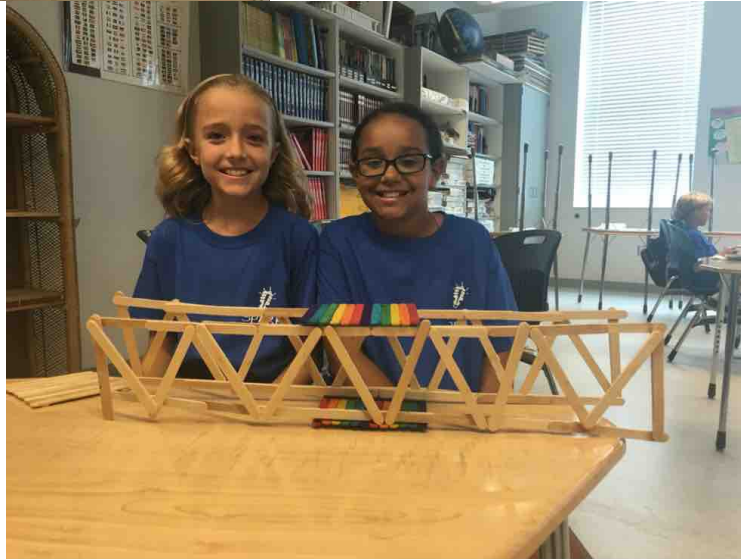
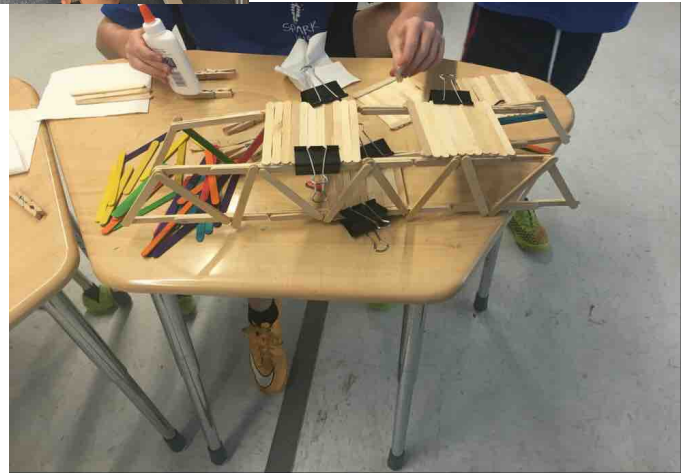
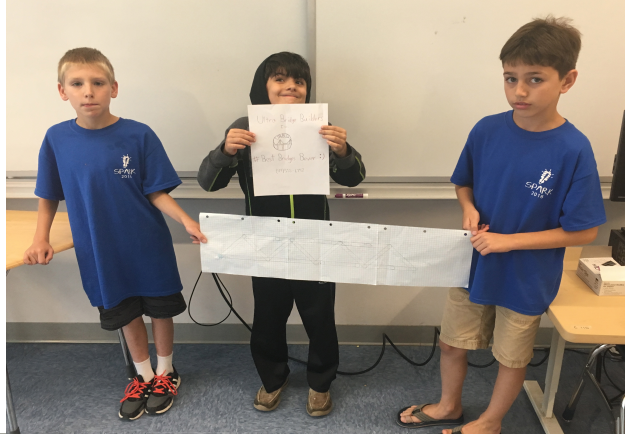


Golden Bridges



Charles Beckley
Lesson Created for 4th-6th Grades
June 20th-June 23rd

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Introduction

This unit was developed for students who are Academically/Intellectually Gifted that are currently in grades 4-6. The area of content can be changed to accommodate any students in grades 4-6 and with more content and higher vocabulary this unit can be adopted by higher grades as well. The concept created in this lesson can be taught in the lower grades and reinforced throughout their life. The lessons were designed based on different instructional models. These instructional models were developed by many different professionals and were created for a richer educational experience for the students. The skills, content, and concepts in this unit are important for students to learn because it expands their higher order thinking skills, knowledge of the content area and students gain a conceptual understanding of strength and structure. This engineering unit can spark interests that normally aren't introduced to children until high school. Student learning from this unit can range from basic vocabulary to a concept that can be used in all facets of life. This unit offers an insight into engineering by using a hands on approach to help students become engaged, interested and helps the student learn the key essentials of construction through building. The engineering field is always growing and the field relies on new and fresh students to propel the civilization forward.

Throughout the unit, students will need certain skills that are important to the understanding of bridge building. These skills range from basic to multifaceted. Reading comprehension, critical thinking, active listening, and speaking are active throughout. These skills are important in completing all the lessons and the performance task to the high level of competency that is required. Complex problem solving, mathematics,

operation analysis, time management, financial management and active learning are more complex skills that with the guidance of the teacher are used to build a strong budget and bridge. I feel one of the most important skills of this unit is teamwork. The overall performance task of this unit depends on their “business” to build a structure that is financially and physically strong, that fits the specification set forth. This team building exercise relies on all the students in the group to put forth effort. This unit is very time consuming and to complete the task in the allotted time, students will have to work together in their business to finish their structure.

The content of the unit gives a surface look at what an engineer has to consider when working in their occupation. This content has been somewhat simplified for the students to get a general understanding of content involved. Students will be introduced to the different types of bridges that have been built throughout history. This history lesson is to explore the materials, design and stability of these bridges. Learning from history and prior structures has helped engineers design more structurally sound bridges. The vocabulary terms of the unit are to be used by the students to “talk” like an engineer. The loads, forces, materials, and structural designs vocabulary that are used by engineers are the exact words that were used by the students. The informal assessments and performance task were completed based on the content they learned from the unit.

The overall goal of this unit was to have the students conceptually understand that structure creates strength. This concept not only pertains to the engineering and science, but to all other subjects throughout school and lifetime. Throughout the whole unit, this conceptual lens of structure was reinforced. Structure should be discussed

with the students when talking about bridges, but also as the blue prints, budgets, and ordinary real-world experiences. In the beginning of the unit, a Taba Lesson is given to help the students create that essential understand. Students are given the freedom to have a friendly conversation about bridges and what it takes to build them. As the conversation dwindles, a rich vocabulary article is given to the students. This is key in the foundation of creating the concept. Students are to create their own personal understanding of the vocabulary in the article by collecting data and grouping the rich vocabulary. This article is also used as an informal assessment to gage the students' level of knowledge.

Skills vary depending on what lesson the class is on. The next two lessons were more based on the content of the unit. The goal of the next two lessons is to create a content knowledge about creating bridges and budgets. These lessons are important because they give the students an essential understanding in building their budget and structure. The final lesson is an overall wrap-up and visual thinking lesson. The goal of this lesson is to finalize the skills, content and concepts surrounding the idea of bridge building. The lesson reinforces the idea of how structure creates strength by finalizing all budgets and bridges. This is assessed by the performance task. The goal is to see which structure can withstand the amount of force exerted on the structure while being economically essential. Bridges are the concrete project behind the unit. This is only a part of what the students should understand in the unit.

