

IRRIGATION CHALLENGE

STEM Camp

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Tennessee 4-H Youth Development

Irrigation Challenge – STEM Camp

Day 1

Skill Level

Beginner

Learner Outcomes

The learner will be able to:

- Identify the steps of the Engineering Design Process.
- Use the engineering design process to build a marshmallow tower.
- Create a plan to solve a real-world problem following the steps of the Engineering Design Process.

Educational Standard(s) Supported

EVSC.LS2.6

4.ETS1.1.

4.ETS2.2

5.ETS1.1

5.ETS1.2

Success Indicator

Learners will be successful if they:

- Complete the Ask, Imagine and Plan stages of the Engineering Design Process.

Time Needed

90 Minutes

Materials List

Irrigation Challenge Handout
STEM Challenge Planning Sheet
Toothpicks
Mini Marshmallows
Pens or Pencils
Large Chart Paper and Markers
Painter's Tape

Introduction to Content

This lesson introduces the concept of irrigation and the Engineering Process. Students will compare and contrast design ideas to find the strongest and most effective design. They will also focus on solving real-world problems.

Introduction to Methodology

Students will first receive a quick lesson about the purposes and practices of irrigation, as well as an introduction to thinking like an engineer. Students will then be split into small groups to explore design ideas for their own irrigation system model. Before making their final product, students will have the opportunity to practice using the engineering process within their small groups with a short activity.

Author

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Terms and Concepts Introduction

- Irrigation: The process of moving water from one place to another to help plants grow.
- Concept of photosynthesis and plant care.
- Engineering Process: Ask, Imagine, Plan, Create and Improve.

Setting the Stage and Opening Questions

Introduce the need for water when growing crops by engaging students in a discussion. Ask students:

- **What are some things that plants need to grow?** (*Sunlight, soil, water, nutrients, etc.*)
- **What happens to plants if they don't get enough water?** (*They might die, turn brown, etc.*)
- **What are some ways that people get water to plants if they don't get enough water from rain?** (*Carry buckets from river, etc.*)

Tell students: **This week we are going to learn about a process called irrigation. Does anyone know what "irrigation" means?** Allow students to share their guesses. (*Irrigation is the process of moving water from one place to another to help plants grow.*)

Ask students if they have seen any examples of irrigation in their village and allow them to share examples. Direct the discussion to include the following important points:

- Irrigation is moving/controlling the movement of water.
- Irrigation is used to water crops/plants.
- Irrigation techniques include tunnels, canals, aqueducts, tanks, pumps, ditches, hoses, pipes, etc.

Tell students: **In this lesson, you are going to pretend to be engineers. What is an engineer?** (*A person who designs, builds or maintains engines, machines or public works.*) **You and a team of your fellow engineers are going to work with a small group to figure out how to build an irrigation system to water crops in your school garden. By the end of this lesson you will be able to:**

- Identify the steps of the Engineering Design Process.
- Use the Engineering Design Process to build a marshmallow tower.
- Create a plan to solve a real-world problem following the steps of the Engineering Design Process.

Experience

Divide students into teams of three. Pass out the Irrigation Challenge Sheet and ask teams to take three minutes to read the challenge sheet to identify:

- **What are you being tasked with accomplishing?**
 - Develop and build a plan to move 250mL water over 1 meter.

Tips for Engagement

Divide students into groups of mixed ability, age and gender to make the groups stronger through their diversity.

- **What are the criteria (the standards by which your product will be judged)?**
 - Maximize the speed at which the water moves while minimizing the loss of water along the way.
- **What are the constraints (limitations or restrictions)?**
 - Use everyday items to build your irrigation system.

Share

Ask students to use the back of the Challenge Sheet to make a list of all the things they need to know to accomplish their task. Give students three minutes to compile their list, then aggregate responses on chart paper.

Tell students: **In this lesson, you are going to work in your teams to solve the challenge of moving water across a distance. Before you get started trying to solve this challenge, I want to share with you a problem-solving tool called the Engineering Design Process.**

Process

Introduce the Engineering Design Process through the following important points. Incorporate examples of each step along the way.

- The Engineering Design Process is a series of steps that engineers use to guide them as they solve problems.
- It is a process that is *cyclical*, meaning you can begin at any step or move back and forth between steps numerous times.
- There are five steps:
 - Ask:
 - Define the problem.
 - What is the issue or problem you need to solve?
 - What are the criteria and constraints?
 - Imagine:
 - Develop solutions by brainstorming ideas.
 - Consider all options, then choose the best one.
 - Plan:
 - Develop a plan that meets the criteria and constraints.
 - Identify materials needed.
 - Create:
 - Build a prototype.
 - Test the prototype — Does it work?
 - Evaluate the prototype — Does it solve the problem? How could it be better?
 - Improve:
 - Modify the prototype to address weaknesses.
 - Retest the solution to see if it works better now.

