



## CLASSROOM ACTIVITY

# Eco-Friendly Manufacturing

## OBJECTIVES

Students will:

- Research and summarize the textile industry's main objectives and the ways in which it contributes to water pollution.
- Review possible strategies for reducing this pollution while maintaining industry success.
- Develop guidelines to help textile manufacturers reduce their environmental impact and help local communities.
- Evaluate their peers' guidelines and apply constructive feedback in order to optimize their own work.

## OVERARCHING QUESTION

How can manufacturing help the world's water scarcity problems?

## ACTIVITY SUMMARY

Students will investigate the textile industry's effect on the world's water scarcity through the lens of engineering. They will seek to understand how the textile industry contributes to pollution, and they will explore possible strategies that the industry could employ to reduce its environmental impact. They will then apply what they have learned as they develop clear guidelines to steer textile manufacturers toward a more sustainable future.

## MATERIALS

- Devices with Internet access, at least enough for half the class
- Designing Solutions Handout, one per student

## TEACHER PREP

Before this activity, try to speak with someone in your school's food services to obtain as many details as possible about a recent meal. A menu will suffice but if you can get additional details—such as the food brands or the source of the produce, meats, etc.—it will be even better!

## CHALLENGE

1. Encourage students to work with a partner as they guesstimate answers to the following questions:
  - What percentage of Earth's water is fresh water?
  - What percentage of Earth's water can be used by humans?
  - Around the world, what percentage of people live in areas with water scarcity?
2. After inviting students to share their thoughts, explain that:
  - Three percent of Earth's water is fresh.
  - 0.5% of Earth's water is available for human use and most

of this water comes from rivers. The other 2.5% can be found in glaciers, polar ice caps, the soil, and even the atmosphere.<sup>1</sup>

- Around the world, about 25% of the population lives in areas of water scarcity and high-water stress—either due to physical shortage or lack of adequate infrastructure.<sup>2</sup>
3. Go on to explain that our world's water situation is worsening due to overuse. This overuse can be attributed to population growth, agricultural practices, urbanization (growth of cities), and industrial production. Water is being used and polluted faster than nature can recycle and purify it.<sup>3</sup>
  4. Tell students that, after agriculture, the textile industry—which designs, produces, and distributes clothing, cloth, and yarn—is the second largest polluter of clean water in the world.<sup>4</sup> Each student will therefore take on the role of an environmental engineer *or* an industrial and manufacturing engineer as they seek to develop recommendations to help textile manufacturers combat this growing problem and positively impact the environment. Further explain that:
    - As environmental engineers, students will tackle the problem from an environmental perspective as they try to design systems that can recycle water, dispose of waste safely, and control pollution.
    - As industrial and manufacturing engineers, students will focus on how to develop systems that maximize the efficiency and effectiveness of the textile industry, while keeping sustainability in mind.
  5. Explain that students will work in teams of four (two environmental engineers and two industrial and manufacturing engineers) as they perform research to better understand how the textile industry is contributing to water stress and best practices that the manufacturing industry could follow to reduce this impact. Distribute one Designing Solutions Handout to each student, and elaborate on the challenge by reading aloud the bullets listed under *Step 1: Define the Challenge*.
  6. Then, divide students into their research teams and give groups a moment to decide who will take on each engineering role. After answering any questions, prepare student groups to perform research to better understand the challenge:
    - Advise groups to split up their research so that a different group member focuses on each of the first three bullets.
    - Write the following websites on the board and encourage groups to use these websites as starting points:
      - **About:** [epa.gov/eg/textile-mills-effluent-guidelines#what-is](https://epa.gov/eg/textile-mills-effluent-guidelines#what-is)
      - **Pollution Background:** [e360.yale.edu/features/can\\_waterless\\_dyeing\\_processes\\_clean\\_up\\_clothing\\_industry\\_pollution](https://e360.yale.edu/features/can_waterless_dyeing_processes_clean_up_clothing_industry_pollution) (or: [tinyurl.com/y2jtbay8](https://tinyurl.com/y2jtbay8))
      - **Industrial Guidelines:** [epa.gov/watersense/types-facilities](https://epa.gov/watersense/types-facilities)
    - Explain that students will have about 20 minutes to complete their research and prepare to share what they have learned with their group members.

