

# A Drop in the Bucket – Ancient Egyptian Irrigation

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**Grade Level** 6  
**Duration** 3 class periods

## National Standards

### GEOGRAPHY

#### Element 5: 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

### NEXT GENERATION OF SCIENCE STANDARDS NEXT GENERATION OF SCIENCE STANDARDS

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.

## AZ Standards

### ELA

#### Reading

#### Integration of Knowledge and Ideas

**6.RI.7** Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

#### Writing

#### Production and Distribution of Writing

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

### SCIENCE

#### Life Science

**6.L2U1.14** Construct a model that shows the cycling of matter and flow of energy in ecosystems.

### MATHEMATICS

#### Ratios of Proportional Relationships

**6.RP.A.1.** Understand the concept of a ratio as comparing two quantities multiplicatively or joining/composing the two quantities in a way that preserves a multiplicative relationship. Use ratio language to describe a ratio relationship between two quantities.

## Arizona Social Science Standards

### GEOGRAPHY

**Human-environment interactions are essential aspects of human life in all societies.**

**6.G2.1** Compare diverse ways people or groups of people have impacted, modified, or adapted to the environment of the Eastern Hemisphere.

**Examining human population and movement helps individuals understand past, present, and future conditions on Earth's surface.**

**6.G3.1** Analyze how cultural and environmental characteristics affect the distribution and movement of people, goods, and ideas.

**6.G3.2** Analyze the influence of location, use of natural resources, catastrophic environmental events, and technological developments on human settlement and migration.

### HISTORY

**The development of civilizations, societies, cultures, and innovations have influenced history and continue to impact the modern world.**

**6.H1.1** Compare the development and characteristics of historical cultures and civilizations from different global regions within designated time periods.

## SIOP Elements



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## A Drop in the Bucket – Ancient Egyptian Irrigation

<b>Preparation</b> Adapting content Linking to background Linking to past learning Strategies used	<b>Scaffolding</b> Modeling Guided practice Independent practice Comprehensible input	<b>Grouping Option</b> Whole class Small groups Partners Independent
<b>Integrating Processes</b> Reading Writing Speaking Listening	<b>Application</b> Hands on Meaningful Linked to objectives Promotes engagement	<b>Assessment</b> Individual Group Written Oral

### Arizona English Language Proficiency Standards

#### 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 1: The student will express his or her thinking and ideas in a variety of writing genres. The student will express his or her thinking and ideas by using a variety of writing genres, as demonstrated by:**

B-3: taking notes using a teacher selected and student created graphic organizer or cloze notes.

**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.

## Overview

Engineering and math concepts were utilized in ancient civilizations. Man learned to harness and to begin directing the forces of nature. Man also created inventions to facilitate the use of available resources for agricultural needs, sustenance, and the growth of culture.

## Purpose

In this lesson, students will learn that human ingenuity enabled the ancient Egyptian culture to survive and to achieve wealth and power. The use of irrigation and the use of the lever in the invention of the shadoof (shaduf) were integral to managing the annual flooding of the Nile River. Students will connect this knowledge with the principles of engineering. This lesson has adaptations for English Language Learners (ELLs).

## Key Vocabulary

**irrigation:** man-made way to water land to grow crops

**shadoof:** a machine used to lift water for irrigation purposes

**lever:** a bar used to raise an object by pushing down on the other end

**fulcrum:** a support about which a lever turns

**counterweight:** a weight that balances another weight

**load:** weight supported by the lever

## Materials

- Computer/internet/projector
- Vocabulary Cards
- Vocabulary Test and Answer Key
- Log Sheet (8 per student)



