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Ocean Eco-Exploration

Objectives

Students wil be able to:

- **Research** and **explain** factors that contribute to climate change and how climate change affects the world's oceans.
- **Consider** actions humans can take to protect the ocean's ecosystems.
- **Design** and **create** a website mock-up of an eco-exploration experience that uses an autonomous sea vehicle to combat climate change.

Overview

In this lesson, students will imagine they are interns on a novel Eco-Exploration team. As such, students will be tasked with helping to expand Boeing's exploration goals from space to ocean—with a special focus on climate change. After learning about one of Boeing's autonomous undersea vessels, students will investigate climate change's effect on the world's oceans. They will then brainstorm and design how an eco-exploration experience could work with one of Boeing's vessels to teach the effects of climate change on our world's oceans, as well as steps eco-explorers can take to combat it in their daily lives.

This lesson focuses on:

Engineering Design Process

- Defining the Problem
- Designing Solutions

21st Century Skills

- Communication
- Collaboration
- Critical thinking
- Creativity

Timing

Two 60-minute class periods

Materials

DAY 1

- Computer or device with the ability to project, one for the instructor
- Image One, to project
- *Introduction to Eco-explorers* article, one per student
- Capture Sheet, one per student
- **Station 1**
  - Each group of 3-4 students will need:
    - Station 1 Directions, 1 copy.

- food storage (at least six inches by six inches), 2 containers.
  - small bowls that can fit upside-down in the food container with room to spare around the edges, 2.
  - two pieces of masking tape (each about 2-inches long).
  - ruler.
- A large bag of ice, stored in an insulated container (at least 80 ice cubes total)
- Pitcher or large bottle of water, one for the instructor
- Access to a faucet or enough water to fill each food container halfway

- **Station 2**
  - Station 2 Directions, 10 copies
  - *Oceans have been 'Taking the Heat' of Climate Change* article, 10 copies
  - Highlighters of various colors, at least 20

- **Station 3**
  - Station 3 Directions, 10 copies
  - Laptops or devices, at least 5
  - *Plastics Aren't Just Polluting* article, 10 copies
  - Highlighters of various colors, at least 20

- **Station 4**
  - Station 4 Directions, 10 copies
  - Laptops or devices, at least 5

DAY 2

- Design an Eco-explorer Adventure handout, one per student.
- Eco-explorer Web Page handout, one per student
- Laptops or devices, at least enough for half the class

Have you ever wondered…

What exactly is ecotourism/eco-exploration?

The International Ecotourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education." The principals of ecotourism include:

- minimizing impacts.
- building environmental and cultural awareness.
- providing direct financial benefits for conservation, local people, and private industry.
- raising sensitivity to and awareness of host countries' political, environmental, and social climates.
- creating low-impact facilities.
- working in partnership with Indigenous People.[1]

How is climate change affecting marine ecosystems?

Ocean temperatures are rising as the ocean absorbs extra carbon dioxide from the air. This has a dramatic impact on both marine animals and the ecosystems in which they live. Carbon dioxide, for instance, makes water more acidic. This ocean acidification is harmful to sea life, especially shellfish and coral. Increased ocean temperatures are also causing coral bleaching—which is when coral expels the algae that normally lives within it. This causes the coral to turn white and (unless the ocean temperature returns to normal) eventually die.[2]

In addition, increased stormy weather and changing climates is forcing many animals to shift the location of their homes as they try to find the water temperature and environment that is best for them. This can impact where, when, and if marine animals reproduce. Global warming also contributes to rising sea levels, which in turn affects ecosystems as coastal habitats are flooded, the amount of light reaching underwater ecosystems changes, and coastal ecosystems that require stable conditions struggle to survive.[3]

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Make Connections

How does this connect to students?

The past five years of ocean temperatures have been the highest five years ever recorded.

This high temperature does not only affects marine life and the ocean's ecosystems, but it also has a direct effect on students because the world in which they live is shifting and changing in unprecedented ways.

Warmer oceans, for instance, affect weather and tidal patterns—which can cause strong storms. In addition, the impact of changing temperatures on marine life can affect the variety and amount of food available for human consumption. Warmer oceans also contribute to rising sea levels, which can affect or even destroy coastal communities.[4]

How does this connect to careers?

Climatologist: These climate scientists study the influences and effects of the Earth's climate. They may use their findings to explore ways to tackle climate change and/or advise policy makers.

