Engineering Design Challenge
NASA: The E in STEM
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# Crossing A New Bridge Design Challenge

Phase I - Research and Planning

1. Identify the “Big” concept to be covered by the engineering design challenge.

The BIG concept to be analyzed and worked through is the idea that technology and engineering connections are related to the historical influences throughout society’s development, such as systems and structures.

2. Research appropriate learning standards associated with the topic.

**VIRGINIA’S STANDARDS OF LEARNING**

Math

4.4 The student will

a) estimate sums, differences, products, and quotients of whole numbers;
b) add, subtract, and multiply whole numbers.

4.6 The student will

a) estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate; and
b) identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms).

4.7 The student will

a) estimate and measure length, and describe the result in both metric and U.S.Customary units; and
b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system.

4.14 The student will collect, organize, display, and interpret data from a variety of graphs.

Science

4.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which

a) distinctions are made among observations, conclusions, inferences, and predictions;
b) objects/events are classified and arranged according to characteristics or properties;
c) appropriate instruments are selected and used to measure length, mass, volume, and temperature in metric units;
d) appropriate instruments are selected and used to measure elapsed time;
e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources;
f) independent and dependent variables are identified;
g) constants in an experimental situation are identified;
h) hypotheses are developed as cause and effect relationships;
i) data are collected, recorded, analyzed, and displayed using bar and basic line graphs;
j) numerical data that are contradictory/unusual in experimental results are recognized;
k) data are communicated with simple graphs, pictures, written statements, numbers;
l) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and
m) current applications are used to reinforce science concepts.

Virginia Studies

VS.1 The student will demonstrate skills for historical thinking, geographical analysis, economic decision making, and responsible citizenship by

d) recognizing points of view and historical perspectives;
f) determining relationships with multiple causes or effects in Virginia history;
g) explaining connections across time and place;
j) investigating and researching to develop products orally and in writing.

VS.9 The student will demonstrate an understanding of Virginia during the twentieth century and beyond by

a) describing the economic and social transition from a rural, agricultural society to a more urban, industrialized society;
b) describing how national events, including women's suffrage and the Great Depression, affected Virginia and its citizens.

Language Arts

4.1 The student will use effective oral communication skills in a variety of settings.

4.2 The student will make and listen to oral presentations and reports.

4.6 The student will read and demonstrate comprehension of nonfiction texts.

4.7 The student will write cohesively for a variety of purposes.

4.8 The student will edit writing for correct grammar, capitalization, spelling, punctuation, sentence structure, and paragraphing.

4.9 The student will demonstrate comprehension of information resources to research a topic.

**ITEEA**

Standard 1. Students will develop an understanding of the characteristics and scope of technology.

Standard 2. Students will develop an understanding of the core concepts of technology.

Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.

Standard 6. Students will develop an understanding of the role of society in the development and use of technology.

Standard 7. Students will develop an understanding of the influence of technology on history.

Standard 8. Students will develop an understanding of the attributes of design.

Standard 9. Students will develop an understanding of engineering design.

**Next Generation Science Standards (NGSS)**

Students who demonstrate understanding can:

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| 3-5-ETS 1-1. | Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. |
| 3-5-ETS 1-2. | Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. |
| 3-5-ETS 1-3. | Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. |

3. Identify and discuss the different types of problem solving and declarative/procedural knowledge needed.

The declarative knowledge that students need to have includes knowing what a bridge is, understanding that structures must be support appropriately and what those supports might look like, and being able to identify the system for the structure.

The procedural knowledge necessary to know includes clear directions on what is expected in the design challenge, as well as how to build things using paper items, tape, and glue. Students will need to be able to predict if their strategy will enable them to complete the challenge, i.e. will their strategy be strong enough for the bridge to remain standing and to withstand twenty-one rolls of pennies.

4. Explore objectives and ancillary concepts/content covered by the project.

Objectives will be for students to use their declarative and procedural knowledge to complete this design challenge. They will also need to work together collaboratively. Some of the ancillary concepts that this challenge cover are the idea that a massive structure can be built and withstand a certain weight load, as well as last for many years.

5. Identify possible activities.

Possible activities that students could carry out might be:

1) looking at where a bridge could be built taking into consideration soil types,
2) identify weather conditions with regard to types of material and finishes that might be able to be used, and
3) span of bridge supports and limit of weight that the bridge would be able to handle,
4) building a bridge that supports a certain weight, and
5) can stand for a certain amount of time.

6. Select the best activity for your classroom.

My fourth graders have learned a wide variety of information this year ranging from natural resources, significant historical events from the settling of Jamestown and their struggle to survive, as well as the importance of the rise of the industrial revolution, to the scientific phenomenon of “everything is science,” as well as math concepts to support their knowledge of the world around them. Based on the time of year, June 2018, the best activities for the classroom would be to conduct research about how:

1) soil types affect a bridge construction project,
2) the distance of support spans are critical, and
3) the weight limit the bridge will be able to support.

The design challenge will be: “Design and build a bridge that will cross a 16-inch space between two desks,” or similar items, “and be strong enough to hold at 21 rolls of pennies. (The estimated weight of a roll of pennies is 125 grams or 4.41 ounces.)” Whiting & Hickey, p. 71.

NOTE: Engineering Notebook to be scanned and sent next week.

**Resources**

Prince, A. (2005). *Twenty-one Elephants and still standing*. HMH Books for Young Readers.

Whiting, G. & Hickey, M. (2012). *Children's engineering: beyond the basics*. Richmond, VA: Children's Engineering Educators, LLC.