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- Answer Key for Captions and Visuals in the PowerPoint
- PowerPoint Presentation and Assessment Checklist
- Social Studies Assessment and Answer Key
- Timer
- Picture of a Shadoof Labeled
- Any items available to demonstrate classes of lever
  - Class 1 – balance scale, crowbar, scissors
  - Class 2 – wheelbarrow, metal nutcracker, bottle opener, door hinge
  - Class 3 – golf club, tennis racket, baseball bat, broom
- Plan Sheet for a Shadoof
- Science and Engineering Rubric
- Shadoof and Ratio Problems and Answer Key
- Shadoof Math Assessment and Answer Key
- For each group, a Shadoof Building Materials Bag containing:
  - Tubular cardboard clothes hanger attachments-- (Most dry cleaners will donate.)
  - Four bathroom-sized paper cups
  - Paper clips
  - Metal brads
  - Roll of pennies
  - Four 12" pieces of string
  - Sandwich bag that zips up
- Each group will also need:
  - Scotch tape
  - Markers
  - Scissors
  - Ruler

## Objectives

The student will be able to:

1. Identify how the ancient Egyptians used irrigation.
2. Describe how a lever (shadoof) was used to take advantage of the flooding of the Nile to develop irrigation systems.
3. Determine a central idea of an image and text.
4. Integrate information from a PowerPoint on the history of irrigation to demonstrate understanding of irrigation in ancient Egypt.
5. Collaborate within a group.
6. Solve ratio problems.
7. Use engineering principles to create a shadoof.

## Procedures

Teacher Background Information can be found at:

<http://en.wikipedia.org/wiki/Shadoof>  
[http://en.wikibooks.org/wiki/Wikijunior:How\\_Things\\_Work/Lever](http://en.wikibooks.org/wiki/Wikijunior:How_Things_Work/Lever)  
<http://www.answers.com/topic/lever>

[http://en.wikipedia.org/wiki/Ancient\\_Egyptian\\_agriculture#Basin\\_Irrigation](http://en.wikipedia.org/wiki/Ancient_Egyptian_agriculture#Basin_Irrigation)  
[http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng\\_Design\\_5-12.html](http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html)  
<http://enchantedlearning.com/physics/machines/Levers.shtml>

## SESSION ONE

### Engage:

1. Ask the students if they know how a bucket changed the culture of Ancient Egypt. Discuss possible answers. (**Preparation: Linking to past learning**)
2. Project the Vocabulary Cards and explain the vocabulary that this lesson will use. Post Vocabulary Cards on the Word Wall.

### Explore:

3. Show students the first 10 slides in PowerPoint presentation on irrigation in Egypt. Don't discuss any of the concepts of the two presentations.

### Explain:

4. Distribute the packet of log sheets to the students. Tell students they will see the PowerPoint presentation again on technology and engineering in ancient Egypt. (**Application: Linked to objectives**)
5. When the slide comes on, students will copy the number and title of the slide on their log sheet. Students will have 2 minutes to study each image and caption from PowerPoint. (**Integrating Processes: Reading**)

### Elaborate:

6. Students will draw a quick depiction and write a sentence about each slide. (**Integrating Processes: Writing**)
7. Do Number 1 as a sample together. Get feedback on what they can reasonably draw and write in two minutes. (**Scaffolding: Comprehensible input**) Set timer so each slide will be shown for 2 minutes, then go to the next slide. (**Scaffolding: Independent practice**)
8. Upon completion of all 10 slides, go back and show each slide for 10 seconds so they can complete unfinished log sheets. (**Preparation: Strategies used**)
9. The next five slides will be done in conjunction with the teacher demonstration on the three kinds of levers. It is important that teacher is conversant with Teacher Background and Notes above. On three separate 4 x 6 cards, print "FULCRUM," "LOAD," and "EFFORT."
10. Students should complete log sheet after each of the following slides.



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- Show slide 11 on how a lever works. Show the students that the effort is 'you.'
- Show slide 12 on class one lever. Have students come up and identify the fulcrum, the load (resistance), and the effort (you) on a pair of scissors or a crowbar. Have 3 students hold a card by the proper part of your examples. Do this for each class of lever.
- Show slide 13 on class 2 lever – Do the same procedure as the above slide with wheelbarrow, metal nutcracker, bottle opener, or door hinge.
- Show slide 14 on class 3 lever – Same procedure as above with broom, baseball bat, tweezers, golf club, or tennis racket.
- Have students remember “FLE123” to remember the class of lever and draw it on the board.  
F (fulcrum) in the middle – class 1 lever  
L (load) in the middle – class 2 lever  
E (effort) in the middle – class 3 lever
- Show slide 15 on the shadoof and discuss with class.
- Show slide 16 and discuss: work = force x distance