Renewable Energy Engineer: Renewable energy engineers work to help the world transition to renewable energy sources and production, such as wind, geothermal, solar, and hydropower. They may monitor current renewable energy systems or develop new ones.

Oceanographer:

Oceanographers focus on a specific area, such as marine life, ocean circulation, or the ocean's chemical properties. They perform research to gain a better scientific understanding of their focus area, and tackle important issues such as climate change.

How does this connect to our world?

Humans around the world are responsible for nearly the entire increase in greenhouse gases that have entered the atmosphere over the last two centuries. During this time, the ocean has absorbed 90% of the excess heat that these greenhouse gases trapped on Earth. While this helps reduce the temperature of the Earth as a whole, it negatively affects the world's oceans.[5]

A recent study shows that 2019 was another record-breaking year of ocean warming, and water temperatures reached the highest ever recorded. Rising temperatures are affecting the ocean's oxygen level and making the water more acidic—both of which affect marine ecosystems. Ocean warming is also changing currents and affecting weather systems at a rate to which the world is having difficulty adjusting. It is therefore up to governments, communities, and individuals around the world to unite in reducing emissions and combatting climate change.

Sources

[1] "What is Ecotourism?" The International Ecotourism Society. ecotourism.org/what-is-ecotourism/.

[2] "Everything You Need to Know About Coral Bleaching." World Wildlife Fund. worldwildlife.org/pages/everything-you-need-to-know-about-coral-bleaching-and-how-we-can-stop-it.

[3] "Climate Change." World Wildlife Fund. wwf.panda.org/our_work/oceans/problems/climate_change/.

[4] "Warmer Oceans." Environmental Protection Agency. archive.epa.gov/climatechange/kids/impacts/signs/oceans.html.

[5] "Understanding Sea Level." NASA. sealevel.nasa.gov/understanding-sea-level/global-sea-level/thermal-expansion.

[6] "Oceans are Warming…". CNN. edition.cnn.com/2020/01/13/world/climate-change-oceans-heat-intl/index.html.

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Blueprint for Discovery

DAY 1

1. Begin class by welcoming students to a "brand-new" Boeing team: Eco-exploration! Explain that students will imagine that Boeing is expanding its exploration goals from space and the sky to the ocean.

2. Project Image One and explain that this is a Boeing undersea vehicle called the Eco Voyager. It is an autonomous boat, which means it can drive and control itself without anyone onboard! It can be programmed to perform a variety of tasks—from collecting data to traveling to areas of the ocean that humans may not normally visit. Tell students that Boeing's challenge for their interns is to explore how they can use autonomous sea vehicles like this one for exploration, with a special focus on climate change.

3. Distribute one copy of the *Introduction to Ecotourism* article to each student, and instruct students to read the article aloud with a partner. Their objective for reading the article is to understand what ecotourism and eco-exploration are. As they read and try to understand this concept, they should annotate (or highlight/underline) 3 facts they learn, 2 things they find interesting, and one question they still have.

4. Once most pairs have finished reading and annotating the article, regain the class' attention. Ask them to summarize: What is ecotourism/eco-exploration?

5. Explain that in order for students to develop a plan that uses one of Boeing's autonomous boats to help humans learn about climate change, they must also have a strong understanding of how climate change is affecting the world's oceans.

    Divide the class into groups of three or four, and distribute one Capture Sheet to each student.

6. Go on to explain that the entire class will start with Station 1, because it must be completed in two parts. The first part will be completed now and the second part will be completed near the end of the class session.

    To prepare for the first part of Station 1:

    - Distribute the materials needed for Station 1 to each group.
    - Show students where they can find the ice and the water.
    - Instruct groups to read the Station 1 Directions and complete Part 1.

7. Once each group has completed Part 1 of Station 1, explain that each group will now split up. Over the next 15 minutes, each group member will explore a topic related to climate change that will help their group prepare for their eco-exploration challenge. As they explore these topics separately, they will use their Capture Sheet to record key take-aways. They will then regroup and share what they have learned with each other.

8. Show students where they can find each of the three stations, and instruct groups to decide who will go to each one. Then instruct students to go to their station, read the directions, and begin.

9. After about 10–12 minutes have passed, give a five-minute warning. If any students finish early, they may begin work at a second station of their choice.

10. Once an additional five minutes have passed, instruct students to find their original group members. They should each share what they learned at their station and explain what they recorded on their Capture Sheet. As each group member shares, the rest of the group should record notes on their own Capture Sheets.

