



CLASSROOM ACTIVITY

Every Drop Counts

OBJECTIVES

Students will be able to:

- **Construct** their own water irrigation system
- **Evaluate** the pros and cons of an irrigation system, including its efficiency and waste
- **Develop** irrigation system design modifications to help reduce water used or wasted
- **Assess** another irrigation system design and apply constructive critiques in order to optimize their own design

OVERARCHING QUESTION

How can irrigation systems be redesigned to reduce water waste?

ACTIVITY SUMMARY

Students will explore the components of irrigation systems used around the world. They will investigate the challenges of different systems and develop an understanding of how irrigation systems can both contribute to and help our global water crisis. Students will ultimately redesign an irrigation system with the goal of reducing water usage or water waste.

MATERIALS

- Introduction Activity:
 - Enough of the following for one-quarter of the class:
 - 3 empty paper cups or bowls
 - 4 straws
 - Clay or play dough
 - Tape
 - A couple feet of aluminum foil
 - For the class to share:
 - Container of water or access to tap water
 - Supplies to clean up water spills
- [Irrigation Water Use Overview](#) article, one per student
- Designing Solutions Handout
- Devices with internet access, at least enough for half the class
- Copy paper, enough for about one-quarter of the class

CHALLENGE

1. **Water Challenge:** Divide the class into groups of four students, and distribute the materials listed under Introduction Activity to each group. Then explain the challenge. Each group will have about five minutes to try to develop a system that will transport water from one cup/bowl and then distribute it into the other two cups/bowls. The water should be transported at least two feet, and the distribution should be as equal as possible.
2. Once students have attempted this challenge, bring the class back together and ask them to share some of the challenges they encountered. Tell students that many similar challenges are faced by people who develop and use irrigation systems around the world.
3. Explain that an irrigation system is a human-made way of bringing water to crops, rather than simply relying on rainfall. Though irrigation systems can be difficult to construct, it's important to take the time to make sure they are efficient. Around the world, more than 40% of the world's population are affected by water scarcity.¹
4. Distribute one copy of the "Irrigation Water Use Overview" article to each student and read it aloud as a class. As students take turns reading, instruct the class to annotate it for key details that explain the pros and cons of irrigation.
5. Tell students that today they will be challenged to select one irrigation technique, analyze its pros and cons, and propose a solution to reduce either the amount of water that the system uses or the amount of water that the system wastes.
6. Distribute one Designing Solutions Handout to each student, and then elaborate on the challenge by reading aloud the bullets listed under *Step 1: Define the Challenge*. Students should complete this challenge with the groups they formed for the irrigation simulation.
7. After answering questions, prepare student groups to perform research to better understand the challenge.
 - Write the following website on the board and explain that students will find an overview of six different irrigation systems detailed here. Groups should take a moment to choose one together and then learn more about this method.
Website: usgs.gov/special-topic/water-science-school/science/irrigation-methods-a-quick-look
 - Explain that groups will have about 10 minutes to perform research. At the end of the research period, each group should understand how their irrigation system functions, as well as its pros and cons. Encourage groups to divide the research responsibilities and remind students to only take notes on information that may be relevant to the challenge.

DESIGN

1. Bring the class back together and explain that it's now time to develop a solution to the challenge. Call on a student to read the handout's *Step 2: Create a Design* section aloud.
2. Encourage students in each group to take on the roles of agricultural engineers and environmental engineers. Explain that:
 - Agricultural engineers combine a background in farming and technology to design new and improved agricultural equipment and processes. Students in this career will keep the interest of farmers' crops in mind
 - Environmental engineers apply their science and engineering background to develop solutions to environmental problems. Students in this job will keep the interest of the environment in mind
 - These two careers will work together to design a new and improved irrigation system
3. Once students have selected a career, tell the class that they will have about 15 minutes to propose a modification to the irrigation system that they researched. They must create a sketch of a new design that reduces the amount of water used or reduces the amount of water wasted. They must be ready to explain and justify the rationale behind their design solution!

SOLVE

1. When there are about 10 minutes left in the class period, pair each student group with another student group.
2. Explain that in order to optimize (e.g. assess and improve upon) their design, collaboration is important, so groups will be sharing their designs with each other.

As each group shares, they must:

 - Pretend that they are presenting their plan to a group of local farmers who will potentially use this system
 - Explain how the original irrigation system functioned, the changes they made, and why/how these changes will help reduce the amount of water used or the amount of water wasted

As each group listens, they must:

 - Listen, ask questions, and provide suggestions from the perspective of a farmer who may use this irrigation system
3. Go on to explain that once both designs have been shared, groups should complete the *Step 3: Analyze Solutions* portion of the handout.

STANDARDS

Next Generation Science Standards

- Earth and Human Activity
 - MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- Engineering Design
 - 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.
- Earth's Systems
 - Disciplinary Core Idea - ESS2.C: The Roles of Water in Earth's Surface Processes: Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)

ITEEA Technological Literacy Standards

- Standard 1. Students will develop an understanding of the characteristics and scope of technology. In order to comprehend the scope of technology, students should learn that:
 - F. New products and systems can be developed to solve problems or to help do things that could not be done without technology.
 - G. The development of technology is a human activity and is the result of individual and collective needs and the ability to be creative.
- Standard 8: The Attributes of Design Inquiry. In order to realize the attributes of design, students should learn that:
 - E. Design is a creative planning process that leads to useful products and systems.
 - F. There is no perfect design.
 - G. Requirements for design are made up of criteria and constraints.
- Standard 15. Students will develop an understanding of and be able to select and use agricultural and related biotechnologies. In order to select, use, and understand agricultural and related biotechnologies, students should learn that:
 - Technological advances in agriculture directly affect the time and number of people required to produce food for a large population.

Source

1. "UN-World Bank panel calls for 'fundamental shift' in water management." UN News. news.un.org/en/story/2018/03/1004982.

STEP 1: DEFINE THE CHALLENGE

Your challenge is to:

1. select and research one irrigation system.
2. evaluate the pros and cons of this system, paying careful attention to the amount of water used/reused as well as the amount of water waste it produces.
3. propose at least one way to modify this system in order to reduce the amount of water used or reduce the amount of water wasted.

List notes below as you learn more about this system and evaluate its pros and cons.

STEP 2: CREATE A DESIGN

Work with your group to propose a change to the irrigation system's design. Your goal is to reduce the amount of water that is uses or wastes. Consider the research you performed and the system's pros and cons as you develop your design.

Use the space below to brainstorm ideas and then work as a team to design a model of your solution on a separate piece of paper.

STEP 3: ANALYZE SOLUTIONS

Think about the feedback your design received, and then either:

1. Consider how you could alter your design based on this feedback, and work as a group to describe at least two design optimizations below.

or

2. Consider how you could improve the communication of your design to local farmers. What key points may help farmers understand how your design will benefit not only their farm, but the world at large? Record these points below.