Differentiation is a framework or philosophy for effective teaching that involves providing different students with different avenues of learning. Differentiation of this unit was beneficial to the students throughout the unit. The entire unit can be differentiated

to support several grade levels and be appropriate for those gifted learners in that grade. The class that was apart of this experience needed that differentiation in the dimensions. The dimensions that were included is the content, process, product, and learning environment. The content of the unit has been altered to accommodate the students of the gifted classroom. Throughout the unit the text was of a higher level that included a wide variety of vocabulary. The students processed the vocabulary in the text and extended their learning by synthesizing the information into different categories and presented their rationales through auditory and visual meanings. The vocabulary throughout the lesson was above their grade level and the students had to use the vocabulary pertinent to bridge design. Processes throughout the unit were student engaging and content driven. Some processes included using props to show the students the different types of forces and loads that can be placed on a bridge. Students throughout the unit were engaged by completing different activities. Another activity that was used as a differentiated process was the budgeting process. This is where the students had to learn the content of the budget and needed to show mastery by connecting with their group to create a budget. The final performance task was differentiated product. The culminating project asked the students to complete a prototype bridge with materials that were given. Being that the students were all academically gifted, the differentiation was that each business needed to design their own bridge. There were no premade plans that the students had to follow. In the performance task, the businesses also had to create a budget that was financially responsible to their the town. These two products combined together extend the learning by seeing which business had the most efficient bridge. Learning environment

throughout the classroom was one of a relaxed and encouraging atmosphere. Students were to work independently, with a group or as a whole class. The classroom knew that they were not tied to their seats. Developing routines with the students helped them practice independence and an understanding that not all students learn the same. Some students need that ability to move around to learn, while others do better sitting there quietly and listening. The features of differentiation exhibited in the unit were complexity, challenge, depth, creativity, and acceleration. The complexity of the unit showed the students that it was very difficult to design, budget and build their bridges without teamwork and cooperation. The final overall task was to combine all three dimensions together to create the ultimate bridge. Challenging features included the difficulty of the text, vocabulary terms, and performance task. Depth of knowledge exhibited in the unit was challenging to some students due to lack of background knowledge. Students who had the prior background knowledge were more inclined to participate in digging deeper with the bridge content. The unit does provide for deeper knowledge of the content. Creativity features showed more at the end of the unit. The creativity of the performance task showed a differentiation between each business because there was no correct way to design their bridge. Finally the acceleration of the unit depended on how the students were responding throughout the lessons. The content that was simplified and direct took less time compared to the creating and mastering of the content portion of the lessons.

Goals and Outcomes

CONTENT GOALS AND OUTCOMES GOAL

1: To develop understanding of the content behind building budgets and bridges.

Students will be able to...

- A. Analyze the key vocabulary that is used to help master the content knowledge
- B. Describe the history of bridges, the forces, loads, and materials that go along with bridges.
- C. Examine the role of an engineer and what they have to do in order to build bridges
- D. Compare and contrast the different types of materials and structural designs that are by different bridges throughout the world.

PROCESS GOALS AND OUTCOMES GOAL

2: To develop a strong budget, blueprint design and prototype of a bridge.

Students will be able to...

- A. Design a budget based on the specifications given
- B. Design a blueprint that meets specifications
- C. Design a prototype bridge that needs to withstand live loads.
- D. Provide evidence that your bridge is the most efficient bridge.

CONCEPT GOALS AND OUTCOMES GOAL

3: To understand the concept of structure

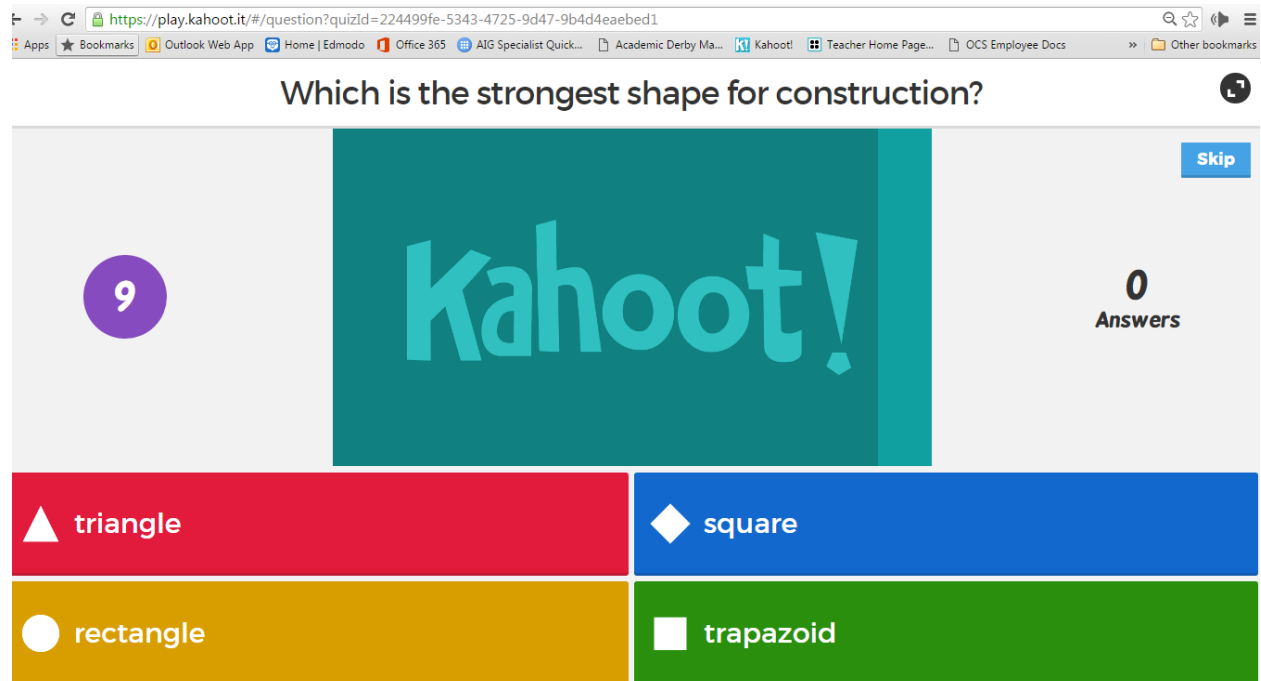
Students will be able to...

- A. Use key vocabulary to define structure and strength
- B. Analyze the relationship between structure and strength
- C. Predict how structure create strength
- D. Transfer their knowledge about structure and implemented the concept throughout other facets of learning.

Assessment Plan

Throughout the unit assessments were used to assess the students understanding of the content and concepts attributed to the unit. Students will be given certain assessments as the unit progresses and a final performance task to assess the overall knowledge of the content and concepts. A formative assessment is conducted during the lessons to evaluate student comprehension, learning needs, and progress. Examples used during the lessons vary based on the lesson. There are a few that are used every day to assess the students. Examples of these are graphic organizers, exit slips, questioning and discussion. These are both formal and informal assessments. Formal assessments are processes that students are to write down their knowledge based on student learning. Graphic organizers were given to the students daily to help collect their thoughts and show their knowledge. During this process, the teacher is guiding the students to write down important content details. Exit slips are also a formal assessment that is used to show understanding of the concept of the unit. The students are asked the same question everyday. Each day they are to build upon yesterday. How does structure create strength? Informal assessments are processes that are observed by the teacher that gauge where the student is at in their learning. Questioning and discussion are examples of these. These assessments help the teacher understand and guide the teaching into the direction that it needs to go to have the student demonstrate content knowledge, skill development, and understanding of the unit's concept. Other formative assessments throughout the lesson include bridge building games, vocabulary quizzes, and interactives. These were used based on the day of the lesson. The summative assessment showed an overall

content knowledge, skills developed during the unit, and a conceptual understanding of how structure creates strength. The performance task was the summative assessment. This was the final project where the students had to put all their learning together and build a bridge that can withstand a load and was financially responsible.

