ONE STEP™

A 2-FOR-1 POLLUTION SOLUTION

LESSON PLAN | GRADES 4–5

#stompoutcarbon for a better tomorrow!

The city of Douala, Cameroon has a major issue. It is a city that thrives mainly on fishing, but the water in the rivers are so polluted with plastic bottles that it is difficult for fish to survive, *and* for fishermen to catch enough fish to support themselves. Decreased fish yields mean less profit for fishermen, which exacerbates the problem of fishermen investing in expensive wooden boats.

C1E1 (7 mins)

Ecoboats: The Solution that Floats

Learn how one person solved two different problems at the same time! Could you solve a pollution crisis and a food shortage at the same time? That's what Ismael Essome is doing in Cameroon, Africa!

Thanks to the resourceful people at Madiba & Nature, this problem has a very unique solution: use the plastic bottles to make boats! These inventions, known as Ecoboats, clean the pollution and provide the local inhabitants with affordable boats for fishing. In this lesson and video, students will see how one young entrepreneur solves two problems with one solution, all while diverting tons of plastic waste. Ingenuity, creativity, and innovation are at the heart of this man's passion for the environment and the people of his city.

OBJECTIVES

Lesson Time: 1 hr 55 mins+

Lesson Description: In this lesson, students will learn about the problem of plastic pollution, especially plastic bottle pollution, and how this problem is being managed in different parts of the world. They will be introduced to the engineering process, and will use the engineering process to design and create an invention that solves a local community problem and upcycles waste materials. Finally, students will design a survey to help pinpoint ways to reduce waste in their own school community.

Students will:

- Students will learn about the value of engineers and the engineering process in solving problems.
- Students will discuss and analyze the negative impacts of plastic waste.
- Students will use the engineering process to create a design that solves multiple community problems.
- Students will analyze the success of their design and reflect on ways to improve their design.
- Students will create a survey to collect data about recycling and waste habits in their school community, and analyze the data to identify opportunities for reducing waste.

TO PREPARE

This lesson requires students to engineer a project by upcycling waste materials from common household materials, and will require 1–2 weeks of collection time before completing the lesson. Collect these materials yourself, set up a bin in the teacher's lounge requesting supplies from faculty, or send home a letter requesting supplies from families.

- **common household materials:** plastic bottles, bottle caps, paper towel/ toilet paper rolls, cardboard, milk jugs, egg cartons, etc.
- scissors, glue, tape

Vocabulary Words

Use the Vocabulary Slides to review these words and concepts as needed.

biodiversity: the variety of life in the world or in a particular ecosystem

economy: the way in which goods and services are made, sold, and used in a country or area

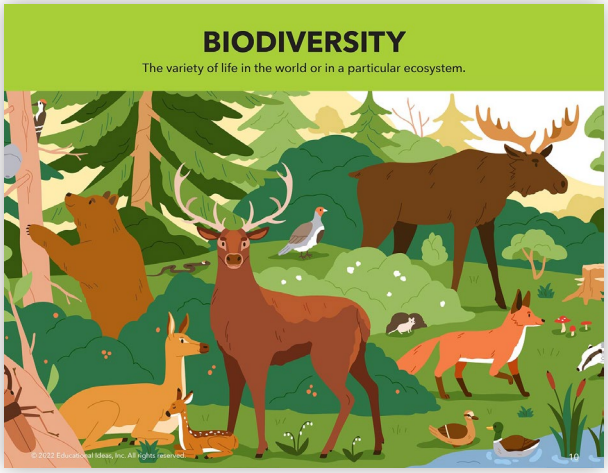
ecotourism: tourism directed toward natural environments intended to support conservation efforts

engineer: a scientist that solves problems by creating products or inventions

engineering process: a series of steps that engineers use to solve problems by creating products or inventions

innovation: a new idea, device, or method

upcycle: the reuse of an object or material that creates a product of higher quality or value than the original



Cross Curricular Lesson Suggestions

Math: Students count the number of plastic bottles each student uses per week and add them together. Then, work as a class to create a formula that will show how many weeks it would take for the class to use enough bottles to make an ecoboat.

Social Studies: Mark locations around the globe showing areas where fishing is the most important industry (Douala, Cameroon; La Higuera, Chile; Dutch Harbor, Alaska, United States; Vladivostok, Russia, etc.). Lead a discussion about what these locations have in common, and ask them to predict the most important industry before revealing it. Discuss the connection between geography and natural resources, and repeat the process with a different natural resource if desired.

