Great Pacific Garbage Patch Teaching Guide

This activity asks students to think like engineers by following the Engineering Design Processto design a device that will capture suspended marine plastics and while using the natural forces in the marine environment to propel the system through the water. If you're new to the Engineering Design Process, take a quick tour and learn more at TeachEngineering.org.

Activity 1: Research The Problem — How are microplastics affecting food chains in the Pacific Ocean?

Inform students that during the 1990's the science community was made aware of large areas called gyres made up of tiny bits of plastic gathering together to create what is called the Great Pacific Garbage Patch. Tell them the garbage has collected in the areas from sea voyaging vessels and offshore waste. A study published in the journal "Environmental Research" in 2008 stated that 44 percent of all seabirds have eaten plastic and 270 other marine animals have been negatively impacted. This plastic impairs the digestive tract and passes on toxins such as PBC and DDT absorbed from seawater to the animal that consumes it, this includes humans as we consume marine life. The toxins stay within the body cells of the consumer (biomagnification) and can eventually through relationships in food chains cause birth defects and cancer in the consumers. Ask students to examine the diagram of a marine food web in the Great Pacific Garbage Patch.

After the video you may consider asking students the following questions:

- How does the ocean cleanup crew work as a team?" (They may suggest that the engineers work together to analyze the data and develop solutions).
- Why does the Ocean Cleanup crew collect data to begin with? (Guide students toward the understanding that the team collects data to learn how their design is working in real-world conditions).
- What has the Ocean Cleanup team done as a result of the knowledge gained from the data collected?" (Guide them toward the understanding that the engineers use the data to continually make improvements to their design).

Students can complete the questions on the student pages individually or within their groups.

Activity 2: Develop Solutions

Student Planning, Design, and Supply List

You may want to allow students 30 minutes to plan their designs. Following planning, allow 1 period to create/ build, and 1 period to test/ improve. Creating their Ted-style talks will take additional time.

Explain the pricing structure for the purchase of supplies for their designs, and hand out "Ocean Cleanup Cash". Be sure to show students where the testing will take place so that they have an idea of the size that their devices should be. Exchange the cash for the materials when each team is ready.

Building Supplies, Per Group

These materials are suggestions, but the best option? Raid your recycling bin! Thoughtful reuse of recyclables or non-recyclables for this activity models for students ways you can reduce plastic waste. Be sure to assign your own values to the materials you supply, or make new materials $$, and recycled/reused materials free!

- 6 foam hair rollers
- 1 pair of pantyhose/ knee highs
- 12 inches of string/ yarn
- 3 rubber bands
- 3 chenille sticks/ pipe cleaners
- 5" x 5" square of cheesecloth/ gauze
- 10" x 3" section of netted material (inexpensive laundry bag or fruit bag from oranges/ tangerines)

Supplies for Testing

- Inflatable baby pool/ plastic baby pool
- Table or Box Fan
- Cut-up plastic straws or recycled bottles and other small plastic bits

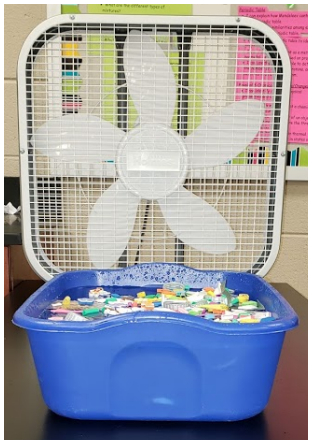
Before building their ocean clean-up devices, students should be encouraged to take a few minutes to make notes or a video with their team members, explaining how they plan to construct their ocean clean-up device, why they chose the materials they did, and what they expect to happen when it is tested. They should take notes throughout the process.