### Evaluate:

11. Give students 5 minutes to study and review their Log Sheets with a partner to clarify what they do not understand. **(Grouping Option: Partners)**
12. Give students the Social Studies Assessment. Collect assessment and Log Sheets.
13. Grade Log Sheets with the PowerPoint Presentation Assessment Checklist. **(Assessment: Written)**
14. Show YouTube video Shadoof 123.

## SESSION TWO

### Engage:

1. Ask, “What are the advantages of using a shadoof?” **(Grouping Option: Whole class)**
2. Review the principles of the shadoof. Ask, “What class of lever is the shadoof?” (class one) **(Preparation: Linking to background)**
3. Draw a diagram of a shadoof on the board. (Refer to slide # 11 from Session One.)
4. Write these words on the whiteboard: fulcrum, lever, load, and counterweight. **(Integrating Processes: Reading)** Show the Picture of a Shadoof Labeled. Call on students to come up to the whiteboard and draw a shadoof and label the parts. **(Grouping Option: Independent)**

5. Ask students to match the correct shadoof part to the correct vocabulary word. **(Grouping Option: Independent)**
6. Tell them the advantage of using the shadoof. (Because of the lever and the counterweight, a person can lift more weight with a shadoof than without it.)

### Explore:

7. Explain, “Today, we’re going to meet an irrigation engineer. Listen carefully for how engineers do their work.” Show video of Dr. Ed Martin. Discuss what he says about basin irrigation, how irrigation has changed since ancient times, how productive the soil is in Arizona, and what does it take to be an engineer. <http://youtu.be/HxCTJuPls5U> **(Application: Meaningful)**

### Explain:

8. In the YouTube video, Dr. Martin encouraged students to think like engineers.
9. Now is their chance! Tell students they are going to design and build their own shadoofs in groups of four. **(Application: Linked to objectives)** **(Application: Hands on)**
10. Project the last slide of the PowerPoint on the screen so students can refer to it during construction. The specifications are:
  - The shadoof must be free-standing.
  - The long end of the lever needs to be at least twice as long as the short end.
  - The lever must be stiff enough to pivot at the fulcrum.
  - Use the same materials (pennies) for the counterweight and the load. Notice that the amounts will be different if the lever is balanced.
  - They must label the parts of their creative model. **(Integrating Processes: Reading)**
  - They must come together to discuss, create, listen, and ask questions.
  - Each group will have a scribe.
11. Group students. **(Grouping Option: Small groups)**

### Elaborate:

12. Distribute group bags containing cardboard clothes hanger rods, paper cups, paper clips, metal brads, rolls of pennies, and four 12” pieces of string. Provide each group with scotch tape, markers, rulers, and scissors.
13. Pass out Plan Sheet for Shadoof. Explain that before they build, they must complete a plan sheet. **(Preparation: Strategies used)** On the plan sheet, the group must decide how they are



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going to build their shadoof. All group members should participate. The scribe should record the group responses to the questions on the plan sheet. (Allow 10 minutes).

14. Start all groups together in the building phase and give them 15 minutes to complete their shadoof out of the materials available. Have them record on their plan sheet how many pennies it takes to lift the load bucket to balance the shadoof with three different loads. **(Application: Promotes engagement)**

### Evaluate:

15. Students will go on a shadoof museum walk. Each group will look at every shadoof and observe the following factors: **(Scaffolding: Guided Practice)**

- o Did the shadoof work?
- o Did the shadoof balance the load and the counterweight?
- o Was the shadoof properly labeled?
- o Were materials used wisely?
- o How would they improve their shadoof based on the museum walk?

16. Students then return to their groups and discuss how they might change their design. **(Integrating Processes: Speaking)**
17. Each group chooses a person to share proposed changes with the class.
18. At end of session, collect Plan Sheet for a Shadoof. **(Assessment: Group)** Have groups gather the pennies and put in sandwich bag. Scribe returns the pennies to the teacher.

