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W 1196

DESIGN THINKING

*Future Ready Skills: A College & Career
Readiness Curriculum for High School Freshmen*

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UT EXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE



FUTURE READY

9TH GRADE CURRICULUM

8 Units of Essential Skills

- | | |
|----------------------|--------------------|
| 1. Freshman Bootcamp | 5. Teamwork |
| 2. Who Am I? | 6. Design Thinking |
| 3. Future Me | 7. Communication |
| 4. Decision Making | 8. Growth Mindset |

Future Ready is an innovative college and career readiness curriculum created for students to develop the social, emotional, and interpersonal skills necessary to navigate the world after graduation. Each unit includes lesson plans and student handouts that require minimal preparation.

Students will discover personal strengths, practice effective communication strategies, and explore growth opportunities. The curriculum is aligned with Tennessee Career Exploration course standards and other state standards in STEM, English/Language Arts, and Social Science. It is easily adaptable for Advisory and other settings.

Future Ready was written by former classroom teachers, Dr. Jennifer Richards and Alexis Hall, at the University of Tennessee Institute of Agriculture. It was created in collaboration with Hardeman County Schools Pilot Teachers and Unit 1 Co-Authors, Nikki Boatwright, Jennifer Cox, and Sherri Johnson. For more information, contact jennifer.richards@utk.edu.



Unit 6

The **BIG** Idea

How can I best solve problems?

OVERVIEW

Lesson 1: Irrigation Challenge- Planning

- *Big Idea:* How can I use the Engineering Design Process to solve a challenge?
- *Time:* 45 minutes

Lesson 2: Irrigation Challenge- Prototype

- *Big Idea:* How can I work with a team to build and test a prototype to solve a challenge?
- *Time:* 45 minutes

Lesson 3: Irrigation Challenge- Improve

- *Big Idea:* How can I communicate effectively with a team to improve a prototype?
- *Time:* 45 minutes

Lesson 4: Real-World Problem Solving

- *Big Idea:* How can I select the best strategy to solve a problem?
- *Time:* 45 minutes

OBJECTIVES

Lesson 1: Irrigation Challenge: Planning

- Create a plan to solve a real-world problem following the steps of the Engineering Design Process
- Practice the Ask, Imagine, and Plan stages of the Engineering Design Process

Lesson 2: Irrigation Challenge: Prototype

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

Lesson 3: Irrigation Challenge: Improve

- 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
- Complete the Improve stage of the Engineering Design Process

Lesson 4: Real-World Problem Solving

- Describe the Six Thinking Hats, Seven Steps to Decision Making, and the Engineering Design Process
- Solve a real-world problem using a proven strategy
- Create a poster to justify logical decision making

Irrigation Challenge: Planning

The **BIG** Idea

How can I use the Engineering Design Process to solve a challenge?

AGENDA

Approximately 45 minutes (1 class period)

1. Warm Up (5 minutes)
2. Irrigation Introduction (5 minutes)
3. Ask (10 minutes)
4. Imagine (10 minutes)
5. Plan (10 minutes)
6. Wrap Up (5 minutes)

MATERIALS

- STEM Challenge Planning Sheet (1/group).
- Irrigation Challenge Handout (1/group).

OBJECTIVES

During this lesson, students will:

- Create a plan to solve a real-world problem following the steps of the Engineering Design Process.
- Practice the Ask, Imagine, and Plan stages of the Engineering Design Process.

STANDARDS

- Career Exploration 15: In a team, research, identify, and apply the steps of the problem-solving process (problem identification, brainstorming, evaluating, solution selection, monitoring and revising) in a contextualized situation to determine a solution to a work-related problem presented from a specific career cluster area. Write a proposal outlining and justifying your team's decision or solution. (TN Reading 3, TN Writing 1)
- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

OVERVIEW

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.

PREPARATION

- List the day's **BIG IDEA** and activities on the board.
- Make copies of the **STEM Challenge Planning Sheet** (1/group).
- Make copies of the **Irrigation Challenge Handout** (1/group).
- The lesson recommends students find items at home to complete the challenge for the next class.
 - You can modify this to have students find items in the classroom, or you can provide them with some specific materials.

RESOURCES

Richards, Jennifer. Irrigation Challenge.

<https://extension.tennessee.edu/publications/Documents/W674.pdf>

ACTIVITY STEPS

I. Warm Up (5 minutes)

Ask students to find their Team Expectations lists from last class (Unit 5 Lesson 3).

SAY SOMETHING LIKE: A few weeks ago, we used the Engineering Design Process to complete the Bug on the Run Design Challenge. Who can remind me of the steps in the Engineering Design Process?

Allow a few volunteers to share the steps. Ask volunteers to share how they demonstrated each step throughout the design challenge.

SAY SOMETHING LIKE: Today you will use the Engineering Design Process to create an irrigation design and identify materials. Look at your Team Expectations lists from last class. Remember to follow the expectations today as we begin the design challenge.

II. Irrigation Introduction (5 minutes)

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.*)

SAY SOMETHING LIKE: This unit 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 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.

