STEAM Bridge Challenge

Lesson Plan for 6th-12th Grade Students

Building a Bridge
Engineering and Architect
Introduction and Background

Building Bridges is a project idea that enhances the "21st Century" of learning through the STEM initiative. In order for students to become "21st Century" learners, it is important to expose them to the areas of STEM that will promote problem-solving skills and make them competitive learners, as they move on to middle school and then high school.

By learning how to build bridges, students will learn how engineers work and what goes into designing and building a complex, but necessary structure that is used by people in all parts of the world every day.

Students will use everyday items, such as, Popsicle sticks, toothpicks, straws, clay, cereal boxes, wood, playing cards...to build their bridges. They will also have to research different types of bridges, sketch the bridge they envision, write a report that provides details on how their bridge will be used, how it makes life easier for everyday activities (and by people) and upon completion, explain the process it took to design and complete their bridge, and how they can improve their bridges.

The eight practices of science and engineering that the Framework identifies as essential for all students to learn and describes in detail are listed below:

1. Asking questions (for science) and defining problems (for engineering)

2. Developing and using models

3. Planning and carrying out investigations

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

6. Constructing explanations (for science) and designing solutions (for engineering

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. · Evaluate limitations of a model for a proposed object or tool. · Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. · Use and/or develop a model of simple systems with uncertain and less predictable factors. · Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. · Develop and/or use a model to predict and/or describe phenomena. · Develop a model to describe unobservable mechanisms. · Develop and/or use a model to generate data to test ideas about

phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. · Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria. · Design a test of a model to ascertain its reliability. · Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. · Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. · Develop a complex model that allows for manipulation and testing of a proposed process or system. · Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Students will participate in the STEM initiative using the component of engineering in designing, creating, and building bridges using materials easily accessible. Building Bridges will introduce students to the skills utilized by engineers through the process of problem-solving, researching, designing and building bridges. This project will be implemented during and outside of school and will incorporate parental/guardian involvement. As a result of this project, students will learn what STEM (Science, Technology, Engineering, and Math) is, what it involves, how STEM relates to our everyday lives, what engineers do, what necessary skills are involved within STEM, such as, how to problem-solve, how to research and re-evaluate their designs, how to improve on what they build, and how "bridges" relate to "real-life".

Building Bridges Lesson Plan for 6th-12th Grades

Student Name_____
Teacher:_____

Design Challenge: Make sure you research what type of bridge you would like to build. Be creative. Make a few sketches of your design before you actually start to build it. That's what great engineers do!

Criteria: Your Bridge must:

• Be at least 12" long • Support 1-2 lbs. (or equivalent metric weight)

• Hold the weight for at least 5 minutes • Label right, acute and/or obtuse angles

• A way to get on and off the bridge (toy car…)

• Optional: colorful & attractive

Examples of Materials you can use:

• Cardboard or cardboard tubes • Paper clips, straws, toothpicks, Popsicle sticks

• Construction paper, tape, Styrofoam, egg cartons, string

• Poster board, food items

Research: Look up the following bridges and decide which one you would like to build:

• Beam bridge

• Suspension bridge

• Arch bridge

• Cantilever bridge

Student Name:_____Teacher:_____

Lesson Plan for 6th-12th Grade

Essential Question: How are structures built and how are they important in our world? (Use this question following the second part of the lesson; provide students first with the engagement/inquiry below first).

Engagement and Explore: Provide students, working in groups, a zip loc bag with one marble, 4-6 bendable straws, 2-3 index cards, one small Dixie cup, one small marble, a cube size piece of clay, toothpicks (optional), and masking tape.

Explain to them that they will be building a structure that will provide a "road way" for the marble and it must be able to travel down the structure till it ends up in the small cup. Tell students that the "tallest" structure will "win". Each student within their group, should first sketch in their journal an idea they may have and then as a group, discuss each other's ideas and come to a consensus as to which model sketched they will build. (This will give the student's the opportunity to share their ideas, sketches and begin teaching them the importance of collaboration**.) Do not give them any more instructions**. Allow the students to work together in designing and building their structure. (You will walk around the room and provide feedback to any questions they may have with guidance, not answers…)

Explanation: Once all groups are finished with building their structure, give them a few minutes to test their design. As they are testing their design have students give you verbal explanations as to why they chose their design and observe whether their goal of the marble ending up in the cup (as well as how high the structure is) was accomplished. Once all the groups have given you a verbal explanation, have the students go back to their journals and write what they observed and guide them to answer the following questions:

1) Did your structure meet the criteria of providing a "road way" for the marble to reach its destination without falling off the track?