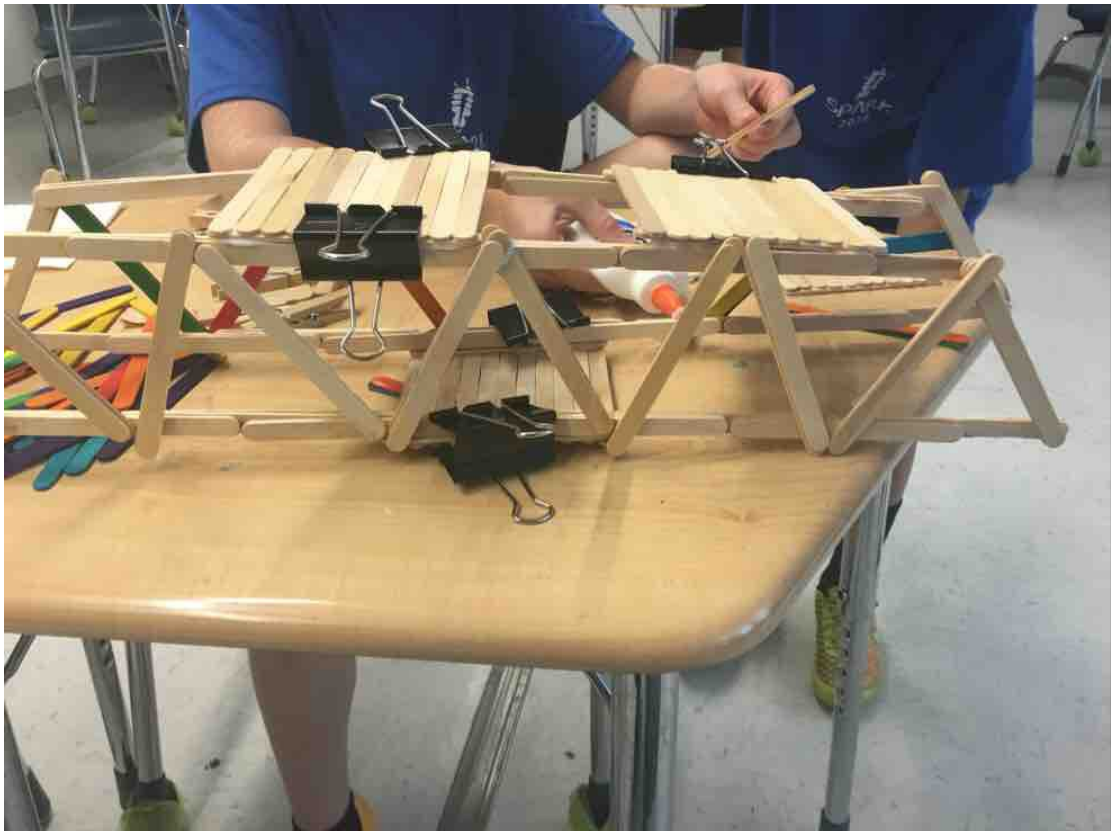
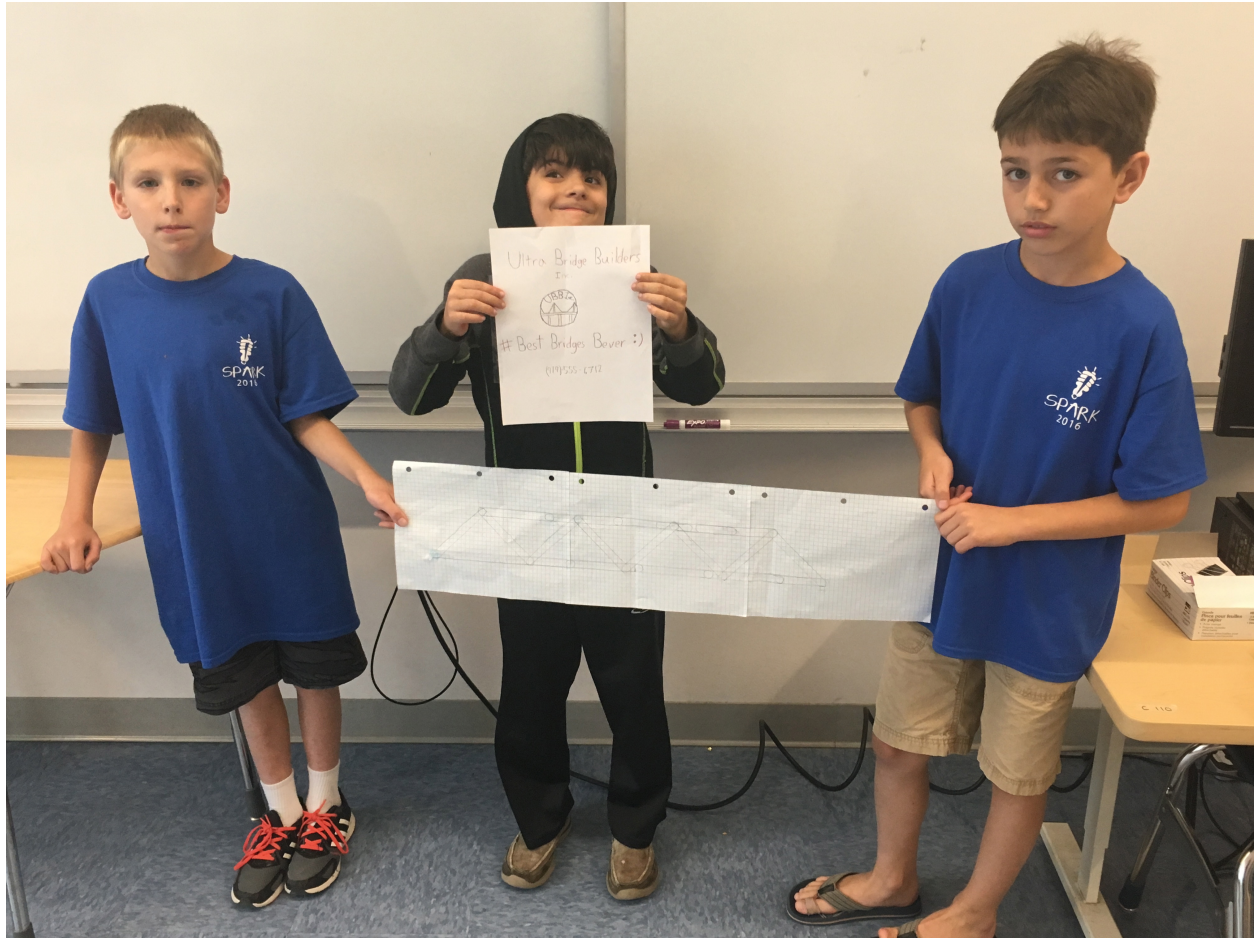


Cargo Bridge

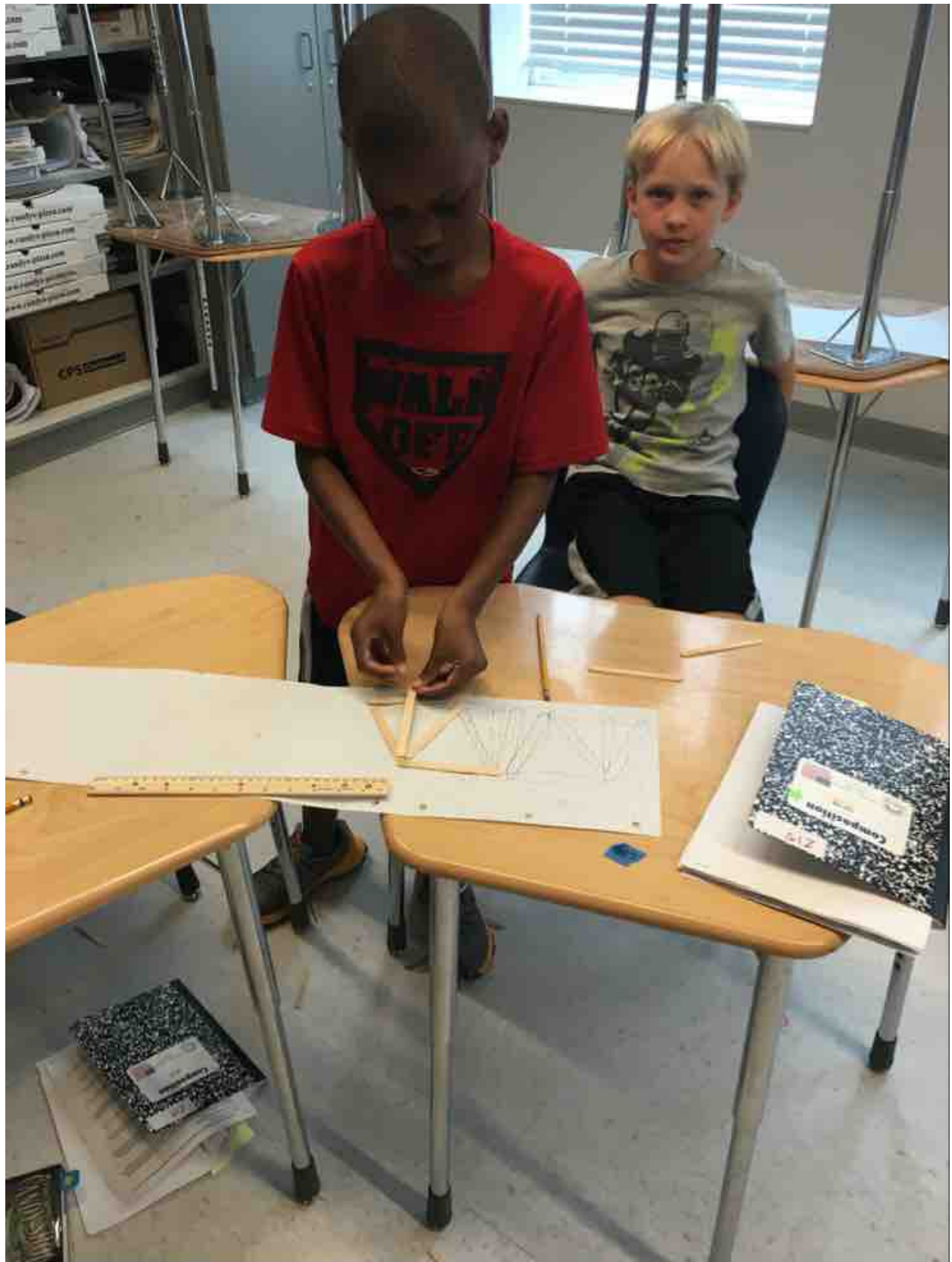
- Linked in Symbaloo & OneNote
- Provides valuable practice for early finishers
- Saves progress on same 1:1 device