ELA: Read about the Plastiki catamaran, created by environmentalist David de Rothschild. Discuss similarities and differences between Ecoboats and Plastiki, including the goal of each project.

Art: Organize a trash cleanup in your community for students. Encourage students to carefully collect trash (always wearing gloves) and design their own work of art with the materials to encourage others to reduce waste.

ENGAGE

10 mins

Engage students in a whole group discussion with the following prompts:

- What do you already know about engineering?
- What do engineers do?

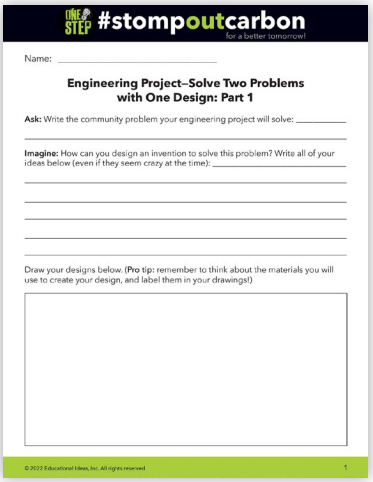
Watch NASA Kids' Intro to Engineering video. Engage students in a whole group discussion with the following prompts:

- What did you learn about the engineering process?
- What do engineers do, and why are they important?
- *(Discuss in partnerships, then share with the whole group.)* Waste, especially plastic waste, is a big problem worldwide. How could engineers help solve this problem?

EXPLORE

45 mins

Ancillary Materials: Global Plastic Bottle Statistics, Engineering Notebook (Part 1)


#stompoutcarbon
for a better tomorrow!

Name: _____

Engineering Project–Solve Two Problems with One Design: Part 1

Ask: Write the community problem your engineering project will solve: _____

Imagine: How can you design an invention to solve this problem? Write all of your ideas below (even if they seem crazy at the time): _____

Draw your designs below. (**Pro tip:** remember to think about the materials you will use to create your design, and label them in your drawings!)

© 2022 Educational Ideas, Inc. All rights reserved. 1

Explain to students that they will act as engineers and create something to solve problems. Tell them that one problem their project will address is plastic waste. Ask students to discuss the following prompts in partnerships:

- Think about a typical day. What are all the things you use that are made of plastic?
- How many plastic bottles do you use on a typical day? How many plastic bottles do you think are used every day around the globe?

Display Global Plastic Bottle Statistics and engage students in a whole group discussion with the following prompts:

- How many plastic bottles are used around the globe every day? *(**Note:** It may be helpful to write out 1.3 billion to help students grasp the enormity of the number.)*
- What surprises you most about this data?
- Where do you think these plastic bottles go?

Tell students that before you reveal the details of their engineering project, they will watch a video about another engineer for inspiration. Watch the video "Ecoboats" and engage students in a whole group discussion with the following prompts:

- How did you feel when you saw the plastic pollution in the rivers and oceans in Doula? What did you think about it?
- How might plastic pollution affect plants and animals in the environment?
- How does reducing pollution affect biodiversity? Why does that matter?
- What are the two problems that Ecoboats help solve?
- How could you use this story as inspiration to solve multiple problems in your community?

Explain to students that they will go through the engineering process in order to design and build a prototype that solves a community problem and uses waste materials, like the engineers at Madiba & Nature did with Ecoboats. Preselect a community problem and display it for students; suggested community problems include:

- Drought/flooding problems
- Not all families have enough money to buy their children toys
- Insufficient shade shelters

Note: *The list above is meant to be used as a guide only. The engineering project will be more meaningful if you choose a problem in the students' local community.*

Encourage students to be as creative as possible during the brainstorming process. The most creative ideas can create the most innovative solutions! Go over brainstorming guidelines with students as needed:

- Use your imagination when brainstorming.
- No negativity or disrespectful comments.
- Write down all ideas, even if they seem crazy at the time.
- Consider the materials you have to build with as you brainstorm - what's the function of each material? How could you use that material to help solve the community problem?
- Think about ways to build on each other's ideas, or combine ideas to come.

Divide students into small groups and distribute a copy of the Engineering Notebook (Part 1) to each student. Ask groups to brainstorm a prototype and record their ideas. Circulate and support groups as needed.