SAY SOMETHING LIKE: In this lesson, 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.

III. Ask (10 minutes)

Divide students into teams of three. Pass out the **Irrigation Challenge Handout** and ask teams to take 3 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.
- **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.

Write student answers on the board or on chart paper to model filling out the **Irrigation Challenge Handout**.

Give each group a copy of the **STEM Challenge Planning Sheet**.

Ask each group to record the important information in the Ask section (2-5 minutes).

IV. Imagine (10 minutes)

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 5 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.

V. Plan (10 minutes)

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 find at home or in nature.
 - Note: You can modify this to have students find items in the classroom, or you can provide them with some specific materials.

VI. Wrap-Up (5 minutes)

1. Ask students to share the types of materials they are going to scavenge to use in the next class.
2. Ask them how they will improvise if they cannot find the materials they need.
3. Remind students to gather their everyday materials before you meet again.
4. Tell students to make sure they keep their papers for tomorrow. You could also take them up and pass them back out at the beginning of the next class.



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 not 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 not 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:

Irrigation Challenge: Prototype

The **BIG** Idea

How can I work with a team to build and test a prototype to solve a challenge?

AGENDA

Approximately 45 minutes (1 class period)

1. **Warm Up (5 minutes)**
2. **Prototype (35)**
3. **Wrap Up (5 minutes)**

MATERIALS

- Materials for building irrigation system
- Water measured in 250mL increments
- Meter stick
- Students were given these pages in the last class, but you may want to have extra copies on hand.
 - **STEM Challenge Planning Sheet** (1/group).
 - **Irrigation Challenge Handout** (1/group).

OBJECTIVES

During this lesson, students will:

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

STANDARDS

- Career Exploration 15: In a team, research, identify, and apply the steps of the problem-solving process (problem identification, brainstorming, evaluating, solution selection, monitoring and revising) in a contextualized situation to determine a solution to a work-related problem presented from a specific career cluster area. Write a proposal outlining and justifying your team's decision or solution. (TN Reading 3, TN Writing 1)
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

OVERVIEW

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.

PREPARATION

- List the day's **BIG IDEA** and activities on the board.
- Gather the Materials for building irrigation system, water measured in 250mL increments, and meter sticks
- Students were given these pages in the last class, but you may want to have extra copies on hand.
 - **STEM Challenge Planning Sheet** (1/group).
 - **Irrigation Challenge Handout** (1/group).

RESOURCES

Richards, Jennifer. Irrigation Challenge.

<https://extension.tennessee.edu/publications/Documents/W674.pdf>

ACTIVITY STEPS

I. Warm Up (5 minutes)

SAY SOMETHING LIKE: 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?

II. Build a Prototype (15 minutes)

SAY SOMETHING LIKE: Yesterday, you identified the everyday materials you would need to find to build your prototypes. If you were able to find all your materials, you are ready to start building. If you couldn't find materials from around your home, take some time now and take a walk around the classroom 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.

III. Check-In (20 minutes)

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:

- 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.

IV. **Wrap-Up (5 minutes)**

SAY SOMETHING LIKE: 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?

SAY SOMETHING LIKE: 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 neighborhood 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.

Irrigation Challenge: Improve

The **BIG** Idea

How can I communicate effectively with a team to improve a prototype?

AGENDA

Approximately 45 minutes (1 class period)

1. Warm Up (5 minutes)
2. Prototype (35)
3. Wrap Up (5 minutes)

MATERIALS

- Prototypes from last class

OBJECTIVES

During this lesson, students will:

- 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.
- Complete the Improve stage of the Engineering Design Process.

STANDARDS

- Career Exploration 15: In a team, research, identify, and apply the steps of the problem-solving process (problem identification, brainstorming, evaluating, solution selection, monitoring and revising) in a contextualized situation to determine a solution to a work-related problem presented from a specific career cluster area. Write a proposal outlining and justifying your team's decision or solution. (TN Reading 3, TN Writing 1)
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

OVERVIEW

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

PREPARATION

- List the day's **BIG IDEA** and activities on the board.

RESOURCES

Richards, Jennifer. Irrigation Challenge.

<https://extension.tennessee.edu/publications/Documents/W674.pdf>

ACTIVITY STEPS

I. Warm Up (10 minutes)

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 neighborhood where you might use the Engineering Design Process to find a solution to the problem. What examples did you find?

SAY SOMETHING LIKE: 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.

II. Improve (25 minutes)

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?

III. **Wrap-Up (10 minutes)**

Ask students to reflect on what they have learned by using the Engineering Design Process to build their bug habitats 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.

Real-World Problem Solving

The **BIG** Idea

How can I select the best strategy to solve a problem?