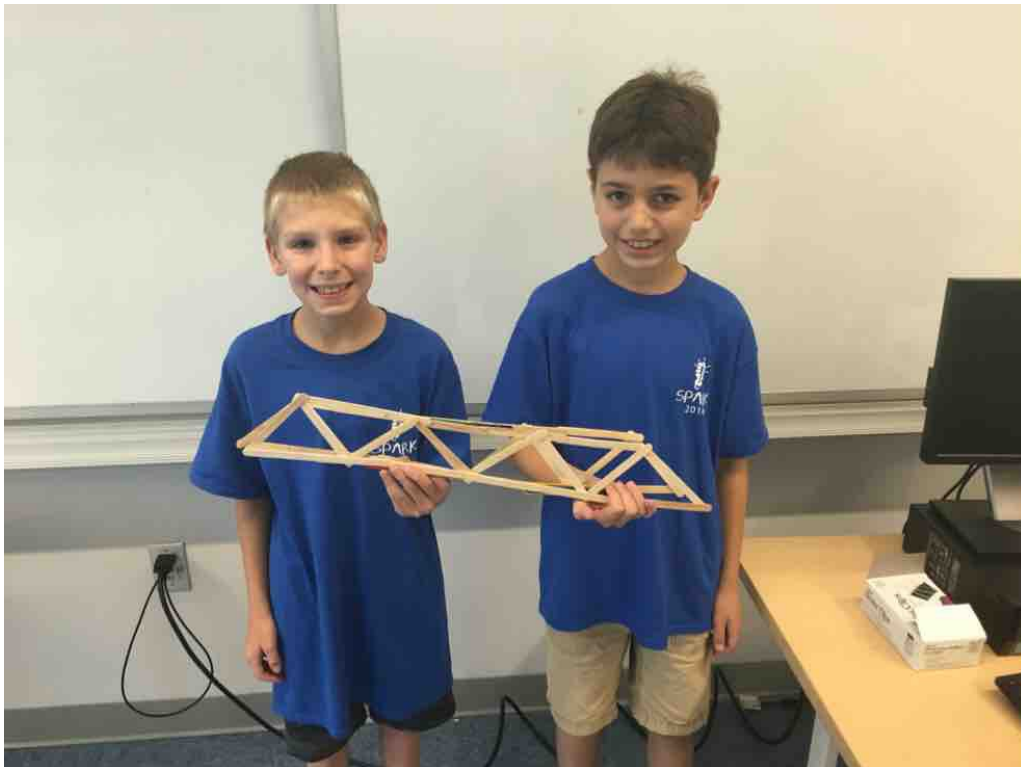
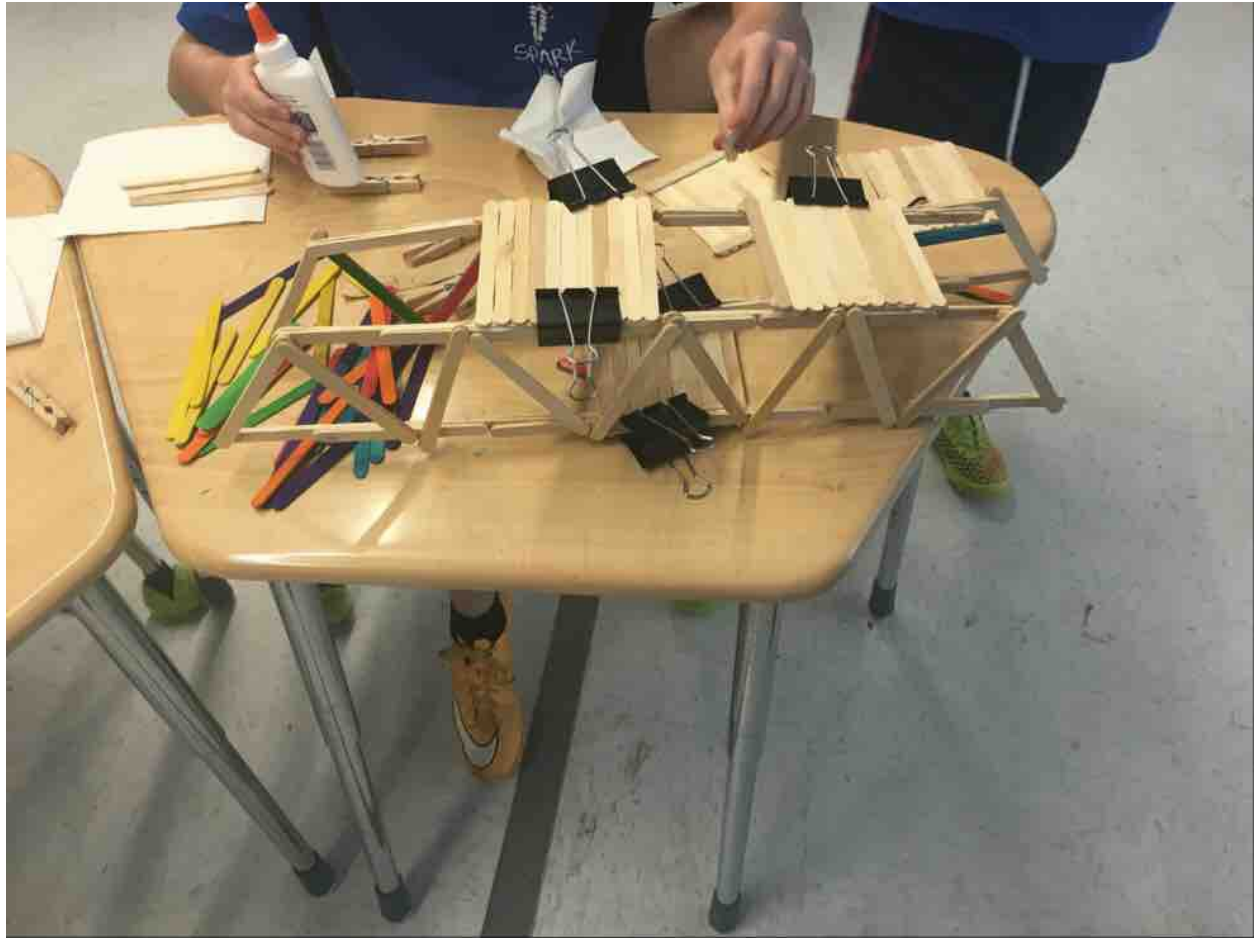
Common Core State Standards
CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them.
CCSS.Math.Practice.MP7 Look for and make use of structure.