Life Skill(s)

Gather relevant information for decision-making (4th – Hands)

As part of a group, identify and agree on a common task (set a goal). (5th – Hands)

Generalize

Practice the Engineering Design Process.

Tell students: **Before we dive into your big challenge as engineers to see if you can build a simple irrigation system out of everyday materials, let's practice with some other fun materials.**

Distribute supply bags to students with marshmallows and toothpicks.

Tell students: **In your bags, you all have the same materials. Take a quick look and see what you have. If you eat your materials now, you won't have what you need to win this challenge!**

Allow students about one minute to explore their bags. Ask students to share what they found.

Tell students: **Now, here is your challenge: In your team, I'd like you to build the tallest freestanding (This means you can't hold it up, prompt it up, etc. It has to stand all on its own for at least 10 seconds) tower you can, using only the materials provided, in just two minutes. But before you just jump right in, let's remember what we just learned about the Engineering Design Process.**

Lead students through an exploratory process that follows the Engineering Design Process:

- Ask (1-2 minutes)
 - What is your challenge? (Build a marshmallow tower.)
 - What are the criteria? (Create the tallest possible tower in two minutes.)
 - What are the constraints? (Use only the materials provided; must be freestanding for at least 10 seconds.)
- Imagine (1-2 minutes)
 - What shapes can you make with the marshmallow and toothpicks?
 - Which do you think are the strongest?
 - Which do you think will NOT work?
- Plan (2 minutes)
 - Decide as a group how you will build your structure.
 - What roles will all the group members play?
- Create (2 minutes)
 - Build your tower!
- Improve (5 minutes)
 - For the purpose of time, combine the test and improve steps here. Instruct each group to release their towers so they are freestanding. Make sure each group's tower stands for at least 10 seconds. Then use a measuring tape to see which is the tallest. Give a prize to the group with the tallest tower.

Lead students through a quick debrief:

- **Which shapes were the strongest?**
- **What building strategies did not work well?**
- **How did your final designs differ from your initial plans?**
- **What did you learn about using the Engineering Design Process in this challenge?**

Apply

Students will now create an irrigation design and identify materials.

Tell students: **Now that you've had a chance to learn about and practice the Engineering Design Process, let's return to your irrigation challenge. We've already identified the challenge, criteria and constraints, so we've already worked through the first step.**

Distribute the Irrigation STEM Challenge Planning Sheet to students and ask them (in their teams) to record the important information in the Ask section (two to five minutes). Review the challenge, criteria and constraints.

Ask students:

- **What step is next in the Engineering Design Process?** (Imagine.)
- **What sorts of things does your team need to do in the Imagine step?** (Consider possible solutions to the challenge, discuss the options and choose the best one.)

Allow students about five minutes to complete this step. Encourage them to take notes on their planning sheet. Give students a chance to share the ideas that their group developed.

Ask students:

- **What step is next in the process?** (Plan)
- **What does your team need to do in this step?** (Create a design that meets the challenge, criteria and constraints and identify materials.)

Give students about five minutes to use their planning sheets to create a plan. Remind students that this is the critically important step to complete today because they will need to gather their everyday materials before you meet again tomorrow! Encourage them to build their plans around materials they can actually find at home or in nature.

Ask students to share the types of materials they are going to scavenge to use tomorrow. Ask them how they will improvise if they cannot find the materials they need.

Review

Tell students:

We started today by working in teams. We also established that by the end of the day, you would be able to (refer to objectives on the chart paper):

- Identify the steps of the Engineering Design Process.
- Use the Engineering Design Process to build a marshmallow tower.
- Create a plan to solve a real-world problem following the steps of the Engineering Design Process.

Who can remind me of the steps in the Engineering Design Process? (Allow a few volunteers to share the steps. If you have time, ask volunteers to share how they demonstrated each step through the day.) **You have all created your plan for developing an irrigation system.**

Tomorrow, we will continue working on your plan to build and test it as well as try out another fun challenge!

Remind students to gather their everyday materials before you meet again tomorrow.

Supplemental Information

Educational Standards Met

EVSC.LS2.6. Evaluate the interdependence among major biogeochemical cycles (water, carbon, nitrogen, phosphorus) in an ecosystem and recognize the importance each cycle has in maintaining ecosystem stability.

