
Photograph: Jasmin Sessler from Unsplash

# Of Pivoting and Plastic

*A Virtual Lesson Sequence on the Great Pacific Garbage Patch*

By **Melanie Master**

IF YOU'RE AN AVID TEACHER of the Next Generation Science Standards (NGSS) or a similarly-structured science framework, you likely felt a shiver run down your spine when you thought about how to teach remotely. You probably wondered, "How can I offer my students phenomena-based, inquiry-driven instruction in a virtual format?"

If I have learned anything from teaching remotely, it's that there is little replacement for in-person interactions to guide learning. However, I discovered that NGSS-aligned environmental education is still possible in a virtual format through a middle-level interdisciplinary project. The Great Pacific Garbage Patch (GPGP), which involves understanding ocean currents, water cycle, and environmental science, is the perfect phenomenon for creating such a project for middle school students.

Throughout the Virtual Lesson Sequence, students explore how the patch forms. Students then model what they have learned and end by exploring methods for minimizing the impact of plastic litter on global and local scales. Educators can use the lesson sequence in multiple formats: five weeks completely virtual with one two-hour assignment per week, one intensive virtual week, or a hybrid learning format with in-class discussions and group activities.

Garbage patches like the GPGP, which is located between California and Hawaii, are currently found in the oceans off every continent. They form patches because surface currents collect debris (mostly plastic) into a centralized area.[1] The GPGP contains *at least* 79,000 tonnes of plastic debris and covers an area of 1.6 million km$^2$, a number much higher than previously thought.[2] This phenomenon directly affects students whose local watershed drains into the ocean, but it also relates to those who live farther inland; freshwater bodies are still contaminated with plastic.[5] With the debris in the GPGP increasing exponentially,[2] educating the next generation is a pressing issue. More than 70 percent of ocean debris originates from land,[2] so we all have a direct impact on keeping garbage out of our waterways. This personal connection to an observable event makes this phenomenon relevant to our daily lives.

To ensure access for all students, each lesson includes multiple virtual teaching concepts outlined in Vista Unified School District's Universal Design for Learning in a Virtual Classroom.[3] The lessons provide multiple achievement levels for students who need a 'low floor' *and* for those who need a 'high ceiling.' The minimum lesson requirements have a 'low floor,' meaning that students who struggle for whatever reason should still be able to attain success independently. All articles have a read-aloud option, and optional sentence starters can help students gain momentum. Multiple additional learning opportunities exist throughout for students who can reach the 'high ceiling.' With students learning on their own, the concept of simplicity drives the format: students navigate assignments in as few clicks as possible, and the lessons do not include any complicated or costly technology.

## The Virtual Lesson Sequence

### *Lesson 1: Introduction to the GPGP*

The first lesson introduces the concept of the GPGP through a 40-minute documentary called *Plastic Paradise* along with a short video and article. The documentary outlines a woman's journey to discover the GPGP for herself, exploring an island called Midway Atoll, which has lots of plastic debris washed ashore. Watch out for the common misconception that the GPGP is an actual island; it's important the teacher emphasizes that the patch is composed mostly of suspended microplastics located under the water's surface. The minimum requirement for this lesson is for students to explain what the GPGP is, but the lesson also includes multiple extension activities for students who can go further. The extensions include getting students to look up answers to their own questions, complete a GPGP interactive quiz, and learn how animals are affected by the plastic.

### *Lesson 2: Water cycle*

The second lesson focuses on the role the water cycle plays in bringing trash from land into the ocean, connecting to NGSS standard *MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.* This phenomenon gives what could be a mundane lesson of the water cycle more meaning, especially considering that the annual input of plastic trash from rivers into oceans ranges from 1.15 to 2.41 million tonnes per year.[4] In this lesson, students explain the concept of water runoff in relation to its role in helping create the GPGP. The extension activities include at-home water cycle experiments for students to deepen their understanding of the concepts.

### *Lesson 3: Ocean currents*

The third lesson focuses on how plastic, once it reaches the ocean, travels via surface ocean currents to add to the GPGP. If students are closer in proximity to the Atlantic or the Indian Oceans, the same concept of ocean currents applies.[1] This lesson connects to the NGSS standard *MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates*. Students learn that surface ocean currents are caused by wind and the rotation of the Earth, which help gather plastic into a patch. Once they understand the concept of ocean currents and runoff, students are ready to model what they know. This extension also includes at-home ocean current experiments for students to help them explore the concept.

### *Lesson 4: Modeling*

This lesson is a performance task to assess students' abilities to model how the GPGP is formed using the principles of ocean currents and runoff. As required by the NGSS Science and Engineering Practices, students' models describe the GPGP phenomenon as well as the unobservable mechanisms of how ocean currents are formed.[6] Students have the option of formatting their model using a Google Drawings comic strip template as a starting point. The template has directions for what students should include in each box. If a teacher is in the classroom working directly with students, this scaffold might not be necessary. The idea is for students to model the story of how a piece of plastic travels from land and into the GPGP. Students also describe the science behind it. Student model examples are located in the Virtual Lesson Sequence link located in the Resources section. (See link to Virtual Lesson Sequence below)

Photograph: National Atmospheric and Oceanic Administration (NOAA)

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### *Lesson 5: Solutions*

The last lesson in the sequence is focused on having students learn about what is currently being done to reduce the size of the GPGP, as well as what they can do at home to help. This lesson serves to provide a sense of hope about the topic and connects to NGSS Disciplinary Core Idea *MS-ESS3.C: Human Impacts on Earth Systems*. Students will learn what the innovative company, The Ocean Cleanup, is doing to remove waste from the ocean, as well as the preventative measures the company is taking to clean up rivers. Students will then learn how they can reduce their plastic consumption to help tackle the plastic problem.

This lesson sequence was crafted as a 'bare bones' exploration of the GPGP, intended for students who are coping with the transition from learning in a classroom to learning completely independently. The richness of this sequence could be enhanced if students are receiving in-person support. For example, students could conduct the optional hands-on extension experiments to learn about the water cycle and ocean currents in class.

In another in-class activity, designed to help students visualize the concept of runoff in their own communities, students could conduct a local watershed exploration. Using Google Maps, students print out aerial images of the school's watershed and make the map '3D' by crumpling up the mountains. Students are then taken outside to sprinkle non-plastic material such as dried oregano on the watershed to represent litter. Last, they "make it rain" by squirting the watershed with water from a squirt bottle. Students will see how the litter flows into the valleys and out into the ocean or other body of water. This could lead to a rich classroom discussion to help students figure out the concept of runoff on their own.

Additionally, the last lesson on solutions could be expanded to have students actually design their own solutions to minimize plastic on their campus. This would connect to NGSS *MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment*. If students design their own solutions, teachers should encourage them to think big and be sure to define the criteria and constraints to their solution. Have students explain how their solution is both monitoring and minimizing the problem.

Regardless of whether you're interested in using this phenomenon to help your students learn in a virtual, hybrid, or in-person environment, you can start by making a copy of the lesson sequence below so you can edit it to meet your students' unique needs. And hopefully, you'll avoid a recurrence of the shivers.

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**Resources:**

Virtual Lesson Sequence: https://drive.google.com/open?id=1UsmtjphrgGmidzCxmQniaiKfAKpsSarj

**References:**

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