Note: *Based on timing and your students' familiarity with Internet research, you may choose to let students research their selected community problem before brainstorming solutions. Regardless, students should be given at least 15 minutes of uninterrupted brainstorming time.*

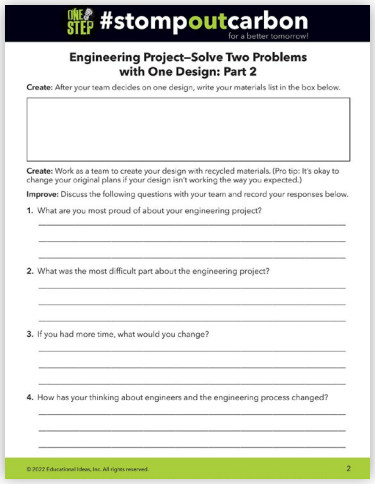
After students finish brainstorming, they should consider each member's design and choose a final design. Remind students that the final design choice can be one student's design or a combination of several student designs. Ask students to complete the materials list in their Engineering Notebook.

EXPLAIN

30 mins

Ancillary Materials: Engineering Notebook (Part 2)

Supplies: plastic/other common waste materials (suggested: plastic bottles, bottle caps, paper towel/toilet paper rolls, cardboard, milk jugs, egg cartons, etc.), tape, scissors, glue


ONE STEP #stompoutcarbon
for a better tomorrow!

Engineering Project–Solve Two Problems with One Design: Part 2

Create: After your team decides on one design, write your materials list in the box below.

Create: Work as a team to create your design with recycled materials. (Pro tip: It's okay to change your original plans if your design isn't working the way you expected.)

Improve: Discuss the following questions with your team and record your responses below.

1. What are you most proud of about your engineering project?
2. What was the most difficult part about the engineering project?
3. If you had more time, what would you change?
4. How has your thinking about engineers and the engineering process changed?

 2

Remind students that their goal is to create an invention that solves a community problem, and contributes to the plastic waste problem. Go over the rubric and answer any student questions before beginning. Distribute requested materials to each group along with tape, scissors, and glue. After students complete their model, ask them to complete the reflection found in their Engineering Notebook.

Ask each group to present their model to the group by answering the following prompts:

- Explain how your design works.
- How will your invention help solve our community problem?
- How would you improve your design if you had extra time?

ELABORATE

30 mins

Engage students in a whole group discussion with the following prompts:

- What types of disposable materials (water bottles, styrofoam trays, milk cartons, etc.) do you think we use the most at our school?
- Do you think most of these materials are thrown away or recycled?
- How could we figure that out?

Explain to students that they will design a survey with the objective of determining:

A) what category of disposable materials are used the most, or

B) if most recycled materials are thrown away or recycled.

ELABORATE *con't*

30 mins

Divide students into small groups and assign an objective to each group. Students should design a survey draft on a free website like Google Forms. *(**Note:** Google Forms will automatically organize data by question for easy analysis.)* After each small group designs their draft survey, they should share with other groups with the same objective for peer and teacher feedback, and combine ideas for one final survey. Once each survey is finalized, groups should share with their intended audience–specific grades of students or the entire student body–and then analyze results.

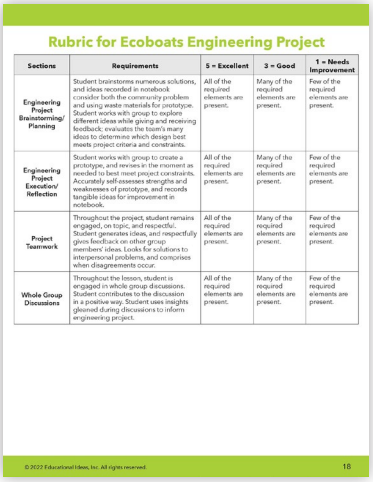
Optional Extension Project: Challenge students to create an awareness raising campaign based on the results of the survey. *(**Example:** If students find that a certain material isn't recycled often, they could create posters encouraging people to recycle that material. If students find that students use lots of plastic water bottles, they could create a poster encouraging students to use reusable water bottles.)*

EVALUATION

Ancillary Materials: Ecoboats Rubric

Evaluate students' efforts throughout the lesson by using the provided rubric.

