### National Standards

**GEOGRAPHY STANDARDS**

**Element Five: Environment and Society**

14. How human actions modify the physical environment
15. How physical systems affect human systems
16. The changes that occur in the meaning, use, distribution, and importance of resources

### Common Core Standards

**ELA COMMON CORE**

Reading Standards for 6-8 for Literacy in History/Social Studies

**Key Ideas and Details**

6-8.RH.4. Determine the meaning of words and phrases as they are used in a text, including vocabulary specific to domains related to history/social studies.

6-8.RH.7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

6-8 Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

**Production and Distribution of Writing**

6-8.WHST.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

a. Produce clear and coherent functional writing (e.g., formal letters, envelopes, procedures, labels, timelines, graphs/tables, experiments, maps, captions, charts, diagrams) in which the development, organization, and style are appropriate.

### Other Arizona Standards

**SOCIAL STUDIES**

Strand 2

World History

PO 8. Describe scientific and cultural advancements (e.g., networks of roads, aqueducts, art and architecture, literature and theatre, mathematics, philosophy) in ancient civilizations.

Strand 4

Geography

Concept 5: Environment and Society

PO 1. Describe ways that human dependence on natural resources influences economic development, settlement, trade, and migration.

Concept 6: Geographic Applications

PO 1. Describe ways geographic features and conditions influenced settlement in various locations (e.g., near waterways, on high terrain, with adequate fresh water, on good land for farming, in temperate climates) throughout different periods of time, places, and regions.
Aqueducts and Aquaduckies

Strand 2: History and Nature of Science
Concept 1: History of Science as a Human Endeavor
PO2 Describe how a major milestone in science or technology has revolutionized the thinking of the time

Strand 3 Science in Personal and Social Perspectives
Concept 2: Science and Technology in Society
PO3. Design and construct a solution to an identified need or problem using simple classroom materials.
PO4. Describe a technological discovery that influences science

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Aqueducts and Aquaduckies

Overview

The ancient Romans constructed many aqueducts to route water to cities and other sites. These aqueducts are considered to be one of the greatest engineering feats of the ancient world. Many of the ancient aqueducts are still in use today. Aqueducts served several functions including providing potable water and supplying water to baths and fountains. Water was then routed into the sewers, where they helped remove waste matter from the cities.

Purpose

In this lesson students solve a problem: How to get water to flow through use of an aqueduct. They will see how gravity plays a large role in the flow of this water while they will also practice the skills of an engineer.

Key Vocabulary

- Trench: a long cut in the ground, a ditch
- Tunnel: an underground passage
- Pressurized pipe: tube used to conduct liquid
- Wall: a structure of stonework, cement, or other materials built to retain a flow of water
- Arcade: a series of arches supported by columns
- Gravity: force by which bodies fall to the earth

Materials

- 4 Styrofoam or plastic cups per group of students
- Yard stick
- Poster Board
- Scissors
- 1 or more rubber ducks (aquaducks)
- Tape
- Tinfoil
- Aqueduct (Aquaducky) Engineering handout
- Rubric for Aqueduct (Aquaducky) Engineering
- Group Work Score Sheet for Aquaducky
- Aqueduct Essay Scoring Guide
- Vocabulary handout and Power Point
- Civil Engineering Power Point
- Aqueduct Photos Power Point
- Vocabulary Test and Answer Key
- Engineering Design Process Model assessment
- Water source (faucet, 2 liter bottles or pitchers to pour the water)

Objectives

The student will be able to:

1. explain how aqueducts worked to transport water
2. describe the job of a civil engineer
3. analyze how the advancement of technology changed a civilization and how geography influenced the development

Arizona English Language Proficiency Standards

ELL Stage IV
Basic
Reading
Standard 4: The student will analyze text for expression, enjoyment, and response to other related content areas. The student will demonstrate knowledge of reading comprehension by:
B-21: applying understanding of content area vocabulary within math, science and social studies texts.
B-22: following a set of written multi-step instructions to perform routine procedures and answer questions.

Writing
Standard 4: The student will integrate elements of effective writing to develop engaging and focused text.
The student will integrate elements of effective writing to develop engaging and focused text as demonstrated by:
B-1: writing text that incorporates details.
B-2: writing a paragraph, focused on a topic, that includes details, clear sequencing, and transitional words and phrases to connect ideas.
Aqueducts and Aquaduckies

Procedures

Prerequisite Knowledge: The students have read about aqueducts in one of their textbooks and are familiar with their uses and importance.