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Lesson Plans

TEACHER NAME		Lesson #
Charles Beckley		1
MODEL	CONTENT AREA	GRADE LEVEL
Taba Concept Development	Science	4/5
CONCEPTUAL LENS		LESSON TOPIC
Structure		History of Bridges
LEARNING OBJECTIVES <i>(from State/Local Curriculum)</i>		
5.G.1.3 Exemplify how technological advances (communication, transportation and agriculture) have allowed people to overcome geographic limitations. RI.5.9 Integrate information from texts on the same topic in order to write or speak about the subject knowledgeably.		
THE ESSENTIAL UNDERSTANDING <i>(What is the overarching idea students will understand as a result of this lesson?)</i>		THE ESSENTIAL QUESTION <i>(What question will be asked to lead students to “uncover” the Essential Understanding)</i>
Structure creates strength		How does structure create strength?
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)
Structure is the arrangement of and relations between the parts or elements of something complex. Bridges are important to the expansion of the United States Bridges are made of many different types of materials. The Iron Age revolutionized the bridge building Bridges are built differently depending on the landscape. Tension is the state of being pulled tight Torque is the twisting force that tends to cause rotation		Students will be able to.... • Create a historical time line of the history of bridges. • Differentiate between the different types of materials used in bridge history • Compare and contrast the different bridges.

GUIDING QUESTIONS

What questions will be asked to support instruction?

Include both "lesson plan level" questions as well as questions designed to guide students to the essential understanding

Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:
• What do you know about bridges? • What are some different types of bridges and the materials they used? • What are some famous bridges? • What do you think makes bridges collapse? • What is structure? • What does strength mean to you?	• What forces act on bridges • What types of materials are used in bridge building? • What are the similarities and differences of each type of material? • How does the structure of the bridge create more strength than other bridges? • What affects the structure of the bridge? • What is torque and tension? • How are tension and torque related to strength?	• Why are bridges important to United States' expansion? • What type of material can be used to create the strongest bridge in event of natural disasters? • Why do some bridges last for a very long time? • How does consideration of a bridge's structure impact the strength of the bridge? • What real world experiences help support that structure creates strength? • How can you justify the concept of structure creating strength? • What evidence can you provide on the relationship between strength and structure? • How does structure create strength?

DIFFERENTIATION

(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.

Content	Process	Product	Learning Environment
Readings and PowerPoint will have more advanced vocabulary.	Some materials will be given to the students with little to no directions so that the student will have to explore. Students will develop a deeper conception of structure.		Students will demonstrate their findings to the groups by explaining their reasoning behind their answers.

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PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.

As students enter, a video of collapsing bridges will be on the screen. We will have a short discussion on why they think the bridge had collapsed.

They will watch a youtube video about bridge disasters. During this exploration students will be trying to compare the different bridges and see if they can find anything that could be similar with the bridges. (5-10 mins)

Biggest Engineer Mishaps 5:28 to 8:33.

Students will be given a blank piece of paper and they have to design a bridge independently. Then they will be put into two groups and the students will talk about their bridges in their group. This pre-assessment is to show students about their structures and how differently the students' mindsets are from the beginning of the class until the end of the class. (5-10 mins)

Youtube Video

Kinzua Bridge 6 minutes and 17 seconds

After the video is completed the teacher will talk to the students about the design of this bridge and why did they bridge collapsed?

Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.

Students will view on a PowerPoint a brief historical lesson on bridges and the different materials and designs that are used throughout history. (10 minutes)

The students are to be looking at how the bridges are built (STRUCTURE) and how much weights can the bridge hold (STRENGTH). They will be exploring the similarities and differences of all the structures with a graphic organizer. Trying to figure out which one is better than the other and what is their explanation.

Looking at the different types of materials hands on in groups. Trying to figure out which one they would feel more confident building a "bridge" with. Talking with their groups to come up with the best possible bridge.

Materials- Wood

Soft Rock

Aluminum

Steel

Teacher will talk to the students about what the differences and similarities between the materials. Which ones will be stronger and easy to build with?

Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

The teacher will pass out an article that describes bridges. The students will read the article about bridges. While they are reading, the students will highlight at least 20 words that are related to strength or structure.

Teacher will be looking for 15-20 characteristics to create a challenge for the students about the details.

The teacher will then have an open discussion about their findings. First we will have a short discussion on what the article was about and how the whole article relates to strength and structure.

A brainstorm session will begin and the teacher will then have the students call out the words that they highlighted in the text. The teacher will hope to have put 30 words on the board. Teacher needs to be prepared to make sure they have enough words if the students have not given enough.

The teacher will then have the students put the words, only using each word once, into groups of 3.

The teacher will reconvene the group and ask the group if they can take any groups that could combine together?

Once they put them all into groups they label each group. The name of the group should describe the words in the groups.

The teacher will bring the students back together and start picking out different groups of words and have each group justify their groupings. The teacher will ask the students why these groups deal with either structure or strength.

What completely new ways can you find to group the items on our list?

Finally the teacher will finally bring together the concept about structure and the structure based on strength. Based on our original list, the groups we've created and the way we've subsumed the groups, what would you conclude about structure?

Elaborate —Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways

Students will be given 4 scenarios and they will have to decide which type of bridge would best go to the scenarios. They will talk in groups about why they decided that would be the best bridge.

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

The teacher will wrap up the lesson by asking the ending questions that are provided in the lesson plan. The students will demonstrate their knowledge by showing students by ticket out the door.

The last 35-40 minutes are for workshop time. The teacher will be splitting the students into groups and they will be tasked with coming up with their business name logos and slogan.

The teacher will give examples of all theses and explain that they are trying to sell the business.

PERFORMANCE TASK

You are an engineer and have been asked by the city council to design a bridge that will withstand heavy traffic and be cost effective to the town. The challenge is to design a prototype and present your design to the council. The council will choose the bridge design that is has the best overall value. The council is looking for evidence of strength in the structure and strength of the budget used for constructing your bridge.

Reading: Bridges

There's something about bridges that I love. From simple stepping stones across a stream to giant overpasses linking continents, they have always been important to civilisation. And since the first Bronze Age river crossings, the objective of bridge building hasn't changed: to get to the other side. It's as simple as that. They're a natural part of everyday life. Bridges are used to cross a variety of obstacles whether a river, a sea, a valley, a road, or a railway line. My most memorable holidays are always associated with bridges: seeing San Francisco's Golden Gate swathed in fog, walking from Zimbabwe across the mighty Zambezi to Zambia, negotiating rickety bamboo bridges in Asia, the Sydney Harbour Bridge, and the wonderful Friendship Bridge connecting Thailand and Laos over the Mekong River. There are three main types of bridges: the beam, the arch and the suspension bridge.



Which bridge when?

Choosing the design of a bridge primarily depends on how wide the obstacle is – is it a small road or an enormous river? The main difference between the three main types of bridges is the distances they can cross in a single span. This means the distance between one vertical support to another. Some bridges can cross an obstacle in a single span, while others need many. If an enormous river is to be crossed, a bridge is needed that doesn't need too many supports. Another consideration of course is the types of material available to be used as well as the overall look of the bridge.

The beam bridge

The beam bridge is basically a rigid horizontal structure that rests on two piers (or supports), one at each end. The weight of the beam pushes straight down on the piers. The further apart the piers, the weaker the beam becomes. Next time you're on a journey, look out for these bridges crossing motorways. They're usually made of concrete or steel. Beam bridges rarely span more than 60m.