***Note:** The goal of this rubric is to provide a holistic grade of students' efforts throughout the engineering project, including teamwork within small groups, creating design prototype and project reflection. The rubric also includes a section for whole group discussions throughout the lesson. Please feel free to alter the categories and/or points values based on the needs of your students.*



Rubric for Ecoboats Engineering Project

Sections	Requirements	5 = Excellent	3 = Good	1 = Needs Improvement
Engineering Project Brainstorming/ Planning	Student brainstorms numerous solutions, and ideas recorded in notebook consider both the community problem and using waste materials for prototype. Student works with group to explore different ideas while giving and receiving feedback; evaluates the team's many ideas to determine which design best meets project criteria and constraints.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.
Engineering Project Execution/ Reflection	Student works with group to create a prototype, and revises in the moment as needed to best meet project constraints. Accurately self-assesses strengths and weaknesses of prototype, and records tangible ideas for improvement in notebook.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.
Project Teamwork	Throughout the project, student remains engaged, on topic, and respectful. Student generates ideas, and respectfully gives feedback on other group members' ideas. Looks for solutions to interpersonal problems, and comprises when disagreements occur.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.
Whole Group Discussions	Throughout the lesson, student is engaged in whole group discussions. Student contributes to the discussion in a positive way. Student uses insights gleaned during discussions to inform engineering project.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.

 18

EXPLORE: GLOBAL PLASTIC BOTTLE STATISTICS

worldwide plastic bottle consumption

481.6

billion bottles in a year

40

billion bottles in a month

1.3

billion bottles in a day

54.9

million bottles in an hour

almost **1**

million bottles a minute

Drowning in Plastic: https://graphics.reuters.com/ENVIRONMENT-PLASTIC/0100B275155/index.html
Euromonitor International; Science Advances; Geyer et al (2017), Our World in Data; Reuters

That's like 5,500 bottles in the blink of an eye!

Vocabulary

BIODIVERSITY

The variety of life in the world or in a particular ecosystem.

ECONOMY

The way in which goods and services are made, sold, and used in a country or area.

ECOTOURISM

Tourism directed toward natural environments intended to support conservation efforts.

ENGINEER

A scientist that solves problems by creating products or inventions.

ENGINEERING PROCESS

A series of steps that engineers use to solve problems by creating products or inventions.

INNOVATION

A new idea, device, or method.

UPCYCLE

The reuse of an object or material that creates a product of higher quality or value than the original.

Rubric for Ecoboats Engineering Project

Sections	Requirements	5 = Excellent	3 = Good	1 = Needs Improvement
Engineering Project Brainstorming/ Planning	Student brainstorms numerous solutions, and ideas recorded in notebook consider both the community problem and using waste materials for prototype. Student works with group to explore different ideas while giving and receiving feedback; evaluates the team's many ideas to determine which design best meets project criteria and constraints.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.
Engineering Project Execution/ Reflection	Student works with group to create a prototype, and revises in the moment as needed to best meet project constraints. Accurately self-assesses strengths and weaknesses of prototype, and records tangible ideas for improvement in notebook.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.
Project Teamwork	Throughout the project, student remains engaged, on topic, and respectful. Student generates ideas, and respectfully gives feedback on other group members' ideas. Looks for solutions to interpersonal problems, and comprises when disagreements occur.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.
Whole Group Discussions	Throughout the lesson, student is engaged in whole group discussions. Student contributes to the discussion in a positive way. Student uses insights gleaned during discussions to inform engineering project.	All of the required elements are present.	Many of the required elements are present.	Few of the required elements are present.

5-ESS3–1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-5-ETS1–1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1–2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1–3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Constructing Explanations and Designing Solutions Planning and Carrying Out Investigations	**ESS3.C:** Human Impacts on Earth Systems **ETS1.A:** Defining and Delimiting Engineering Problems **ETS1.B:** Developing Possible Solutions **ETS1.C:** Optimizing the Design Solution	Systems and Systems Models Influence of Science, Engineering, and Technology on Society and the Natural World **Connections to Nature of Science** Science Addresses Questions About the Natural and Material World.

#stompoutcarbon

for a better tomorrow!

Student Materials

Name: _____

Engineering Project—Solve Two Problems with One Design: Part 1

Ask: Write the community problem your engineering project will solve: _____

_____

Imagine: How can you design an invention to solve this problem? Write all of your ideas below (even if they seem crazy at the time): _____

_____

_____

_____

_____

_____

Draw your designs below. (**Pro tip:** remember to think about the materials you will use to create your design, and label them in your drawings!)

Engineering Project—Solve Two Problems with One Design: Part 2

Create: After your team decides on one design, write your materials list in the box below.

Create: Work as a team to create your design with recycled materials. (**Pro tip:** It's okay to change your original plans if your design isn't working the way you expected.)

Improve: Discuss the following questions with your team and record your responses below.

1. What are you most proud of about your engineering project?

2. What was the most difficult part about the engineering project?

3. If you had more time, what would you change?

4. How has your thinking about engineers and the engineering process changed?