AGENDA

Approximately 45 minutes (1 class period)

1. Warm Up (10 minutes)
2. Problem Solving Planning (15 minutes)
3. Problem Solving Poster (10 minutes)
4. Wrap Up (5 minutes)

MATERIALS

- Blank Paper (1/student)
- Pencils or Pens (1/student)
- Real-World Problem -Solving handout (1/group)
- Giant Sticky Notes (1/group)
- Markers

OBJECTIVES

During this lesson, students will:

- Describe the Six Thinking Hats, Seven Steps to Decision Making, and the Engineering Design Process
- Solve a real-world problem using a proven strategy
- Create a poster to justify logical decision making

STANDARDS

- Career Exploration 15: In a team, research, identify, and apply the steps of the problem-solving process (problem identification, brainstorming, evaluating, solution selection, monitoring and revising) in a contextualized situation to determine a solution to a work-related problem presented from a specific career cluster area. Write a proposal outlining and justifying your team's decision or solution. (TN Reading 3, TN Writing 1)
- English/Language Arts 9-10.W.PDW.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- English/Language Arts 9-10.W.RBPK.9 Support and defend interpretations, analyses, reflections, or research with evidence found in literature or informational texts.

OVERVIEW

After reviewing the Six Thinking Hats, Seven Steps to Decision Making, and Engineering Design Process strategies, students will select a real-world problem and explain how they would solve it using a chosen strategy. They will create a poster to explain their thinking.

PREPARATION

- List the day's **BIG IDEA** and activities on the board.
- The warm-up asks for students to get out a piece of paper. This can be completed in a notebook if students have them, or you can give them a blank sheet.
- Make copies of the Real-World Problem-Solving handout (1/group).
- Gather 1 giant sticky note per group and markers.

ACTIVITY STEPS

I. Warm Up (10 minutes)

Ask students to get out a sheet of paper and a pen or pencil. Tell them that they have 1 minute to write down or draw as many things as they can remember about Engineering Design Process. This is called a “brain dump.” They do not need to worry about being correct; the only goal is to write or draw as many things as possible before time is up. After 1 minute has passed, repeat this process with the Seven Steps to Decision Making and the Six Thinking Hats.

Give each group a copy of the **Real-World Problem Solving Handout**. Instruct them to compare what they wrote with the descriptions on their handout.

SAY SOMETHING LIKE: In the past two units, we have used these three different strategies to practice decision making and problem solving. Today we will finish things up by solving a real-world problem of your group’s choice.

II. Problem Solving Planning (15 minutes)

Guide students through the steps of the **Real-World Problem Solving Handout**.

1. Choose a problem to solve with your group. Here are some examples:

- Students need more mental health support.
- Playing on a sports team is too expensive for some students.
- New employees at your job don’t get enough training

Explain your problem in the space below. Write 1-2 sentences to explain your thinking.

Give students 2-3 minutes to choose their problem and explain it in the box on their handout.

Feel free to help students generate other examples based on their personal experiences. What have they been complaining about lately? Are they annoyed with something at school or work? These would be great examples.

2. Which strategy will your group use to solve your problem? Circle it below. Why did you choose this strategy? Write 1-2 sentences to explain your thinking.

Instruct students to choose a strategy to solve their problem and circle it on their sheet. Give them 2-3 minutes to explain why they chose it. Consider asking questions such as, “Why did you choose ____ instead of ____? What makes it better?” if they are stuck.

3. Use the space below to solve the problem using your chosen strategy.

Give students about 10 minutes to complete this section. Encourage them to write out each of the steps and apply it to their problem.

III. Problem Solving Posters (10 minutes)

Give each group a giant sticky note and markers. Instruct them to create a poster that explains their problem-solving process. When they are finished, they can hang them up in the room.

IV. Wrap-Up (5 minutes)

Tell students to look around the room at their classmates' posters and answer questions such as:

- What are some things that the posters have in common?
- Which of the topics are similar?
- Which was the most popular: Engineering Design Process, Seven Steps to Decision Making, or Six Thinking Hats?
- Why was this one the most popular?
- What did you like about using these strategies? What did you dislike?
- If you were creating your own problem-solving strategy, what might it look like?

Real-World Problem Solving

Engineering Design Process	Seven Steps to Decision Making	Six Thinking Hats
• Ask ○ Problem ○ Criteria ○ Constraints • Imagine ○ Ideas ○ Best Idea ○ Pros ○ Cons • Plan ○ Plan ○ Materials • Create ○ Prototype ○ Test • Improve ○ Modify ○ Retest	1. Define your problem 2. Gather information and resources 3. List options 4. Weigh and compare options 5. Make a decision 6. Make a plan of action 7. Evaluate the decision	• Blue Hat- Process • White Hat- Facts • Red Hat- Feelings • Green Hat- Creativity • Yellow Hat- Benefits • Black Hat- Cautions

1. Choose a problem to solve with your group. Here are some examples:

- Students need more mental health support.
- Playing on a sports team is too expensive.
- New employees at your job don't get enough training.

Explain your problem in the space below. Write 1-2 sentences to explain your thinking.

2. Which strategy will your group use to solve your problem? Circle it below.

Engineering Design Process	Seven Steps to Decision Making	Six Thinking Hats
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Why did you choose this strategy? Write 1-2 sentences to explain your thinking.

3. Use the space below to solve the problem using your chosen strategy.



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