The arch bridge

It is the shape of the structure that gives the arch bridge its strength; they're a natural form of bridge. That's why they're so beautiful. An arch bridge doesn't need any additional supports or cables. In fact, an arch bridge made of stone doesn't even need mortar. Imagine that! There are still many arch bridges built by the Romans 2,000 years ago, without mortar, which are still standing today, real proof of the natural effectiveness of an arch as a bridge structure. Modern arch bridges can span up to 300m.

The suspension bridge

But surely the most elegant and sophisticated of all bridges is the suspension bridge. Modern suspension bridges usually have two tall towers (the supports) joined by cables

TEACHER NAME		Lesson #
Charles Beckley		2
MODEL	CONTENT AREA	GRADE LEVEL
Questioning	Science	4-6
CONCEPTUAL LENS		LESSON TOPIC
Structure		Bridge Basics
LEARNING OBJECTIVES <i>(from State/Local Curriculum)</i>		
CCSS.ELA-Literacy.RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question or to solve a problem efficiently.		
THE ESSENTIAL UNDERSTANDING <i>(What is the overarching idea students will understand as a result of this lesson?)</i>		THE ESSENTIAL QUESTION <i>(What question will be asked to lead students to “uncover” the Essential Understanding)</i>
<i>Structure creates strength</i>		How does structure create strength?
CONTENT KNOWLEDGE <i>(What factual information will students learn in this lesson?)</i>		PROCESS SKILLS <i>(What will students be able to do as a result of this lesson?)</i>
• Three types of bridges- beam, truss, arch, suspension • Key details about the four types of bridges • 5 different forces on a bridges • Squeezing force is called compression • Stretching force is called tension • Bending force is when straight materials curve • Sliding force is called shear • Twisting is torsion • Different types of loads • Weight of the structure • Weight of objects on the bridge • Settlement loads (when the bridge settles into the earth) • Temperature (expansion and contractions of the structure) • Earthquake loads (push and pull horizontally) • Wind loads • Vibrations (Dynamic Loads) • Different types of materials used in bridges • Wood, Plastic, Aluminum, Brick, Concrete • Reinforces Concrete, Cast Iron, Steel		• Students will be able to compare and contrast the different types, forces, and loads of bridges. • Students will be able to compare and contrast the different types of materials used in building bridges • Students will be able to generalize by using manipulative on the different type of forces. • Students will predict what different forces will do to the different types of bridges. • Students will be able to make connections by seeing real life examples. • Students create business names, logos and slogans. • Students will design your truss bridges. • Students will evaluate their understanding of why structure creates strength.
GUIDING QUESTIONS <i>What questions will be asked to support instruction?</i> <i>Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding</i>		
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:
What are some types of materials are bridges made out of? What are some forces that could push on bridges? What influences the different types of bridges at different landscapes? What is force? What types of bridges have you seen in real life? What form does a bridge take? Why types of bridges have you seen?	What type of bridges do you think they are and explain your reasoning? Which bridge do you think is the strongest in the pictures? What is happening to the structure and what the term is call for the squeezing force on a bridge? By exploring the sponge what do you see is happening when you stretch it out? What is the force that is being	What materials are being used? Why did you use these materials? What function will these materials provide? Where can you see some weaknesses? Why do you think they built this bridge on this landscape? Why did you build this bridge using this design or form? What are the four types of bridges? Then what are 4 different types of

Why are bridges different in looks? What do you think of when you hear the word, "function"? What is function? Why is function important to strength and structure?	exerted on the sponge by stretching? What force is being exerted to the sponge? What is the scientific name for that force? What force is happening now? What is the force that is happening here? What are some examples of loads that are used on the bridges? What are the different types of loads? What do they think pushes down on bridges? What makes this bridge heavier than this bridge? What goes along with the weight of the structure? What are examples of weight loads that use bridges? What types of transportations use bridges? What happens when you put your foot in mud or a soft surface? What do you think happens to bridges? What are some examples of settlement loads? What is happening to the metal and why? What temperature does to bridges? Natural occurrences in the world? Wind, weather, earthquake? Test the tuning fork and what is happening? What is the function of a bridge? How is form of a bridge related to strength? How is function of a bridge related to the structure and strength?	loads? What are four examples of different materials used in building bridges? How can you apply your knowledge to your bridge design? How can you illustrate your bridge design? How does structure create strength?
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DIFFERENTIATION

(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.)

Content	Process	Product	Learning Environment
Students will be using higher levels of vocabulary; authentic to the discipline.	Students will be able to use IPAD that will be used to help visually explain the different types of materials loads, and forces. PBSBuildingBig .com	Students will begin designing their bridges on blueprints bridge designs will be different from group to group. Students will work in groups to help design their own bridge together using a simple graph paper and pencil.	

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.

As students enter the room, four types of bridges will be displayed on the board. Students are instructed to work in groups to discuss what they notice about each of the bridges. What is the form of the bridge? What is the use (function) of the bridge? What are the features of the bridge? What is the landscape that the bridge is on?

*The class discussion will ensue about the bridges looking at the bridges. What is the same about them all? How are they different? How is the geography landscape the same or different? What is the difference between them? What is function? What does function mean for a bridge? What can you tell about the function related to strength?
Teacher writes all information on the board.*

I will ask the students what are the different factors that engineers have to deal with in building bridges.

They will design a bridge based on the pictures and talk about the materials they would use.

Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.

Students will start by talking to their groups about the structures and the forms are related to the function of the bridges.

We will talk about the different ideas that we can conceptually understand about strength related to the structure.

Teacher will show the students a picture of an elephant being pushed onto the bridge. What do you think is happening in this picture? Do you think they are just trying to get him to the other side? It is a legend that if an elephant doesn't hesitate cross the bridge that the bridge is built sturdy and strong. What is the relationship between the strength of the bridge and the form and function of the bridge? They will know that the form of the bridge creates the strength and that the function of the bridge determines the strength needed for the bridge.

Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

Students will look at the four different types of bridges again. What type of bridges do you think they are and explain your reasoning? Which bridge do you think is the strongest in the pictures?

Ask the students why do they think that the bridges are different for each landscape.

The class will talk about the four different types and differentiate between the four different types on their graphic organizers.

We will start looking at the different types forces. Students will be given each a foam sponge.

We will explore the different forces that can be put on a sponge. The class will be engineers and use the proper vocabulary. Students will also be given a blank graphic organizer. Each page has a different table to put each type of vocabulary word on their with their definition.

The students will explore in their groups the idea of putting changing the sponges' form. Then once they have explored they will come back together as a class. Each student will squeeze their sponges together, while this process is happening the teacher will be asking about what they see is happening to the structure and what the term is call for the squeezing force on a bridge. Next the student will stretch the sponge (hopefully with out ripping it apart). By exploring the sponge what do you see is happening when you stretch it out? What is the force that is being exerted on the sponge by stretching? Students will bend the sponge. What force is being exerted to the sponge? What is the scientific name for that force? Students will hold the sponge in place and slide the object across the table. What force is happening now? Finally the students will twist the sponge. What is the force that is happening here?

What are some examples of loads that are used on the bridges? What are the different types of loads? Teacher will ask students what do they think pushes down on bridges? What makes this bridge heavier that this bridge? What goes along with the weight of the structure? What are examples of weight loads that use bridges? What objects use bridges? What happens when you put you foot in mud or a soft surface? What do you think happens to bridges? What are some examples of settlement loads? Show an image of a piece of steel expanding and contracting. What is happening to the metal and why? What temperate does to bridges? Natural occurrences in the world? Wind, weather, earthquake? Lastly, so them a tuning for. Test the tuning for and what is happening? Dynamic load vibrations.

Students will look a slide show of different types of bridges very quickly. Then we will have a contest to see who can come up with the

most different types of materials that are used on bridges. We will talk about the strengths and weaknesses using the different materials. T

Elaborate —Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways

Next will look at PBSbuildingbig.com. This websites gives us definitions of bridge types, forces, load and materials used for building bridges

Finally the students will put their knowledge to the test using the I Pads and this app call “Cargo Bridge.” In this app they will have to build bridges putting together all the factors and they will be tested right in front of their eyes. Each scenario builds on the next one. They will see how far they can get.