4.ETS1.1 Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.

4.ETS2.2. Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.

5.ETS1.1. Research, test, re-test, and communicate a design to solve a problem.

5.ETS1.2. Plan and carry out tests on one or more elements of a prototype in which variables are controlled and failure points are considered to identify which elements need to be improved. Apply the results of tests to redesign the prototype.

Tennessee 4-H Youth Development

Irrigation Challenge – STEM Camp

Day 2

Skill Level

Beginner

Learner Outcomes

The learner will be able to:

- Apply the steps of the Engineering Design Process to solve a real-world problem.
- Demonstrate effective teamwork.

Educational Standard(s) Supported

EVSC.LS2.6

4.ETS1.1.

4.ETS2.2

5.ETS1.1

5.ETS1.2

Success Indicator

Learners will be successful if they:

- Build a prototype.
- Test the prototype.
- Evaluate the prototype.

Time Needed

90 Minutes

Materials List

Materials for building irrigation system

Water measured in 250mL increments

Meter stick

Introduction to Content

This lesson reinforces the concept of irrigation and the engineering process. Students will work in groups to utilize their creativity and problem-solving skills to finalize the designs of their irrigation systems.

Introduction to Methodology

This lesson is Day 2 of the Irrigation Challenge – STEM Camp lesson plan. In this lesson, students will work in teams to execute the designs they brainstormed the previous day. Students will have the opportunity to experiment with trial and error as they continue to search for their best design for the task.

Author

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Terms and Concepts Introduction

Irrigation: The process of moving water from one place to another to help plants grow.

Concept of photosynthesis and plant care.

Engineering Process: Ask, Imagine, Plan, Create and Improve.

Setting the Stage and Opening Questions

Tell students: **Yesterday, your team of engineers was presented with the challenge of using everyday materials to build an irrigation system that can move 250mL of water over 1 meter. You worked with your team to move through the Ask, Imagine and Plan stage. Today, we are going to work on the Create stage. By the end of our time together, you will be able to:**

- **Apply the steps of the Engineering Design Process to solve a real-world problem.**
- **Show that you can work effectively in a team.**

Remind students of the important points in Create:

- Build a prototype.
- Test the prototype — Does it work?
- Evaluate the prototype — Does it solve the problem? How could it be made better?

Apply (continued)

Tell students: **Yesterday, you identified the everyday materials you would need to find to build your prototypes. If you were able to find all of your materials, you are ready to start building. If you weren't able to find materials from around your home, take some time now and take a walk around the school to see what you can find that might be useful.**

Encourage students to record notes about their progress on their *Challenge Planning Sheet* from yesterday. Tell students that when they believe they are ready to test their irrigation system, they should come to you.

While students are working, ask them questions about their plans, particularly to explain their rationale for why they made certain choices.

After students have been working for about 20 minutes, have all groups stop working and engage the whole group in a “check-in.” Ask each group to share their answers to the following questions:

Tips for Engagement

- Circulate around the room to observe the students working.
- Answer questions and facilitate problem-solving as students run into barriers and problems.

- **Tell us a bit about your progress so far. What are you working on now?**
- **What problems have you encountered? How have you addressed those problems?**
- **What will your next steps be?**

Tell students they will have another 15 minutes to work today. During this time, they should wrap up their tests and finalize their designs.

Review

Tell students: **We've spent our time together working in teams on a STEM engineering challenge. We also established that by the end of today you would be able to:**

- **Apply the steps of the Engineering Design Process to solve a real-world problem.**
- **Show that you can work effectively in a team.**

Ask students:

- **What do you have left to finish up tomorrow? What step is left in the Engineering Design Process?**

Tell students:

- **While you are at home this afternoon and tonight, see if you can find examples of other real-world problems at home or in your village where you might use the Engineering Design Process to find a solution to the problem.**
- **Tomorrow, you will finish up your designs and each team will test their design in front of the whole group.**

Life Skill(s)

Gather relevant information for decision-making. (4th – Hands)

As part of a group, identify and agree on a common task (set a goal). (5th – Hands)

Supplemental Information

Educational Standards Met

EVSC.LS2.6. Evaluate the interdependence among major biogeochemical cycles (water, carbon, nitrogen, phosphorus) in an ecosystem and recognize the importance each cycle has in maintaining ecosystem stability.

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Tennessee 4-H Youth Development

Irrigation Challenge – STEM Camp

Day 3

Skill Level

Beginner

Learner Outcomes

The learner will be able to:

- Apply the steps of the Engineering Design Process to solve a real-world problem.
- Use strong communication skills to explain your design plan to others.