<sup>1</sup> [usbr.gov/mp/arwec/water-facts-ww-water-sup.html](https://usbr.gov/mp/arwec/water-facts-ww-water-sup.html)

<sup>2</sup> [unwater.org/water-facts/scarcity/](https://unwater.org/water-facts/scarcity/)

<sup>3</sup> [un.org/sustainabledevelopment/wp-content/uploads/2019/07/12\\_Why-It-Matters-2020.pdf](https://un.org/sustainabledevelopment/wp-content/uploads/2019/07/12_Why-It-Matters-2020.pdf)

<sup>4</sup> [un.org/sustainabledevelopment/wp-content/uploads/2019/07/12\\_Why-It-Matters-2020.pdf](https://un.org/sustainabledevelopment/wp-content/uploads/2019/07/12_Why-It-Matters-2020.pdf)

## DESIGN

1. Bring the class back together and explain that it's 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. Tell the class that they will have about 15–20 minutes to complete the *Design* portion of their handout. Quickly recap and encourage students to:
  - Share what they learned from their research with the rest of their group.
  - Continue to approach the challenge from the perspective of their engineering career, with the goals of sustainability and industry success in mind.
  - Develop a set of clear and simple guidelines for the textile industry that could help the world's water situation, improve communities, and protect the textile industry.
  - Use a separate piece of paper to outline the guidelines that address the questions provided on the handout.
  - Be ready to share their work with another group.

## SOLVE

1. When there are 10–15 minutes left in the class period, read *Step 3: Analyze Solutions* aloud. Explain that when solving a complex problem, it is important to take a variety of perspectives and opinions into account to ensure all needs are met. Therefore, groups will review each other's work in order to provide suggestions for improvement.
2. Go on to explain that once groups have recorded their questions and suggestions, they should share their feedback with each other. If time allows, they may then edit their own guidelines based on the feedback they received.

## STANDARDS

### Next Generation Science Standards

- Engineering Design:
  - 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.
  - 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.
- Human Sustainability:
  - HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
  - Disciplinary Core Idea:
    - ESS3.C: Human Impacts on Earth Systems:
      - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

**ITEEA Standards for Technological Literacy**

- Standard 5: Students will develop an understanding of the effects of technology on the environment. In order to discern the effects of technology on the environment, students should learn that:
  - G. Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling.
  - L. Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.

### Step 1: Define the CHALLENGE

Your challenge is to:

1. Gain a better understanding of the textile industry's goals and processes.
2. Consider how and why this industry is a major contributor to water pollution.
3. Explore possible strategies and processes that would reduce this pollution while maintaining industry success.
4. Develop simple and straightforward guidelines to help the world's textile industry combat water stress and have a positive effect on communities.

As you perform research to help you tackle the challenge, jot notes below.

### Step 2: Create a DESIGN

**Overview:** Share what you learned from your research with your group. Then collaborate to develop a set of basic global guidelines to be used by the textile industry.

**Requirements:** Your guidelines must include:

1. **Clear, tangible steps:** What specifically must all textile manufacturers do to reduce and/or avoid water pollution? What else could they do to positively impact the environment and struggling communities?
2. **Rationale:** How will these actions help the world's water situation?
3. **Challenges:** What challenges may manufacturers encounter? What could they do to overcome these challenges.

Jot notes below and then complete your guidelines in a format of your choice on a separate piece of paper.

### Step 3: Analyze SOLUTIONS

Swap guidelines with another group and review their work from the perspective of your engineering careers. Then develop at least three questions, suggestions, or pieces of constructive feedback that could help their guidelines better protect the world's water, more positively impact local communities, and/or better serve the textile industry.