The teacher will close out their ipads and return them to the cart. A discussion will follow the different types of structures they built and the materials that they used. Overall discussion will be about how each different structure has its own strength based on its structure. Why are the bridges different, but still hold true to strength creates structure?

Evaluate: This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.

We will relook at our pictures that are on the beginning pictures and decide what types of bridges they are and what materials are being used? Where can you see some weaknesses? Why do you think they built this bridge on this landscape?

Teacher will give the students an exit ticket.

What are the four types of bridges?

It will be a simple matching the different types of forces.

Then what are 4 different types of loads?

How does structure create strength?

Start designing the bridges on the graph paper. They will have to design three parts of the bridge with specifications. The group will take the blueprints and submit to the teacher to show the teacher their design and the teacher will make sure they are following specifications.



TEACHER NAME		
Charles Beckley		
MODEL	CONTENT AREA	GRADE LEVEL
Creative Problem Solving	Math/Science	4 th -6 th
CONCEPTUAL LENS		LESSON TOPIC
Structure		Building on a Budget
LEARNING OBJECTIVES (from State/Local Curriculum)		
Math 4.NBT.4 -Fluently add and subtract multi-digit whole numbers using the standard algorithm 4.NBT.5 -Multiply a whole number of up to four digits by a one-digit whole number, and multiply two by two digits # 4.MD.2 - Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money.		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to “uncover” the Essential Understanding)
Structure creates Strength		How does structure determine strength?
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)
Students will know that: - A good business generates profit. - Financial literacy is the knowledge of management - The budget process is very time consuming. - Budgeting is knowing your limits - Building materials cost money - Blueprints are used as preliminary designs by engineers - Blueprints can change depending on your cost - Blueprints can only go as far as your budget allows - It's the responsibility of the whole group to analyze all numbers associated with their budget.		Students will be able to: - Create a team name and logo - Build a blueprints of their bridge - Compile a materials list - Create a budget - Work with in the lines of that budget - Collaborated with team members. - Research the possibility of different bridge styles - Use reasoning and logic behind their drawings - Use reasoning and logic behind their budgets - Use problem solving to help solve differences
GUIDING QUESTIONS What questions will be asked to support instruction? Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding		
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:
What is a company/business? What makes a good business? What are blueprints? What is a budget? What does it mean to have strength when talking about bridges? What does structure have to do with strength? How do you build a strong bridge? What do engineers use to help plan in building a bridge? How does a structure budget help with the structure of your bridge? How does a strong budget help with the structure of your bridge?	What is good about budgeting? How is a budget planned? What is the goal of a budget? What makes a strong budget? What happens if you are over budget? What happens if you are under budget? Why do you think a budget is important? Why should engineers make a blue print? How does your budget show strength? What does a budget do for your	What makes you think your budget is strong? What makes What have you done to keep your bridge under budget? How does the structure of your budget help determine the amount of materials you need to create a strong bridge? Why do you think the structure of your bridge will hold that weight? What makes your bridge the best? How does structure determine strength? How can you create a strong

	structure of your bridge? How can you structure your budget to build a strong bridge? What makes a strong budget? How can we structure a budget to ensure it is strong and supports a successful business?	budget?	
DIFFERENTIATION <i>(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.</i>			
Content	Process	Product	Learning Environment
	Students will learn the process of a budgeting by using the prices set by teacher to help construct their bridge.	Students will have blue prints of their bridges. Students will create their budget to start their construction project of their bridge. Students will incorporate their blue prints and their budget together to start building their bridge.	

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.

As students walk into the room the teacher will have on the board a list of items with set prices on the board. The objective of this is to have the students pick two things that they would like to do for summer vacation. They only have \$200. They need to decide which two they want to do and why they decided to do these two activities compared to the other ones.

The teacher will then move into what the lesson is about today. The teacher will ask what this exercise was about? The exercise was about budgeting. What is a budget? How do we use budgets in everyday life? What happens if you have a strong budget? Why can't you go over budget? What if you go over budget?

What is a company/business? Students will converse with a partner about what a company does. What is important about having a strong business plan? Why can't a business go over budget? What if the business goes over budget?

Students will have an open discussion about what they think makes a strong business.

Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.

What makes a strong budget?

Teacher will have students discuss what makes a strong budget and relate the process of having a strong budget to what needs to be in a budget. The teacher will direct students to the setup or structure of the budget. What are the positives of having a strong, structured budget?

What do you call someone who is a bridge designer?

What do engineers use to help plan in building a bridge?

What are blueprints?

What makes blueprints strong? What does blueprints strength have to do with the structure of the design?

Students will then look back at the concept and talk about the strength.

Teacher will direct the students into how their budget for their bridge relates to both the budget and the blueprints of their bridges?

What does it mean to have strength when talking about bridges? What does structure have to do with strength? How do you build a strong bridge with a strong budget?

Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

The students will look a planning a budget of meals for the week. They will have a set amount of money. They will then have to decide which meals they want to buy, but also having a balance diet. There will be a choice of ten meals that they can choose from in each category. Each meal will have a set price. The goal of this problem solving strategy is to have a balanced week's worth of meals with as much money left over as they can.

What does the meal plan having to do with a strong budget? Why did you decide to choose those meals? What does creating a meal budget have to deal with creating a budget for bridge building?

Teacher is looking for the students to understand building a structured budget reinforces a strong budget.

Teacher will introduce that each group will have to create a budget for their bridge design.

How is a budget planned?

What is the goal of a budget?

What happens if you are over budget?

What happens if you are under budget?

Why do you think a budget is important to the structure of your bridge?

Elaborate —Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways

Teacher: Everyone company will start with \$300,000 to build their bridge. The goal is to have the strongest most budget efficient bridge. The bridge has certain regulations that it has to meet. This will be explained to them.

Materials will be given a price. The students will have to decide what materials they need and make a purchase order. Throughout the whole simulation you only can make three mass purchases. Their goal is to plan everything out on the blue print then make one big order.

Teacher will pass out the blueprint papers and the teacher will explain the process of how they should start. The goal is for the students to start the design process.

They will then start designing their bridges. They will have to come up with a trusses style bridge. The construction companies will each get four pieces of graph paper. They will then label each paper as a different view of their bridge. Bottom, Top, and Side views.

The materials that will be used are Elmer's glue, popsicle sticks, and clips to help the gluing process.

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

Students will start to work on their design process blueprints and must be approved by the bridge inspector (Teacher). Once completed they will then start working on their budget and purchase orders. Then once completed they can go to the materials store (Teacher B). Finally they will get their materials and will start to construct their bridges.

Students will look at their own budget and decide if there is anyway that you can trim or inflate their budget to make their bridge stronger or more under budget. The students will also have to have their bridge in the desired dimensions and restrictions of the contest. Members will reflect on their own experiences of the building process. They will write down what they learned about budgeting and blueprints. Then will make a prediction on how much weight that their bridge will hold and what can make their bridge better?

What have you done to keep your bridge under budget?

Do you think your bridge will be strong enough to hold weight?

What type of bridge did you use?

Why did you use that type of bridge structure?

What makes your bridge the best?

How does strength reinforce structure?