Educational Standard(s) Supported

EVSC.LS2.6

4.ETS1.1.

4.ETS2.2

5.ETS1.1

5.ETS1.2

Success Indicator

Learners will be successful if they:

- Complete the Improve stage of the Engineering Design Process.

Time Needed

90 Minutes

Materials List

Prototypes from Day 2 of this lesson

Introduction to Content

This lesson reinforces the concept of irrigation and the engineering process. Students will work in groups to utilize their creativity and problem-solving skills to finalize the designs of their irrigation systems. Students will then reflect on their successes and failures in this activity.

Introduction to Methodology

This lesson is Day 3 of the Irrigation Challenge — STEM Camp lesson plan. In this lesson, students will reflect on the experimentation process for their irrigation system designs and settle on a final design idea. The ideas will then be shared with the rest of the class. Students will be given an opportunity to reflect on the similarities and differences of the designs and the role of the Engineering Process throughout the week's activities.

Author

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Terms and Concepts Introduction

Irrigation: The process of moving water from one place to another to help plants grow.

Concept of photosynthesis and plant care.

Engineering Process: Ask, Imagine, Plan, Create and Improve.

Setting the Stage and Opening Questions

Lead students through a quick review of what you did yesterday:

- **What steps in the Engineering Design Process did we use yesterday? (*Create*)**
- **Before you left yesterday, I asked you to see if you could find examples of other real-world problems at home or in your village where you might use the Engineering Design Process to find a solution to the problem. What examples did you find?**

Tell students: **This week, your team of engineers has been working with everyday materials to build an irrigation system that can move 250mls of water over 1 meter. You worked with your team to move through the Ask, Imagine, Plan and Create stages. Today, we are going to finalize the Improve stage and present your final design to the whole group. By the end of our time together, you will be able to:**

- **Apply the steps of the Engineering Design Process to solve a real-world problem.**
- **Use strong communication skills to explain your design plan to others.**

Remind students of the important points in Improve:

- **Modify the prototype to address weaknesses.**
- **Retest the solution to see if it works better now.**

Apply (continued)

Allow students about 10 minutes to finish testing and final designs.

Invite students to present their final products to the whole class. Encourage the other students to ask questions about why certain design elements were included, why they chose particular materials, etc.

Lead the whole group in a debrief discussion:

- **How were the designs from one group similar to another? How were they different?**
- **Was there one design that worked better than the others? (*The speed of water movement, minimized water loss, etc.*)**
- **In what ways did using the Engineering Design Process allow you to work as a team to meet your challenge?**

Tips for Engagement

Write sample questions on chart paper as models for students to use for their own questions.

Review

Ask students to reflect on what they have learned by using the Engineering Design Process to build their marshmallow towers and their irrigation systems. Ask them to share with a neighbor where they might use this process in their everyday lives. Encourage volunteers to share their reflections with the class.

Life Skill(s)

Gather relevant information for decision-making. (4th – Hands)

As part of a group, identify and agree on a common task (set a goal). (5th – Hands)

Supplemental Information

Educational Standards Met

EVSC.LS2.6. Evaluate the interdependence among major biogeochemical cycles (water, carbon, nitrogen, phosphorus) in an ecosystem and recognize the importance each cycle has in maintaining ecosystem stability.

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5.ETS1.2. Plan and carry out tests on one or more elements of a prototype in which variables are controlled and failure points are considered to identify which elements need to be improved. Apply the results of tests to redesign the prototype.



Imagine you are an engineer and part of a team that has been asked to build an irrigation system to water your school garden. Your challenge is to build a prototype or a model using everyday items you can find at home or in nature. Your model will be successful if it is able to move of 250mL of water over 1m. Make sure your prototype moves the water as quickly as possible (speed) while losing water along the way.

Challenge:

Criteria:

Constraints:



Imagine you are an engineer and part of a team that has been asked to build an irrigation system to water your school garden. Your challenge is to build a prototype or a model using everyday items you can find at home or in nature. Your model will be successful if it is able to move of 250mL of water over 1m. Make sure your prototype moves the water as quickly as possible (speed) while losing water along the way.

Challenge:

Criteria:

Constraints:

STEM CHALLENGE



Ask

Problem:

Criteria:

Constraints:



Imagine

Ideas:

Best Idea:

Pros:

Cons:



Plan

Plan:

Materials Needed:



Create

Prototype:

Test Results:

What do we need to change?



Improve

Modify:

Retest: