mind the gap

BRIDGING GEOMETRY AND NUMBER SENSE

NCTM 2014 Annual Meeting & Exposition New Orleans
April 11, 2014

PK-5 Gallery Workshop

CCSSM Areas:	Geometry Operations and Algebraic Thinking
Grade Band/Audience:	Grade PK-2, Grade 3-5
Focus on Math:	To model project-based learning, attendees will design and construct a bridge made out of different materials (e.g., toothpicks, cardstock, sticks, gummy drops, marshmallows). Participants will have to consider what materials to use to create a strong and stable bridge while minimizing the cost. They will have the opportunity to describe their physical world using geometry and operations and algebraic thinking. They will use basic shapes, spatial reasoning, and place value to model objects in their environment.

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Javier Builds a Bridge

"Javi, wait for me!" my little stepsister whined-but I kept running. Reaching the riverbank, I leaped onto the rope and plank footbridge. It wobbled and rocked side to side under my feet. I jumped off the bridge and grabbed the sweet gum tree branch hanging low over my head. I dangled and then let myself drop onto the pebbly bank, ready to run. I couldn't wait to get to my fort. I wanted to finish painting it before the big family party we were having the next day. Everyone was coming to our house in Texas to celebrate the anniversary of Abuelita and Abuelito, my grandparents.

"Javi!" Luisa called. I wanted to leave her there, but something made me stop. I turned around. At the opposite bank, she put a little white sneaker on a plank of the bridge and pulled it back. The bridge was still swaying from my leap. Her face was wet with tears.

I groaned. "Don't you want to go color? You can use my markers."

"Javi!" she sniffled.

"All right, wait a second." I walked back to take her hand. The stream flowed brown beneath us. Luisa peered between the boards. Her body stiffened as she watched the water.

"Come on, you're a big girl," I said—but I was really thinking about how little she was. Being a new big brother wasn't always as much fun as I had thought it would be. Before Mamá married Joe, I used to be able to play by myself on the island. Now Joe's daughter, Luisa, followed me everywhere.

Luisa was inching slowly across the bridge. I was in a hurry. "Look, Luisa, why don't you let me carry you the rest of the way?" I asked. I bent down to pick her up but she pulled away. The bridge tottered and lurched. Plunk! Splash! We were in the water.

Images and excerpt taken from "Javier Builds a Bridge". Written by the Engineering is Elementary Team. Illustrated by Jeannette Martin.

Create and Test the Original Bridge

Stability Score	How many times did the wind-up toy successfully roll across your bridge?
1	1 time
2	2 times
3	3 times
4	4 times

Strength	How many weights did your bridge hold before it failed?
1	fewer than 2 weights
2	3-4 weights
3	5-6 weights
4	7-8 weights

After testing the Original Bridge, what can you conclude about its design and construction?

Improve your Bridge

How will you improve the Original Bridge design?

Adapted from "Javier Builds a Bridge". Written by the Engineering is Elementary Team. Illustrated by Jeannette Martin.

The New and Improved Bridge

Being a new stepbrother to little Luisa isn't always as much fun as Javier first thought it would be. When Luisa falls off the bridge leading to Javier's fort, his mother tells him they'll have to take the bridge down.

After some careful thinking, Javi realizes that he might be able to convince his parents to let him keep the bridge to his fort if he can design a safer one. Javi will have to come up with a new bridge design. But will it pass the inspection of his stepfather Joe, a real civil engineer?

How can you help Javi? How can you use your knowledge of materials and their properties and different bridge trusses to design a strong, stable bridge and help Javi out?

Use your creativity and knowledge of bridges to design and construct a scale model of a strong, stable bridge. Remember to think like a Civil Engineer. Good luck!

Imagine and Plan your Bridge

Brainstorm some different bridge designs. Draw and label your bridge. List the materials that you will need. Show where you will use each material.

Requirements:

Span: a distance of 8 in Width: _____

Taken from "Javier Builds a Bridge". Written by the Engineering is Elementary Team. Illustrated by Jeannette Martin.

Plan your Bridge: Amount and Cost of Materials

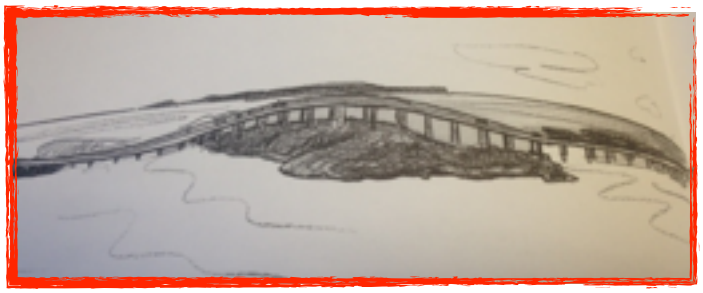
Material	Packs of Tens	Loose Ones	Total
Toothpicks			
Gum drops			
Long Sticks			
Short Sticks			
Marshmallows			

Material	Dollars	Dimes	Pennies	Total cost per unit ($)	Units	Total Cost of Material
Toothpicks				1.34		
Gum drops	1	7	5			
Long Sticks				3.68		
Short Sticks	2	6	3			
Marshmallows	0	9	2			

Total Cost of Bridge Design:_____

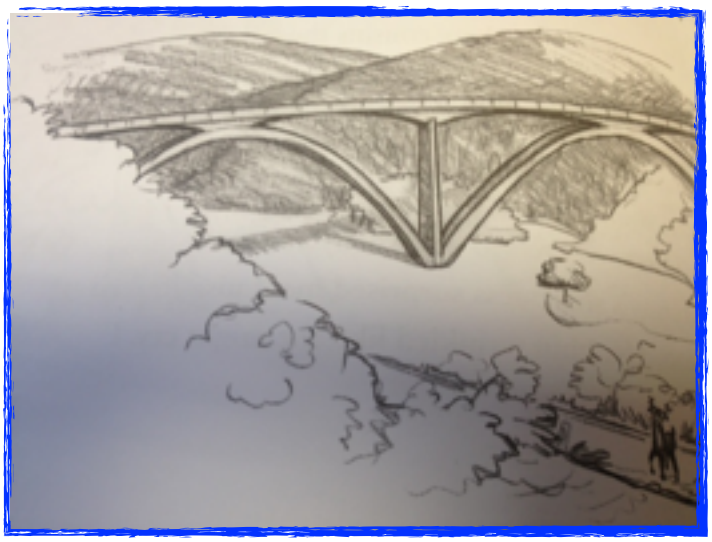
Types of Bridges

The beam bridge...
consists of a horizontal beam supported at each end by piers. The weight of the beam pushes straight down on the piers. The farther apart its piers, the weaker the beam becomes. This is why beam bridges rarely span more than 250 feet.



Lake Pontchartrain Causeway, Louisiana

The arch bridge...
has great natural strength. Thousands of years ago, Romans built arches out of stone. Today, most arch bridges are made of steel or concrete, and they can span up to 800 feet.



Natchez Trace Bridge, Tennessee

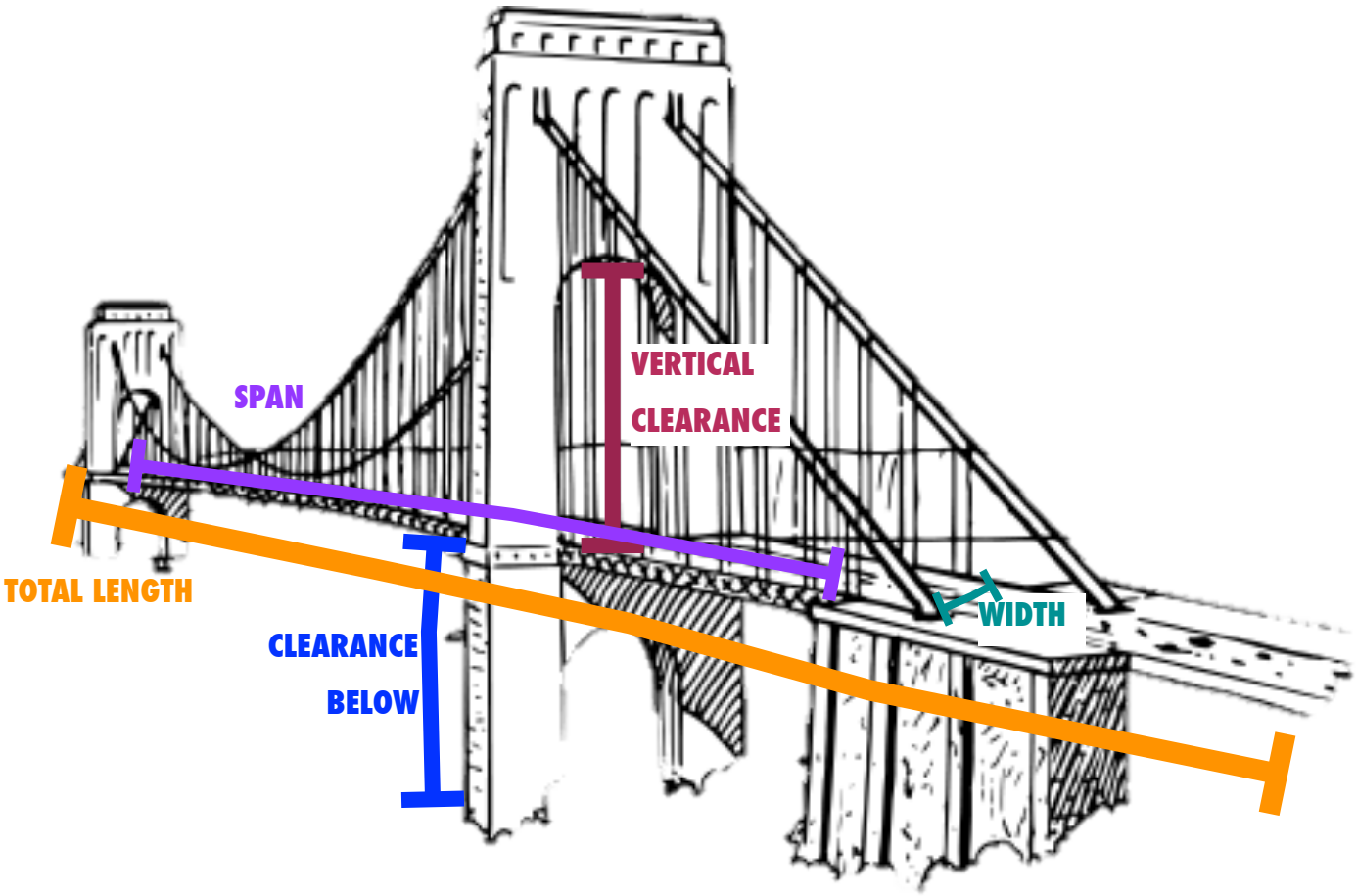
The suspension bridge...
can span 2,000 to 7,000 feet – way farther than any other type of bridge! Most suspension bridges have a truss system beneath the roadway to resist bending and twisting.

Golden Gate Bridge, San Francisco

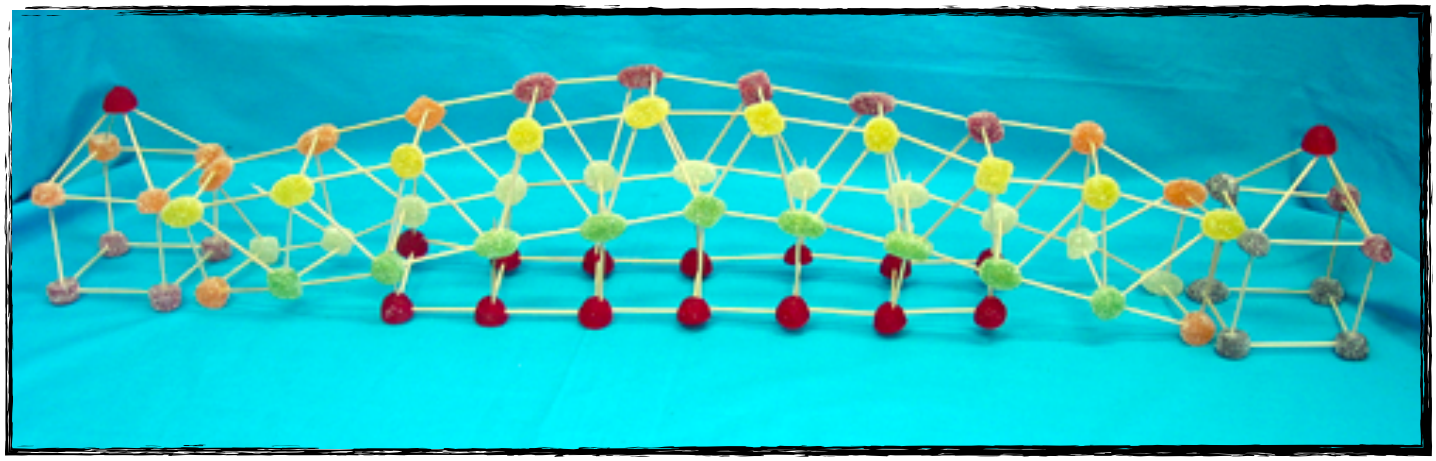
Images taken from "Javier Builds a Bridge". Written by the Engineering is Elementary Team. Illustrated by Jeannette Martin.