2) Would you have done something different or changed it in any way?

3) Were there any materials that you did not used and why?

4) What materials were the most useful? Least useful? 5) How does your structure relate to our everyday lives?

Engagement and Extension: The following week have the students watch the “Bill Nye, the Science Guy” video on building structures. It is a great tool to introduce the lesson on Building Bridges. If your media center does not have this video, any other short clip on bridges will suffice. In addition, as a further engagement, you can read one of the books provided on the book list. During this time, you can then go over certain vocabulary as “personal terms”, the purpose being that students will begin to understand what a structure is and that a “bridge” is a structure used all over the world for traveling and transferring. The vocabulary will then be more meaningful than having them look up the words “structure, engineering, designing…” Elaborate and Evaluation: They will research bridges, sketch their designs, re-design if necessary, and complete a written report with their bridge. (This will be part of the evaluation). The evaluation component has a rubric that students will use as a checklist to ensure they have met all the criteria of building their bridge.

****Do not make this a Mandatory assignment**. The whole purpose of this lesson is to get students excited about the engineering component in STEM, have them begin to think about Science in a whole new way, integrate Math (to minimize fear, especially for those students that have difficulty with math), use technology and learn how to research, begin to write their thoughts and ideas, which will lead them to have more questions which they can record and research.

Name_____Teacher_____

Bridge Design

Draw or describe some possible bridges

First Sketch	Second Sketch
Third Sketch	Fourth Sketch

***Make sure you label all the parts with the materials you think you will use.**

Notes below: (These notes can be what problems/solutions to create your bridge, how you solve them, what materials worked or didn't worked, what you had to change/adjust while making your bridge…)

Test your Bridge:

- **Is your bridge at least 12" long? Yes No**
- **Does your bridge support/hold at least 1-2 pounds or the metric equivalent? Yes No**

- **Does your bridge hold this weight for at least five minutes? Yes No**
- **Does your bridge contain right, acute, or obtuse angles? Yes No**
- **Is there a way to get onto and off your bridge? Yes No**
- **Is your project neat and colorful? Yes No**

Evaluate your Bridge:

1. **What would you have done differently?**_____
2. **What could you add to it to make it better?**_____
3. **What was the easiest part to build/what was the most difficult?**_____
4. **How does this bridge relate to "real-life"? How would it be used? Where would it be located?**

Resources on Bridges

Websites:

http://www.pbs.org/wgbh/buildingbig/bridge/ http://www.instructables.com/id/Popsicle-Stick-Bridge/ http://pbskids.org/zoom/activities/sci/ http://www.kids-fun-science.com/physical-science-activities.html http://www.ehow.com/info_8297542_crafts-kids-bridges.html http://www.ehow.com/how_10052209_make-bridges-toothpicks-kids.html http://www.pbs.org/wgbh/nova/ http://www.exploratorium.edu/structures/ http://www.learner.org/catalog/resources/activities/sact9806/sact9806-2.html http://www.pbs.org/wgbh/nova/tech/build-bridge-p1.html http://www.bcps.org/offices/lis/models/3%20Bridges/index.htm

Books on Bridges:

Building Bridges: Amazing Structures to Design, Build and Test by Carol A. Johmann: $10.36

The Ghost of the Golden Gate Bridge by Carole Marsh $7.99

Brooklyn Bridge by Lynn Curlee $15.08

Draw 50 Buildings and Other Structures: The Step-by Step Way to Draw Castles, Cathedrals, Skyscrapers, and Bridges, and So Much More…by Lee J. Ames: $9.99

Bridge Building: Bridge Designs and How They Work (High Five Reading) by Diana Briscoe $9.00

The Family under the Bridge by Natalie Savage Carlson and Garth Williams $5.99

Golden Gate Bridge: History and Design of an Icon by Donald MacDonald and Ira Nadel $11.58

Where is London Bridge? A Kid's Guide to London by Penelope Dyan and John D. Weigand $11.95

Famous Bridges of the World: Measuring Length, Weight, and Volume by Yolonda Maxwell $10.00

Building Toothpick Bridges (Math Projects: Grades: 5-8) by Jeanne Pollard and Dale Seymour $ 16.47

Bridge to Terabithia (Fiction) by Katherine Paterson Bridges!

Amazing Structures To Design, Build And Test (Turtleback School & Library Binding Edition)

(Kaleidoscope Kids Books) Let's Try It Out with Towers and Bridges: Hands-On Early-Learning Science

Activities by Seymour Simon Bridges by Seymour Simon Bridges: From my side to yours by Jan Adkins