Real-Life Problem Solving

Gaining Access to Water

Rationale:

- During this lesson students will learn that many people in the world do not have efficient access to water, and thus have to spend a considerable amount of their day transporting water from its source to their home. In relationship to this problem, students will research how the Romans constructed aqueducts to transport water. Using Legos, students will design a mock aqueduct to get water from its source to the home.

Goal:

- To understand the design process of aqueducts and how humans devised a way (aqueducts) to bring water to their cities

Standards:

Engineering Procedural Standards:

- **Standard One:** Students will apply the engineering design process, troubleshooting, research and development, invention and innovation, and experimentation in problem solving and engineering design.
- **Standard Two:** Students will be able to apply concepts of science, technology, and mathematics in an engineering design process.
- **Standard Three:** Students will be able to be creative and innovative in their thought process and actions.
- **Standard Four**: Students are able to use effective communication and teamwork skills to acquire information and convey engineered outcomes to a variety of stakeholders.
- **Standard Five:** Students will be able to investigate and analyze the impact of engineering on a global society.

Common Core State Standards (Lesson can be modified for grades 3-8)

- **W.5.7:** Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- **W.5.8:** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

- **W.5.9:** Draw evidence from literary or informational texts to support analysis, reflection, and research.
- **SL.5.4:** Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
- **SL.5.5:** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

Next-Generation Science Standards

- **MS-ETS1-1:** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2:** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-4:** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- **MS-ESS3-3:** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Objectives:

- Students will employ the 5Es as they design solutions to clean up oil spills.
- Students will work collaboratively to solve problems while working in small groups.
- Students will design a solution and present their findings to their class.

Materials:

- Legos
- Water
- Paper cups
- Receptacle to capture the water below the Lego model
- Paper and pencils to draw designs

Procedures:

Hour 1: Introduction and Discussion

- Begin the lesson by having students visit the website, http://anarkiesmusings.blogspot.com/2015/03/we-all-need-water.html to learn more about World Water Day.
- Generate a discussion about what they read and saw on the site.
    - Why do you think people do not have direct access to water?
    - Where do you think people do not have direct access to water?
    - How do you gain access to water?

Hour 2: Research

- Explain that ancient Romans created a way to transport water to its cities by building something called an aqueduct. Read the short article to the students, http://www.kidsdiscover.com/quick-reads/roman-aqueducts-dawn-plumbing/.
- Arrange students into groups of four.
- Have the groups research the following questions:
    - How did the Romans figure out the problem of getting water to their cities?
    - How did the Romans engineer the aqueducts?
    - How did the Romans store the water brought to their cities by the aqueducts?
- Have the groups develop short PowerPoint presentations that answer the above three questions.

Hour 3: Design and Present:

- Next explain that they will be using Legos and will design a structure on a flat board that can transport water from one corner of the board to the opposite side and corner.
- Provide students with the materials. Review the directions and invite them to begin.
- After a few trials, ask all groups to come before the class, explain their design and display how it works.
- Generate a classroom discussion of which approaches worked the best.
- Extend the discussion to the challenges that humans face when gaining access to water.

(Picture from: http://littlebinsforlittlehands.com/lego-water-activity-building-dams-stem/)

Teacher Tips:

- Ensure that you have a reservoir to collect the water that is larger than the Lego boards.
- Prime the pump by discussing the types of landforms that may be in the way of the water's path (mountains, hills, buildings, rocks, etc.)

Evaluation:

- Students will be evaluated on their ability to employ all of the directions, their ability to work collaboratively in their groups, and the success of their final design.

Extension Activities:

- Invite students to conduct research about how their water comes from its source to their home. Instructors can schedule a field trip to their local water processing plant.

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Water Design Directions

1. Today you are going to design and create a model to get water from one location to another.
2. In your design you have to simulate obstructions that the water has to go around. These obstructions include:
    - Three walls that are half the length of your board that are a minimum of two blocks high (that simulate hills).
    - You also need to include four rectangular structures that are two Legos wide by two Legos (that simulate buildings).
3. You have to create a place where the water goes in and the water goes out.
4. Your goal is to get as much water in the cup as possible with each pour.
5. But before you begin, work with your team to draw a picture of your design.
6. You will have 30 minutes to draw your designs and test your design.
7. At the end of 30 minutes you will come to the front of the class to display your final design.
8. Your group will be evaluated your ability to follow directions, how well your group works together, and the success of your final design.

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Project Rubric

Element	1 – Unsuccessful	2 – Satisfactory	3 – Good	4 - Excellent
The group followed directions and created a design with all required elements.	The group did not draw designs for any trials, and missed most of the required elements.	The group drew designs for most of their trials, and included some of the required elements.	The group drew designs for all trials, and included most of the required elements.	The group drew designs for all trials, and included all required elements.
The group worked collaboratively and respectfully toward each other.	The group did not get along and were not able to complete the project.	The group worked together, but at times they argued with one another.	The group worked together.	The group worked collaboratively and respectfully throughout the whole process.
The final design was successful.	The final design did not meet the requirements and was not successful.	The final design included the required elements but only captured a quarter of the liquid.	The final design included the required elements but only captured half of the liquid.	The final design included the required elements but only captured three quarters of the liquid.