

Reduce Beach and Ocean Plastic Pollution

Middle School Guam STEM Design Challenge

Anchor Question: How can we help reduce plastic pollution on our beaches and in the ocean around Guam?

Overview

Guam Connection

Currently, recycling on Guam only partially addresses the waste stream. At this point, Guam can only recycle aluminum cans, metal cans and cardboard. However, Guam's Solid Waste Authority is still accepting paper and plastics 1&2 in the curbside recycling bins because they do not want to change people's habits because hopefully the situation with paper and plastics will change in the near future. Our island's recycling coordinator continues to encourage people to generate as little plastic as possible and shred paper so it can be used for mulch by farmers. Recycling glass is dependent on having a functioning glass pulverizer on Guam.

Engineering Design Challenge

The plastic debris is accumulating on the beaches both from on island and from the ocean where it is brought in by the tides. Recycling on Guam is an ongoing issue and plastics in particular. Some islands have banned single-use plastics (plastic straws, bags, and water bottles). Design a plan to monitor and reduce the plastic debris that is found on our beaches and within our surrounding ocean water.

NGSS Performance Expectation

[MS-ESS3-3](#). Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include pollution]

STEM Concepts (NGSS Disciplinary Core Ideas)

LS2.A: Interdependent Relationships in Ecosystems. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. Growth of organisms and population increases are limited by access to resources. Although the species involved in competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.

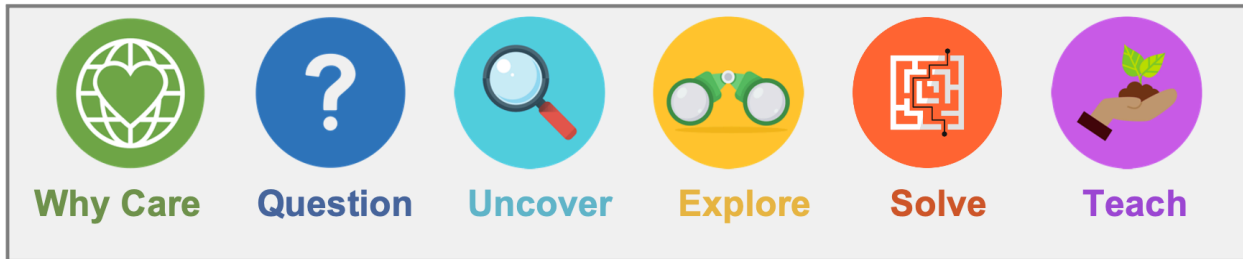
Time: Estimated Number of Classes

3 - 6 classes (45-minute class)

Materials for the Design Challenge

Trash bags, gloves, hand lens, digital microscope, sand from local beaches, 5-gallon bucket

The Q-U-E-S-T Experience



Why Care?

What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?

Question

Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.

Uncover

Learn the science ideas needed to understand the problem and design a project to solve the problem.

Explore

Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.

Solve

Use the engineering design process to design and do a project that helps SOLVE the problem.

Teach

Share your project with others to help others understand the problem and how your project helped solve it.



Why Care?

What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?

Introduce the Quest

1. **Post and read the anchor question:** How can we help reduce plastic pollution on our beaches and in the ocean around Guam?
2. **Read, describe, and post the design challenge:** The plastic debris is accumulating on the beaches both from on island and from the ocean where it is brought in by the tides. Recycling on Guam is an ongoing issue and plastics in particular. Some islands have banned single-use plastics (plastic straws, bags, and water bottles). Design a plan to monitor and reduce the plastic debris that is found on our beaches and within our surrounding ocean water.
3. **Share and talk about the Driving Question for why we should care:** Why should we care about the presence of marine debris in our surrounding ocean water? Why is preventing all pollution, particularly plastic pollution important on an island like Guam?
4. **Do this:**
 - a. **Explain how Guam disposes of waste:** Currently, recycling on Guam only partially addresses the waste stream. At this point, Guam can only recycle aluminum cans, metal cans and cardboard.

However, Guam’s Solid Waste Authority is still accepting paper and plastics 1&2 in the curbside recycling bins because they do not want to change people’s habits because hopefully the situation with paper and plastics will change in the near future. Our island’s recycling coordinator continues to encourage people to generate as little plastic as possible and shred paper so it can be used for mulch by farmers. Recycling glass is dependent on having a functioning glass pulverizer. Have students share and discuss:

- i. Does your family recycle all waste, including paper and plastics?
 - ii. Do you think everyone should be required to recycle?
- b. **Share this article:** [Guam endorses the Pacific declaration to prevent marine plastic pollution](#). The document supports a call to the UN Environment Assembly for a global, legally binding agreement addressing the life cycle of plastics. Here is a resource page on marine debris. Decide what you want students to read and understand. [Marine Sanctuaries Marine Debris Resource Collection](#). From what you give students, have them share and discuss:
- i. What is marine debris?
 - ii. What can we do on Guam to help reduce plastic pollution in our ocean and trash on our beaches?
- c. **Explain:** The plastic debris is accumulating on the beaches both from on island and from the ocean where it is brought in by the tides. Plastic waste on our beach can create a variety of problems— harm to marine and land animals, harm to people, pollution of water and land.
- i. Have students discuss these two issues. Gather the ideas from all students to consider while conducting your QUEST.
- d. **Watch these two videos.** Have students make a list of the issues in your region and around Guam. What other issues are you aware of that should be added to your class list?
- i. [Earth is Blue 1-minute video](#) on marine debris in Papahānaumokuākea Marine National Monument.
 - ii. [Protect Guam's Beaches from Marine Debris](#) - Guam Coastal Management Program PSA

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Write or draw your “why I care” and why others on Guam care.