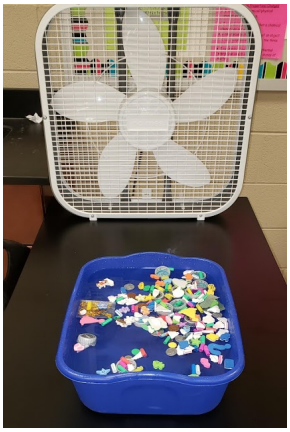
Activity 3: Prototype the Designs

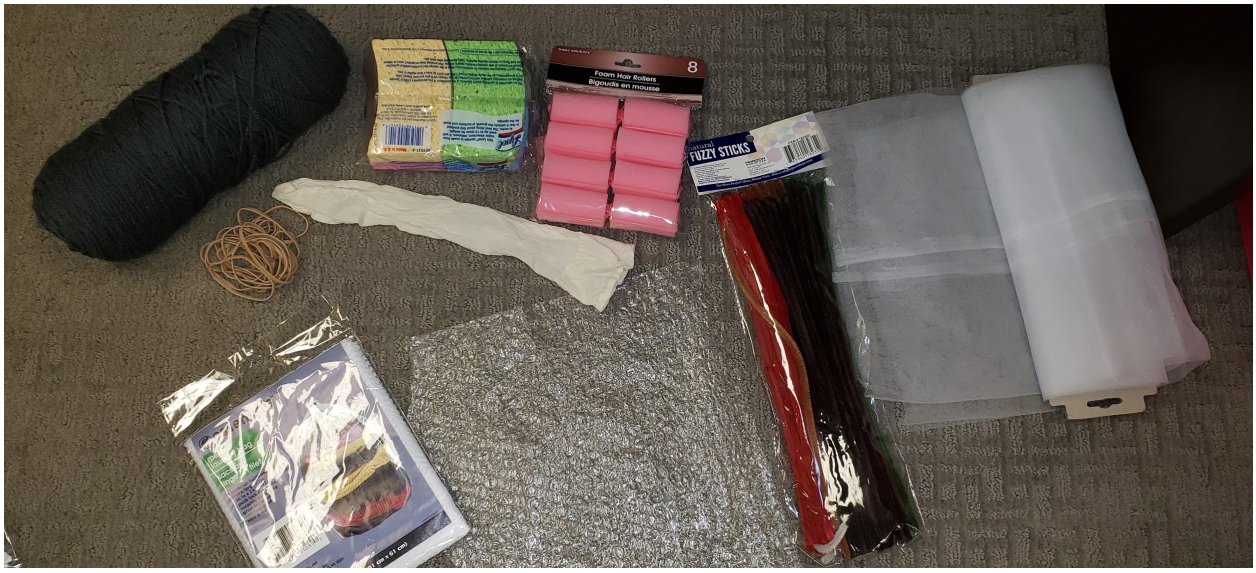
Provide students with ample amounts of time to prototype their designs. Consider giving teams an opportunity to walk around and share ideas with other teams during the prototyping phase. Encourage students to document their modifications and discuss the features, budget, and effectiveness of their design as it changes in the prototyping phase.

Activity 4: Test the Designs and Improve Them

Once students have completed the building of their designs, set up a testing station using a fan baby pool. Place the fan at least 15 inches from the baby pool. The fan will simulate ocean winds and the pool will represent the garbage patch ocean site. Place tiny pieces of plastic in the test water for the device to trap and collect. An example of a testing station is pictured below:







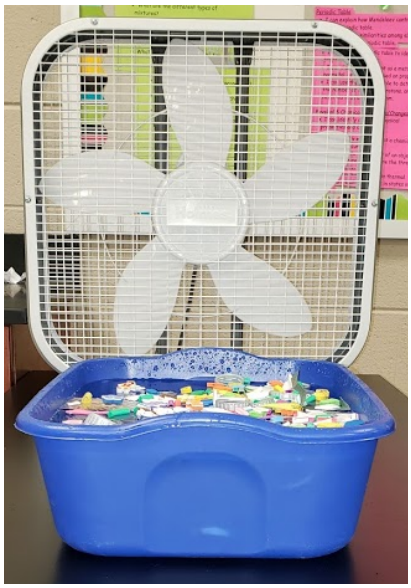
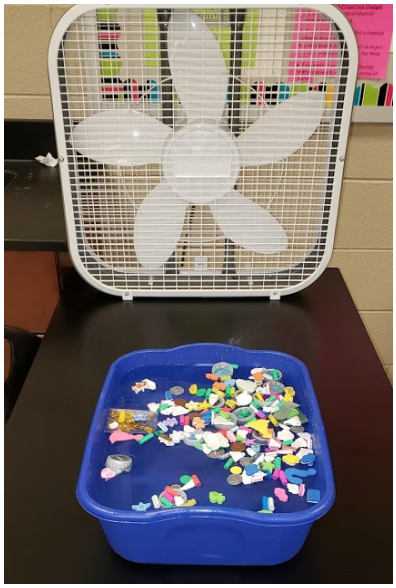
Materials for the testing station.

To test the student designs, place their designs in the water with the "U" structure facing the "garbage patch", with the fan positioned behind the device, so that the fan will blow design toward plastic debris. Turn on fan beginning at speed 1 for 30 seconds and then adjusting to speed 3 for an additional 30 seconds. You may choose to also tilt the fan to simulate wind and ocean waves. Have students make notes every 30 seconds to indicate whether their system stayed afloat or sank and how many debris pieces the system collected. Instruct students to record all debris contained within "U" shaped device.