SESSION ONE

1. Engage: Show the students the rubber duck. Explain the play on words (Aqueduct, Aquaduck). (Scaffolding: Comprehensible input)
2. Then explain the problem: The herdsman who discovered Romulus and Remus has a problem. Remus is sad. His rubber duck was left behind in Rome. The fastest way to get the duck would be to float it through the Roman aqueducts to Remus. Can you help?
3. Have students share what they know about aqueducts since they will be using this invention to solve the problem. Record their comments on the whiteboard. (Preparation: Linking to past learning)
4. Show the Aqueduct Photos Power Point slides 1-3 only. Have students contribute more comments to the whiteboard after viewing the 3 slides. (Preparation: Linking to past learning)
5. Explore: Return to the problem of getting the duck to Remus. Divide students into groups of 4 and have them design an aqueduct using the following list of materials: poster board, cups, tape, scissors, and tin foil. Have 1 member of the group create a drawing of the proposed aqueduct. Have another member create a detailed materials list. (Application: Promotes engagement) (Grouping Option: Small groups)
6. Have groups share their ideas.
7. Explain that in the next session, they will become civil engineers. To understand what civil engineers do, show the Civil Engineering Power Point. (Application: Meaningful)
8. Then show slides 4-15 of the Aqueduct Photos Power Point.
9. Conclude class with students sharing with a classmate three things that they learned today about aqueducts or about civil engineering. (Assessment: Group)

SESSION TWO

1. Elaborate: Distribute the Aqueduct (Aquaduck) Engineering handout. Explain that as Civil Engineers, this is the problem they must solve (Remus needs his duck) and these are the specifications for building the aqueduct as decided upon by supervisors of the project. It is their job, as a group of 4 to create a model of the proposed aqueduct using the plans provided. If this model is successful, the larger (actual) project would be started.
2. Divide students into groups of 4 and review the requirements of the project including the grading rubric at the end of the handout. (Grouping options: Small groups) (Scaffolding: Comprehensible input)
3. Groups will gather materials and begin working on the prescribed design. (Application: Hands on, Promotes engagement)

SESSION THREE

1. Evaluate: Have students complete their aqueducts. When they are ready for testing, give them water. Work with each group to assess their success: Did the aquaduck float from one end to the other of the aqueduct? Provide time for re-engineering. (Application: Hands on, Promotes engagement)
2. When all of the groups have re-engineered their projects, go from group to group and evaluate their aqueduct using the rubric. (Assessment: Group)

SESSION FOUR

1. Have students recall individually on a piece of paper some of the vocabulary words from Session Two and Three that they used in building the project. Distribute the Vocabulary handout and show the Vocabulary Power Point. (Scaffolding: Comprehensible input) (Integrated Processes: Reading, listening, speaking) Give vocabulary test later in the week. (Assessment: Individual)
2. Share the Aqueduct Essay Scoring Guide with the students and explain your expectations.
3. Have students write an essay describing how Roman aqueducts were made, what they were used for, and how they worked. The essay should include a diagram of the aqueduct that the group created with the following labels: arch, column, water channel, and keystone. Extra credit points can be given for tunnels, shaft, and gravity. (Assessment: Individual) (Integrated Processes: Reading, Writing)
4. Have students return to their groups and identify the Engineering Design Process Model with steps from the aqueduct building activity. (Assessment: Group)

Assessment

Students will score:
Aqueducts and Aquaduckies

- 3 or higher on the Rubric for Aqueduct (Aquaducky) Engineering for a science grade.
- 4 or higher on the essay using the 6 Traits Writing Rubric in the area of Ideas/Content for a language arts grade and social studies grade or use Aqueduct Essay Scoring Guide.
- 80% or higher on vocabulary test for language arts grade.
- 4 or higher on the Engineering Design Process Model diagram using the 6 Traits Writing Rubric in the area of Ideas/Content for a language arts grade and science grade.

Extensions

1. Have the students connect their aqueducts to make a series, float a ducky for this longer distance, and demonstrate their understanding of gravity.
2. Play build an aqueduct at the following website:
   http://www.pbs.org/wgbh/nova/lostempires/roman/aqueduct.html

Sources

Vocabulary definitions

Other sources:
Clip art provided copyright free from

http://science.howstuffworks.com/engineering/structural/10-roman-engineering-tricks.htm


http://www.ehow.com/list_7599352_uses-roman-aqueducts.html