Question

Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.

Ask Questions

1. **Create a KND Chart (Know, Need to know, Do)** with the three driving questions below. Save the questions and responses to look at during the QUEST; writing them on chart paper, butcher paper, in student design notebooks, or use a digital organization chart, like Jamboard. KND Questions:
 - a. What do we **KNOW** already about plastic debris (pollution) on our beaches and the harm it causes?
 - b. What do we **NEED TO KNOW** so we can help reduce plastic debris (pollution) on our beaches and the harm it causes?

- c. What could we **DO** to help solve the plastic debris (pollution) problem or problems caused by plastic debris on our beaches?
2. **Gather responses from students.** Have students think and write responses: First, silently and individually. Then, in small groups. And finally, with the full class. The end result is a class KND chart to refer to, add to, and reorganize throughout the QUEST. Students could sort the responses that are similar. This information will help guide the UNCOVER and EXPLORE.

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Write KND lists. Organize the questions (Need to Know) from class. Record the categories, or themes, of the questions and ones you are most interested in.



Uncover

Learn the science ideas needed to understand the problem and design a project to solve the problem.

Uncover Key Ideas

1. **Share the Driving Question:** What are common types of marine debris? Record new understandings in your Design Notebook.
 - a. Lessons provided by:
 - i. [Earth Genius lesson plans](#) (One Cool Earth's) Adapt from K-6
 - ii. [Trash Shouldn't Splash Toolkit](#) (Sea Education Association)
 - b. Jigsaw, with everyone required to summarize or list key points for the facts they were not responsible for presenting:
 - i. [Marine Debris Fact Sheet](#) (NOAA)
 - ii. [Plastic Marine Debris Fact Sheet](#) (NOAA)
 - iii. [Microplastic Marine Debris Fact Sheet](#) (NOAA)
 - iv. [Garbage Patches Fact Sheet](#) (NOAA)
 - c. Watch: [A tiny island with no humans is getting buried in plastics](#) (PBS News Hour) WHY? How are they getting there?
2. **Share the Driving Question:** How does marine debris impact animals and plants, water and land ecosystems, and people?
 - a. Go through 5E Lesson on Albatross Bolus Analysis
 - b. Lesson 4: [Albatross Bolus Analysis](#) (regurgitated ball of plastic)
 - c. Website with information: [Plastic waste in the oceans is linked to disease in coral reefs](#)
3. **Share the Driving Question:** How are people helping reduce plastic pollution in the ocean on both the causes and impacts side of the issue – changes in products made and purchased, technology and efforts to clean up the debris already in the ocean and on beaches?
 - a. Lessons on reducing waste, trash audits:
 - i. [Earth Genius lesson plans](#) (One Cool Earth's) K-6 adapt
 - ii. [Trash Shouldn't Splash Toolkit](#) (Sea Education Association)
 - iii. Video: Boyan Slat is a 20-year-old on a mission - to rid the world's oceans of floating plastic. He has dedicated his teenage years to finding a way of collecting it.

- iv. <https://www.bbc.com/news/magazine-29631332>
4. **Share the Driving Question:** How could plastic waste be repurposed to reduce beach and island plastic pollution?
- [One solution to Guam’s plastic problem could be a plastic solution](#), Pacific Island Times
 - [Guam Waste Composition Study](#) (2020) slide deck of data that students could interpret and summarize.
 - Research other ways plastic waste is being repurposed or could be repurposed. This could become a design project.

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Write the driving question and summarize what you did and learned. (blank page)

Students will understand these NGSS Disciplinary Core Ideas:

LS2.A: Interdependent Relationships in Ecosystems. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. Growth of organisms and population increases are limited by access to resources. Although the species involved in competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.



Explore

Apply what you’ve learned in Uncover to **EXPLORE** the problem in your community and consider project ideas to solve the problem.

Teacher prep: Download the [Marine Debris Monitoring Toolkit](#) for Educators produced by NOAA’s Office of National Marine Sanctuaries. In it you’ll find lessons, videos, and instructions on how to conduct a marine debris survey with your students.