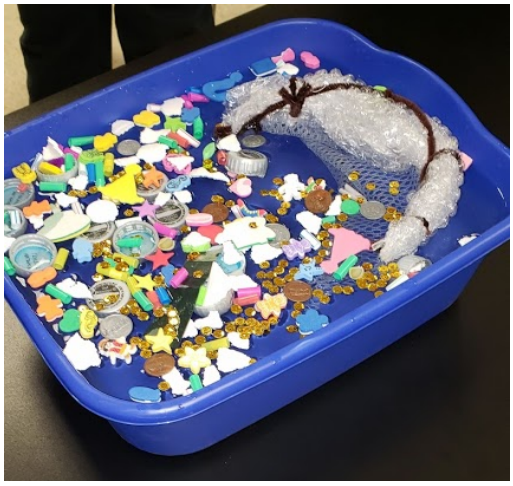
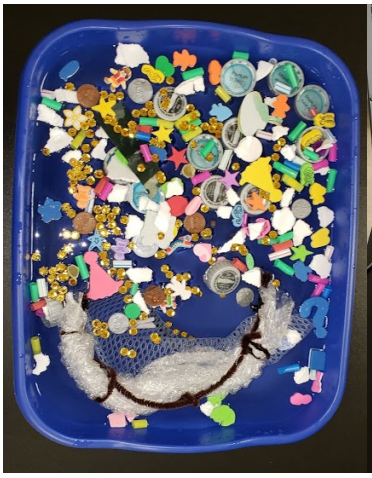
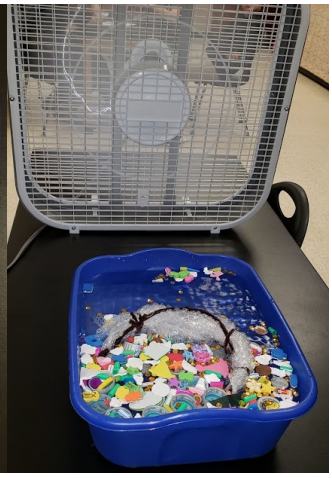
Testing the designs:

The testing area should include a baby pool full of water, with a fan at least 15 inches from the pool. Once students are completed with building their design, set up a testing station using a fan baby pool. Place the fan at least 15 inches from the baby pool. The fan will simulate ocean winds and the pool will represent the

garbage patch ocean site. Place tiny pieces of plastic in the test water for the device to trap and collect. An example of a testing station is pictured below:

Turn on fan beginning at speed 1 for 30 seconds and then adjusting to speed 3 for an additional 30 seconds. You may choose to also tilt the fan to simulate wind and ocean waves. The ocean clean-up device creators should take Have students make notes every 30 seconds to indicate whether their system stayed afloat or sank and how many pieces of debris the system collected. Instruct students to use the handout to record all debris contained within their device.

Following testing, ask students to total the number of pieces of plastic their system collected. Record each group's total on the board/ chart paper/ google document.

Have groups compare what worked best and what worked least in their designs by sharing the observations they made during testing. Encourage students to consider patterns in the shape, size, or type of plastic their system collected. Have groups present their data by standing in front of the class, explaining what debris was

collected, how much was collected, and how long it took to collect debris, and what they thought was most successful. Alternatively, you can have each group select a pair of "delegates" to travel to each group and do mini-presentations to smaller groups of peers. Allow the groups time to improve upon their design plans by indicating what they would change about their designs and why they would make the changes. If time allows, let students make changes to their designs and retest.

Activity 5: Let's Give A TED-style Talk!

All group members must be part of the planning and delivering of the speech. To ensure all group members have an equal part in the talk you may choose to assign roles or job descriptions. One suggestion is to have each member of the group to be responsible for addressing one question under the task requirements. You may also choose to have a panel made up of peers, other faculty members, or volunteers for the student teams to present their TED-style talk to. The main purpose of this part of the lesson is to evaluate what they learned during the engineering design process.

Extension: Young Engineer Poster

An alternative to this activity is to have the students focus on any young environmental engineer. Allow students the opportunity to research any up-and-coming engineer.

Questions to follow the Boyan Slat video:

- How does the ocean cleanup crew work as a team?" (they may suggest that the engineers work together to analyze the data and develop solutions).
- Why does the Ocean Cleanup crew collect data, to begin with? (guide students toward the understanding that the team collects data to learn how their design is working in real-world conditions).
- What has the Ocean Cleanup team done as a result of the knowledge gained from the data collected?" (Guide students toward an understanding that the engineers use data to continually make improvements to their design).