Facts about bridges taken from http://www.pbs.org/wgbh/buildingbig/bridge/basics.html

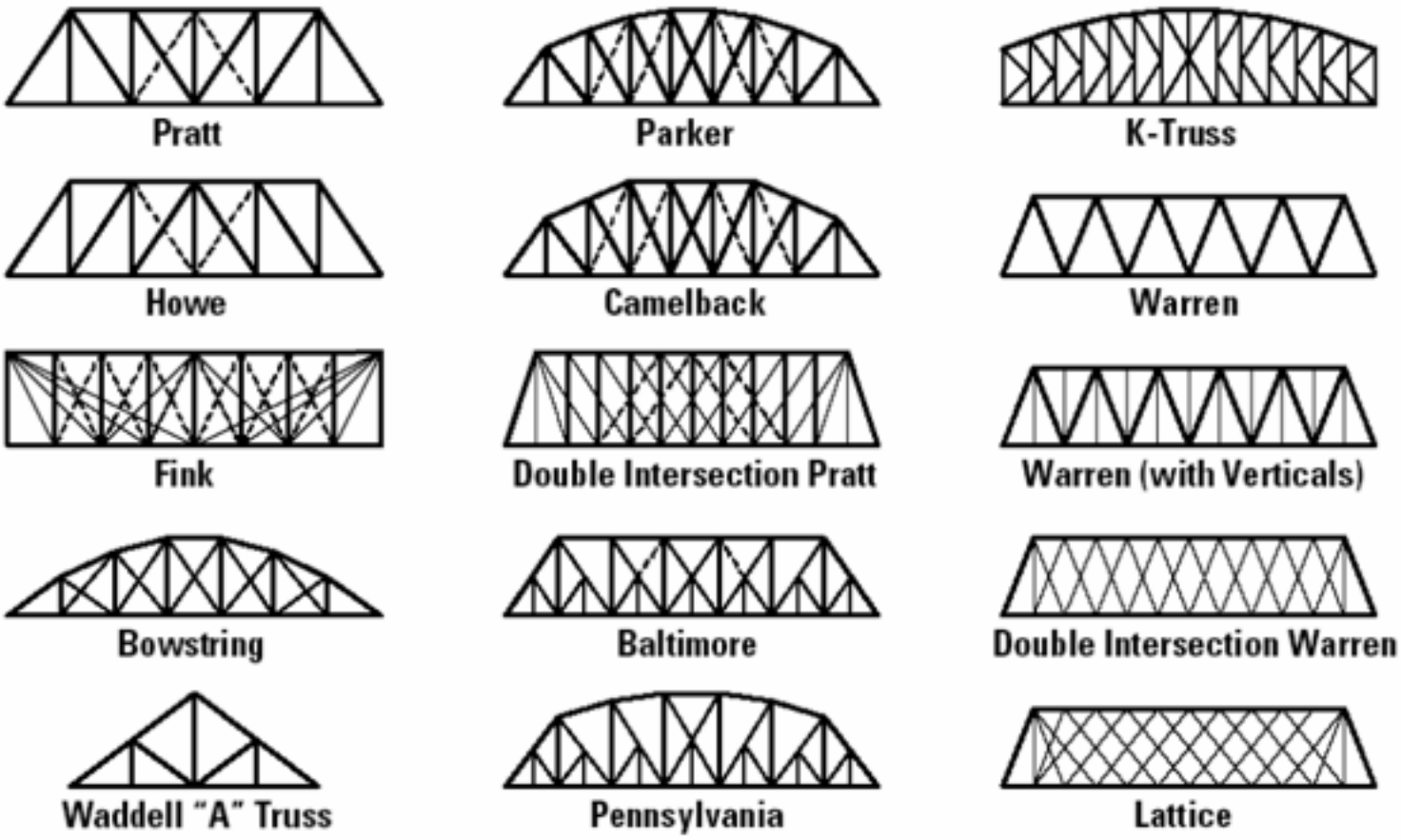
Bridge Design Specifications



Create a Toothpick Bridge



Truss Bridge Designs



3rd Grade Rubric

Students will be able to…	4	3	2	1
Test the strength and stability of the Original bridge design and analyze test results		Tests are carefully conducted and recorded; analyses his/her bridge design for strengths and weaknesses.	Tests are somewhat well conducted and recorded; analyzes a few aspects of his/her design, but may need significant support.	Does not successfully test and analyze his/her bridge design.
"Improve" the Original Bridge design based on testing results and analysis		Identifies ways to improve his/her bridge design and explains how they are based on test results.	Brainstorms a few ways to improve his/her bridge design, but does not take testing results into consideration. May require significant support.	Is not able to brainstorm ways to improve his/her bridge design.
Utilize what they have learned about different bridge trusses and the properties of shapes to design and construct a strong, stable bridge		Correctly and completely utilizes what he/she has learned about bridge types and properties of shapes to inform a bridge design	Uses some prior knowledge of bridge types and shapes and their properties to inform bridge design. Not all information is correctly used, or student requires significant support.	Does not successfully use what he/she has learned to inform a bridge design.

