city and most of the children have visited Lighthouse Park. We would be able to visit both sides of the river and the students would really be able to get a feel for the project.

I thought that it would be a good experience for students to work in groups. There would be four main jobs. The teacher would act as the representative of the client and would give out specifications for the bridge. The teacher would also be in charge of all inspections and in approving the finished bridge.

Each group would have a Head Supervisor who makes sure the project is running smoothly. If there were problems such as members not contributing to the project they would advise the teacher.

The group would plan and the Bridge Designer would draw a picture of the proposed bridge. The Contractor would be in charge of the actual building of the bridge, while the Project Superintendent would make sure that the bridge has the added touches necessary to make it fit into its setting like trees, plants, parks, or other forms of beautification.

Each group would also be asked to submit a name for their bridge. It could be named for a famous person past or present or some other appropriate name having to do with the areas being joined. Students might also consider naming the bridge after a student who they feel really put a lot of effort into the project.

The teacher would meet with each group and once a design was determined the group would not be allowed to change to a similar design used by another group. I would allow the finished bridge and its surroundings to be no more than 3' by 3' by 3'. I give it this proportion because some of the children may find it easier to work in a large scale.

They would use all kinds of materials from corrugated cardboard to construction paper, Popsicle sticks, toothpicks, wood scraps, paper towel, toilet paper rolls, and poster paint. They could also use wire, string, rope, tacks, glue, staples, as well as tape, and plaster.

I would not make it a true competition, but there would be a formal presentation of the bridges at which each group would explain their project: how and why they did it. They might also explain why they called the bridge the name they chose. This would be a great activity to invite parents and allow other classes to preview. Students enjoy the opportunity to show off their projects especially to family and friends. Each group would be given certificates, and as part of the festivities, perhaps we might just end the unit by taking inspiration from the Jack Prelutsky poem, and make ourselves some gigantic banana bridge splits!

Appendix A

I'm Building A Bridge of Bananas

By Jack Prelutsky

I'm building a bridge of bananas

it's pretty, but not very strong.

Bananas are not very sturdy,

bananas don't last very long.

Initially green, and then yellow,

increasingly speckled with brown,

inevitably, as they ripen,

it's clear that my bridge will fall down.

My bridge is developing fissures,

and even some sizeable gaps.

It's senseless to try and repair it,

I might as well let it collapse.

It waggles and sags in the middle,

It wobbles and droops at the end,

and so I've alerted by neighbors

as well as my family and friends.

They're trucking in freezers of ice cream

of every last flavor that's made,

plus whipped cream and chocolate syrup,

both of a premium grade.

They're bringing me barrels of walnuts,

and cherries without any pits -

we'll shortly be sharing delicious

gigantic banana bridge splits!

(figures available in print form)

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_____ *Big Machines At Work: Diggers* , Eden Prairie, MN : The Child's World, Inc., 1999. Briefly describes the parts of a digger or excavator, and the work it does.

_____ *Big Machines: Dump Trucks* , Eden Prairie, MN: The Child's World, Inc., 1999. Describes the parts of a dump truck and how it works.

Carlson, Natalie Savage. *The Family Under the Bridge* , New York: Harper Trophy, reissue ed. 1989. The story of Armand, a hobo who lives alone under a bridge, until a mother and her children seek refuge there. At first Armand resents the family, but then he decides to help them find a home.

Cooper, Jason. Man-Made Wonders: Bridges, Vero Beach, FL: Rourke Enterprises, Inc., 1991. Discusses the history and uses of bridges and cites several famous examples.

Johmann, Carol A. and Elizabeth J. Rieth. *Bridges! : Amazing Structures to Design, Build & Test* , Charlotte, VT: Williamson Publishing Co., 1999. Describes different kinds of bridges, their history, dilemmas, safety, and demonstrations and projects students can do.

Ring, Susan. *Bridges* , New York: Newbridge Educational Publishing, 1999. This book is part of the Newbridge Discovery Links reading series. This book is for fluent readers. It is very general in its information about bridges (16 pages).

Stevens, *The Three Billy Goats Gruff* , New York: Harcourt Brace Jovanovich, Pub., 1987. Three clever bill goats outwit a big ugly troll that lives under the bridge they must cross on their way up to the mountains.

Resources

Video Tapes

Popular Mechanics for Kids. *How Do They Build Bridges* , Distributed by Anchor Bay Entertainment Inc. Troy, Michigan, 1996. This film covers beam, arch, suspension, and movable bridges. It is informative but Not too detailed for elementary age children.

Web Sites

AkashiKaikoBridge-Honshu-ShikokuBridg Authority: http://www.hsba.go.jp/e-index.htm Information on the bridge, detailed sketches, photos, and history of the world's longest Suspension bridge.

Brooklyn Bridge Web Page. http://www.endex.com/gf/buildings/bbridge/bbridge.html A guide to photos and the history of the bridge.

Building Big: All About Bridges Web site. http://www.pbs.org/wgbh/buildingbig/bridge/index.html Follows the PBS Special with more information, pictures of famous bridges. Links to web sites of many well- known bridges.

Tacoma Narrows Bridge: http://www.fen.bris.ac.uk/engmath/research/nonlinear/tacoma/tacoma.html Check out photos and download video clips.