Apply Your Learning

- Share the Driving Question with students:** How can we apply what we learned in UNCOVER to understand the problem in our community of marine debris and to come up with project ideas to help solve the problem?
- Revisit the KND lists** you wrote at the beginning of your Quest. Add and edit them to include new understandings and experiences from UNCOVER.
 - KNOW - What have you confirmed as accurate? Correct any inaccurate information.
 - NEED to know - Mark any questions that you have answered, and ones you still need and want to answer. Add new questions.
 - DO - Add any new project ideas you could do to help solve the problem.
- Return to the anchor question:** How can we help reduce plastic pollution on our beaches and in the ocean around Guam?
- Read and talk about the design challenge:** The plastic debris is accumulating on the beaches both from on island and from the ocean where it is brought in by the tides. Recycling on Guam is an ongoing issue and plastics in particular. Some islands have banned single-use plastics (plastic straws, bags, and water bottles). Design a plan to monitor and reduce the plastic debris that is found on our beaches and within

our surrounding ocean water. Discuss this to the class and how what you have uncovered relates to the design challenge.

5. **Explore these resources** and others you find, and decide on materials, investigations, etc.
 - a. Go here for ideas about procedure: [Scouting out marine plastics on the shores of Guam](#) Decide: What procedure was used to identify plastics on Guam beaches? How can we use what was done here to design a project to identify plastics and come up with a plan to help reduce them?
 - b. Video: Help your school reduce waste: organizing waste stations! [Kids Go Green! Waste Less](#) (PBS Media)
 - c. Get ideas and inspiration from watching video about this teen invention: First recognized as a valid invention: [Dutch teen designs giant 'plastic trap' to clean world's oceans](#)
 - d. And then watch [What he is doing now: Boyan Slat talks up his latest invention: The Interceptor.](#)
6. **Conduct a [school campus debris survey](#)** as practice before shifting focus to the beaches. Following the campus debris survey lesson plan, get outdoors to your school's campus, a nearby beach or park, or any outdoor location, and [complete a debris survey and cleanup](#).
7. **Make several decisions about your beach debris project.** Decide what beach you want your project to help. Decide what island expert(s) you could invite to advise you so your project is most effective. Define the criteria (what are you trying to do) and constraints (what are the limitations) of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific ideas and potential impacts on people and the natural environment that may limit possible solutions.

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- Design Challenge Map- Complete as much as you can. Then add to and edit it throughout SOLVE.
- Design Requirements and Limitations (criteria and constraints)



Solve

Use the engineering design process to design and do a project that helps SOLVE the problem.

Design Your Project

1. Determine how you will monitor marine debris to determine the extent of the problem in various areas on Guam. Use [Marine Debris Monitoring Toolkit](#) (MDMAP) for Educators for lessons, videos, and instructions on how to conduct a marine debris survey with your students. If you are new to MDMAP and looking for steps to get started:
 - a. Review the protocol documents and field datasheets in this toolbox.
 - b. Decide if you want to survey an existing active site, rejuvenate a historical site, or start a new MDMAP site in your area. A map of all existing MDMAP sites can be found [here](#).
 - c. [Request an account](#) if you'll be entering data. MDMAP staff will work with you to set up your account.
 - d. Reach out to md.monitoring@noaa.gov (link sends e-mail) with any questions.
2. Your steps will follow the [Engineering design process](#) (Poster). Gather class data and generate a map to indicate the areas tested where marine plastic debris is an issue. Explain and justify how the evidence supports your claim.

- a. Plan for removal and reduction of marine debris.
- b. If possible, test your solution multiple times. If you are planning to reduce the marine debris, explain how that would happen. If possible, test your solution and record your findings.
- c. Share your findings with other teams from your class and discuss what worked. (See Feedback pages in Design Notebook.)

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- Edit and complete the Design Challenge Map.
- Edit and complete the Design Requirements and Limitations (criteria and constraints)
- Action Plan: List steps to complete the project, and who will do what.
- Team Self-Review: Review your project design to make sure it is focused on the design challenge, anchor question, and Guam.
- Gathering Feedback from Others: Get input from others to help strengthen your project.
- Claim-Evidence-Reasoning (CER): Give evidence for the most effective project design.



Teach

Share your project with others to help others understand the problem and how your project helped solve it.

Share & Reflect on What You Learned

1. **Return to the anchor question:** How can we help reduce plastic pollution on our beaches and in the ocean around Guam?
2. **Students creatively share your project and how it helped solve the problem:**
 - a. Build your presentation around the anchor question. How can we help reduce plastic pollution on our beaches and in the ocean around Guam?
 - b. Who's your audience? Who will benefit from hearing about and seeing your project?
 - c. How will you share this information?
 - d. What do you want them to know and understand about the problem of marine debris, your findings when monitoring marine debris, and your proposed solution?
 - e. When and where will you share?
3. **Student reflection:** Students can reflect on their experience with this design challenge while preparing their presentation or afterwards. Here is one reflection idea. 4-3-2-1: Looking back, planning forward. Respond to:
 - a. FOUR of the most important things I learned doing this design challenge
 - b. THREE of the most important things I learned about myself doing this design challenge
 - c. TWO things I will do differently in my next problem-solving experience
 - d. ONE thing I now want to learn more about

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- TEACH. Make a plan for sharing your project with others.
- Looking back, planning forward. Reflect on what you did and what you might do next time.



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