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4=Exceeds Standards 3=Meets Standards 2=Almost Meets Standards 1=Beginning to Meet Standards

3rd Grade Rubric

Students will be able to…	4	3	2	1
Build and draw triangles and squares to possess defining attributes		Identifies the defining attributes of the triangle (e.g., closed figure, three straight sides, three sharp corners/vertices) and of the square (e.g., closed figures, four straight congruent sides, opposite sides are parallel, four sharp corners/vertices, four right angles).	Identifies some defining attributes of the triangle (e.g., closed figure, three straight sides, three sharp corners/vertices) and of the square (e.g., closed figures, four straight congruent sides, opposite sides are parallel, four sharp corners/vertices, four right angles). May require significant support.	May be able to draw and identify triangles and squares, but is not able to articulate any defining attributes.
Decompose and compose two-digit numbers using place value		Determines the packs of ten and loose ones of each type of material that is needed to construct the bridge. Determines the total amount of each type of material. Decomposes the cost of materials in dollars, dimes, and pennies. Uses the total amount of dollars, dimes, and pennies to determine the unit cost of the materials.	Determines the packs of ten and loose ones of each type of material that is needed to construct the bridge. May require support to determine the total amount of each type of material; decomposes the cost of materials in dollars, dimes, and pennies; and uses the total amount of dollars, dimes, and pennies to determine the unit cost of the materials.	Is not able to group materials into packs of ten and loose ones in order to determine the total amount of each material.

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4=Exceeds Standards 3=Meets Standards 2=Almost Meets Standards 1=Beginning to Meet Standards

5th Grade Rubric

Students will be able to…	4	3	2	1
Test the strength and stability of the Original bridge design and analyze test results		Tests are carefully conducted and recorded; analyses his/her bridge design for strengths and weaknesses.	Tests are somewhat well conducted and recorded; analyzes a few aspects of his/her design, but may need significant support.	Does not successfully test and analyze his/her bridge design.
"Improve" the Original Bridge design based on testing results and analysis		Identifies ways to improve his/her bridge design and explains how they are based on test results.	Brainstorms a few ways to improve his/her bridge design, but does not take testing results into consideration. May require significant support.	Is not able to brainstorm ways to improve his/her bridge design.
Utilize what they have learned about different bridge trusses and the properties of shapes to design and construct a strong, stable bridge		Correctly and completely utilizes what he/she has learned about bridge types and properties of shapes to inform a bridge design	Uses some prior knowledge of bridge types and shapes and their properties to inform bridge design. Not all information is correctly used, or student requires significant support.	Does not successfully use what he/she has learned to inform a bridge design.

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4=Exceeds Standards 3=Meets Standards 2=Almost Meets Standards 1=Beginning to Meet Standards

5th Grade Rubric

Students will be able to…	4	3	2	1
Build and draw triangles and squares based on the category they belong to		Constructs a conjecture about the 2-D shapes and the categories they belong to. The conjecture uses the defining attributes of the triangle (e.g., closed figure, three straight sides, three sharp corners/vertices) and of the square (e.g., closed figures, four straight congruent sides, opposite sides are parallel, four sharp corners/vertices, four right angles).	Constructs a conjecture about the 2-D shapes and the categories they belong to, but the conjecture only uses some of the defining attributes of the triangle (e.g., closed figure, three straight sides, three sharp corners/vertices) and of the square (e.g., closed figures, four straight congruent sides, opposite sides are parallel, four sharp corners/vertices, four right angles).	Is unable to construct a conjecture about the 2-D shapes and the categories they belong to.
Decompose and compose two-digit numbers using place value		Determines the packs of ten and loose ones of each type of material that is needed to construct the bridge. Determines the total amount of each type of material. Decomposes the cost of materials in dollars, dimes, and pennies. Uses the total amount of dollars, dimes, and pennies to determine the unit cost of the materials.	Determines the packs of ten and loose ones of each type of material that is needed to construct the bridge. May require support to determine the total amount of each type of material; decomposes the cost of materials in dollars, dimes, and pennies; and uses the total amount of dollars, dimes, and pennies to determine the unit cost of the materials.	Is not able to group materials into packs of ten and loose ones in order to determine the total amount of each material, and may need significant support to determine the total amount of each type of material.

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