## SESSION THREE

### Engage:

1. Take a survey of your students. **(Grouping Option: Whole class)** Write the following quantities and record them on the board.
  - o Number of students who rode the bus to school today, compared to those who did not
  - o Number of people wearing long sleeves to short sleeves
  - o Number of boys to girls

### Explore:

2. Show a picture of a dog (or any animal.) How many legs? How many ears? Eyes? Tails? **(Preparation: Adapting content)** Show a picture of another animal and ask similar questions.

### Explain:

3. Explain to students that a ratio is a relationship between 2 quantities. Look back at the survey information for a simple ratio. (15 boys and 15

girls would be 1:1) (20 long sleeves to 10 short sleeves would be 2:1) Write this information as a ratio. Then draw a T chart on the board. Label columns heads and tails.

4. Tell students to think back to the animal pictures. In some cases, the ratio of legs to tails is 4 to 1. It is expressed as 4:1 Draw another T chart and ask about 3 dogs. Would the ratio be the same? Explain that 12 legs would represent 3 tails, but the 4:1 ratio is the same.

### Elaborate:

5. Tell students that ratios are used daily by people during work and play. Show the NASA video on ratios.  
<http://www.youtube.com/watch?v=GVte5q8jz7M> **(Preparation: Strategies used)**

### Evaluate:

6. Pose this problem on the board. The well under the bucket of the shadoof can distribute 2 quarts of water per second. How much water can the well distribute in sixty seconds?  
$$\frac{2 \text{ quarts}}{1 \text{ second}} = \frac{?}{60 \text{ seconds}}$$
  
Cross multiply 2 (quarts) x 60 (seconds) = 120 quarts. The ratio of quarts to seconds is 2:1. Whether there are 2 quarts or 120 quarts, the ratio is still 2:1.
7. Distribute the Shadoof and Ratio Problems. Have students work in pairs to complete the worksheet. **(Grouping Option: Partners)**
8. Go over the answers and help those who made mistakes. Give students the Shadoof Math Assessment. **(Assessment: Individual)**

## Assessment

### ELA and Social Sciences

Students will score 80 % or higher on the PowerPoint Assessment Checklist for a reading grade. There are 32 total checkmarks possible for each student. A checkmark is given if they understand the image portrayed, not for artistic skills. A checkmark is given if they write a sentence explaining the main idea or topic of the caption. Figure the percentage based on number of checks.

### Social Sciences

Students will score 80% or higher on the Social Studies Assessment. Grade the Social Studies Assessment with the provided answer key.

### Science





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Students will score 80% or higher on the Science and Engineering Rubric.

### Mathematics

Students will score 80% or higher on the Shadoof Math Assessment and the Shadoof and Ratio Problems assessment.

### ELA

Students will score 80% or higher on the Vocabulary Test.

## Extensions

1. Compare and contrast ancient Egyptian irrigation with modern irrigation used in the United States.
2. Research the six simple machines.  
<http://www.mikids.com/Smachines.htm>
3. Using Mike Molyneaux' website, <http://www.catchpenny.org/mmbuild.html>, Create real-life examples of levers used in building Egyptian pyramids.
4. Check out irrigation timeline  
<http://www.irrigationmuseum.org/exhibit2.aspx>

5. Check out shadoof irrigation (1.20 min)  
<https://www.youtube.com/watch?v=ZEXE5eEaQAc>
6. Have students make ratio cartoons. Google ratio cartoons for examples.

## Sources

<http://www.bookrags.com/research/water-pump-woi/>  
<http://www.catchpenny.org/mmbuild.html>  
<http://www.riseofthewest.net/thinkers/wittfogel105.htm>  
<http://www.waterhistory.org/histories/nile/t1.html>  
<http://www.irrigationmuseum.org/exhibit2.aspx>  
<http://www.youtube.com/watch?v=GVte5q8jz7M>

EiE “What is Engineering?” HighTech U Teacher Academy: Critical Thinking: Engineering Design Challenge

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