TEACHER NAME			
Charles Beckley			
MODEL	CONTENT AREA	GRADE LEVEL	
VTs	Science	4-6	
CONCEPTUAL LENS		LESSON TOPIC	
Structure		Bridges around the World	
LEARNING OBJECTIVES (from State/Local Curriculum)			
CCSS.ELA-Literacy.RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question or to solve a problem efficiently.			
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to “uncover” the Essential Understanding)	
Structure creates Strength		How does structure create strength?	
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)	
- History of the Brooklyn Bridge - Three types of bridges- beam, truss, arch, suspension - Key details about the four types of bridges 5 different forces on a bridges - Squeezing force is called compression - Stretching force is called tension - Bending force is when straight materials curve - Sliding force is called shear - Twisting is torsion		- Students will be able to compare and contrast the different types of bridges on display. - Students will demonstrate their overall knowledge of the content learned by walking through making observations on the bridges. - Students will examine their bridges to see where their weak points were in their bridges. - Students will apply their knowledge of structure to their own lives. - Students will apply their knowledge of strength to their own lives. - Students will relate structure and strength.	
GUIDING QUESTIONS			
What questions will be asked to support instruction? Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding			
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:	
What type of bridge is this? How much weight do you think the bridge will hold? Why do you think the bridge will hold that much weight? What about the bridge’s structure will allow it support that much weight? Where do you think the weak points are in your bridge?	What do you like about the bridge? What type of bridge is this? If you were the engineers of this bridge what would you have done differently? How much weight do you think the bride will hold? What led you to this prediction? Where is the weakest point of the bridge? How can you modify the bridge to strengthen it? What do you see in this picture? What do you think is happening? What do you see that makes you think that? What else do you see?	Where can you see some weaknesses in the bridges? Why do you think they built this bridge on this landscape? What are the four types of bridges? Why do you think that this bridge was the strongest? Why do you think this bridge was chosen as most creative? Why do you think that this bridge with the least amount of materials failed? Why do you think the most efficient bridge was strong? How does structure create strength?	
DIFFERENTIATION			
(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.			
Content	Process	Product	Learning Environment
Learning about the different vocabulary learned about building bridges. Their goal is to think like civil engineers and use the proper vocabulary and exposure to	Students will observe pictures and come up with different observations based on their prior knowledge. The goal of the VTS model is		

new vocabulary and terms within the field of engineering?	to enrich the students mind by digging deeper into each students' personal experiences.		
PLANNED LEARNING EXPERIENCES <i>(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)</i>			
Engage and Connect - <i>This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.</i> As students walk into the classroom a picture of a man crossing a very unstable bridge. What do you see in this picture? Students will have a general conversation of what they see is in the picture. What do you think is happening? Teacher will paraphrase students answers and follow up with the question: What do you see that makes you think that? The goals of these questions are to spark conversations between students about what is going on in the picture. What do you see that makes you think that? Explore - <i>In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.</i> <i>Students will put the finishing touches on their bridges and business plans. Students will need to work with their partners to complete their business plans. Teacher will ask: Why do you think your bridge is finished? Why is your bridge going strong? How much money did you spend? Is there anyway that you could have cut some materials out to save money without hurting the structure? How much money do you think you could have saved? How does the structure of your bridge relate to its strength? How does the structure of your bridge create strength?</i> How much money did you spend to reinforce you bridge? How does this modification to the bridge's structure affect the strength? Students will turn in all materials. Explain - <i>Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.</i> Gallery Walkthrough: Students will display all their bridges out on their tables. Each group will inspect and collaborate on each bridge. The students will have to answer the following questions: What do you like about the bridge? What type of bridge is it? What about the bridge's structure led you to this conclusion? If you were the engineers of this bridge what would you have done different? How much weight do you think the bride will hold? Create a landscape where you think the bridge would work? Where is the weakest point of the bridge? How can you change the bridge to strengthen the bridge? Students will be using their engineering terms to help explain their findings. Students will make a hypothesis on what bridge is the strongest and why?. Based on its structure and design why do you think this bridge is the strongest? These questions will be answered about each bridge. This is a simple 3-5 minutes at each bridge. The students will keep their documentations of each bridge observations.			

Elaborate —Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways

The students will see the bridge created by the teacher being destroyed. They will be looking at the different points of stress and waiting for the bridge to break.

Teacher will then to proceed to put weight on the bridge. The students will observe the bridge collapse and see if they were right on their prior observations.

Observations:

What type of bridge is this?

How much weight do you think the bridge will hold?

Why do you think the bridge will hold that much weight?

What about the bridge's structure will allow it support that much weight?

Where do you think the weak points are in your bridge?

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

Students will now begin to destroy their bridges.

During this time students will observe and enjoy their bridges being destroyed. Students will put weight on their bridge until the bridge fails. The satisfaction comes when they are the ones destroying their own bridge. While the students are destroying their bridges we will observe their design and reflect on the journal entries that the groups have made about each bridge. They will be looking for real life deformities to their bridges and talk about what is happening to their bridges using their engineering vocabulary.

The award ceremony will culminate at the end of all bridge destruction.

Students will receive awards in three areas.

Most Creative

Strongest

Most Efficient

The teacher will have a short review over a lot of the material that is learned from the week. Students will receive small prizes for their knowledge.

Where can you see some weaknesses?

Why do you think they built this bridge on this landscape?

What type of bridges do engineers build to ensure strength and structure of the designs?

Why do you think that this bridge was the strongest?

Why do you think this bridge was chosen as most creative?

Why do you think that this bridge with the least amount of materials failed?

Why do you think the most efficient bridge was strongest?

If the most efficient bridge wasn't the strongest why did it fail?

What are your life goals to become the strongest person in your career?

The teacher will wrap up the unit with the question How can you apply your knowledge of how structure creates strength to your personal life goals?

PERFORMANCE TASK

You are an engineer and have been asked by the city council to design a bridge that will withstand heavy traffic and be cost effective to the town. The challenge is to design a prototype and present your design to the council. The council will choose the bridge design that has the best overall value. The council is looking for evidence of strength in the structure and strength of the budget used for constructing your bridge.

PBS Building BIG Lab Notes

The screenshot shows the PBS Building BIG Lab interface. At the top, there's a navigation bar with links: Home, Site Map, Labs, Databank, and Glossary. Below this is a menu with tabs: FORCES, LOADS, MATERIALS, and SHAPES. The main content area displays three bridge types: a rectangle, an arch, and a triangle. Each bridge has a weight icon on top. To the right of the bridges is a vertical scale with numbers 1, 3, 6, and 9. Below each bridge is a text box explaining the forces: for the rectangle, 'The weight pushes down on the rectangle and causes the top side to bend.'; for the arch, 'The weight presses down on the arch and is spread outward along the curve to the ground below.'; and for the triangle, 'The weight causes the top two sides to squeeze together and the bottom side to pull apart.'

Online Lab provides students opportunities to manipulate how forces, loads, materials and shapes effect bridges.





Unit Resources

Building Big. (n.d.). Retrieved June 23, 2016, from <http://www.pbs.org/wgbh/buildingbig/index.html>

This website was used during lesson 2 of the unit. It encompasses the entire content needed for the lesson.

Bridge Disasters [Video file]. (n.d.). Retrieved June 23, 2016, from <https://www.youtube.com/watch?v=XggxeuFDaDU>

This was used during lesson 1. It was used in the beginning of the lesson to show structure and strength problems.

Cargo Bridge. (September 11, 2014). Software Planet Group Ltd.

This was used for lesson 2. This was used as a formative assessment to see if the students understood the structural design of bridges.

Elephant Crossing a Bridge. (n.d.). In *Google*. Retrieved June, 2016, from <http://www.nonfictionminute.com/uploads/2/7/0/0/27004167/1432231719.png>

This was used in lesson 4. The picture was used as VTS strategy.

Google.com. (n.d.). Retrieved June, 2016, from <http://trulytraveled.com/wp-content/uploads/2016/06/Man-Made-Amazing-And-Adventurous-Bridges-09.jpg>

This was used in lesson 4. The picture was used as a VTS strategy.

Kahoot Bridge Basics. (2016, January). Retrieved June 23, 2016, from <https://play.kahoot.it/#/k/224499fe-5343-4725-9d47-9b4d4eaebed1>

This was used in lesson 3. The goal of this was a game to see if the student completely understood the content knowledge.

Reading: Bridges. (2005). Retrieved June 23, 2016, from onestopenglish.com

This was used in Lesson 1. The reading was used in the Tabla Lesson. The goal of the lesson for the students to read and choose vocabulary.