11. Next, instruct each group to return to their Station 1 work and complete Part 2. As they do, explain that their "glaciers" have only started to melt. To simulate what it would look like if these glaciers had more time to melt, pour about a quarter of a cup of water into each group's glacier containers.

12. Once students have finished recording notes on their Capture Sheet, bring the class back together and spend a few minutes recapping the students' work with the following questions:

    - How is climate change affecting our world's oceans?
    - How does this in turn affect our world's plants, animals, and people?
    - What can humans do to counteract climate change and help our world's oceans?

13. Collect the students' Capture Sheets or instruct them to keep them in a safe place until the following session.

DAY 2

1. Welcome students back to their Boeing Eco-exploration Internship, and instruct students to take out their Capture Sheet and find their group members from the previous session. Then distribute one Design an Eco-exploration Adventure handout to each group.

2. Read the handout's directions aloud and reiterate that students will be following the step-by-step directions on this handout in order to brainstorm for their eco-exploration experience. Explain that they can assume that the autonomous sea vehicle can be programmed to perform nearly any task: from collecting samples or materials it comes across to recording measurements, taking pictures, etc.!

   Students should use the notes on their Capture Sheet to guide their brainstorming. If needed, they may also perform additional Internet research.

3. Continue to explain that once groups complete this handout, they will move on to creating a mock-up (or design) of a webpage that advertises their eco-exploration adventure. Show students where they can find this Eco-exploration Webpage handout, and again, remind them to carefully read the handout's direction when they get to this step.

4. Then instruct students to begin! When there are about 25–30 minutes left in the class session, encourage groups to wrap up the Design an Eco-exploration Adventure handout (if they haven't done so already), and move on to the Eco-exploration Webpage handout.

5. When there are 15 minutes left in the session, give students a five-minute warning. When five minutes are up, signal for the class' attention and explain what is about to take place. In a moment, each group will place their Eco-exploration Webpage handout around the classroom. Students will then walk around quietly and view the eco-exploration experiences that their peers have created. Instruct students to be ready to share which experiences they think would be most impactful and why.

6. Once students have observed their peers' work, wrap up the session by asking: Based on what you learned about climate change and its effects on the world's oceans, which experience(s) has the power to make the biggest difference? Invite a few students to share their thoughts.

7. Conclude by congratulating students on a successful start to their eco-exploration internship. Remind students that eco-exploration isn't the only way to combat climate change, and encourage students to try to help preserve our world's oceans by applying what they've learned here to their everyday lives.

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Extend

Students can create a campaign for their school community that teaches their peers about steps they can take to protect and preserve the world's oceans. They can apply what they have already learned, and perform additional research as they further consider what humans can do in their everyday life to reduce their carbon footprint and minimize their impact on Planet Earth.

National Standards

Next Generation Science Standards

Weather and Climate

- MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Human Impacts

- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- ESS3.C: Human Impacts on Earth Systems:
  - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
  - Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)

Common Core English Language Arts Standards

Reading:

- R.1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
- R.7: Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.

Writing:

- W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Speaking & Listening:

- SL.1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

Ocean Explorations

Station 1

1. In which scenario did the water level rise the most? Why?

2. What connections can you make between this activity and climate change?

3. How could what you learned in this station affect animals and people who live in and around the ocean?

Station 2

1. If you were responsible for teaching others about how climate change is affecting the world's oceans, what key facts should they know?

2. How could the ocean help us combat climate change?

Station 3

1. How is plastic negatively effecting oceans and marine ecosystems?

2. What can individuals do to help this problem?

Station 4

What steps (big and small) can individuals take to fight climate change and help protect our world's oceans?

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Station One Directions

Directions: This station will be completed in two parts. After you complete Part One, you will regroup at the end of the class session to complete Part Two.

Part One

1. Place a bowl open-side down inside one container. Then fill the container with water, until the bowl is about halfway covered. You now have an **island**.

2. Place four ice cubes in the water. These are your **icebergs**.

3. Insert a ruler into the water and measure how much of the island is underwater to the nearest 1/8 centimeter.

4. Record this measurement on a piece of masking tape. On this piece of masking tape, also write "Icebergs." Then place the tape on the outside of the container.

5. Next, place your second bowl open-side down inside your second container. Make another island by filling the container with water until the bowl is about halfway covered.

6. Place as many ice cubes as you can <u>on top</u> of your island. You now have a **glacier**.

7. Insert a ruler into the water and measure how much of the island is underwater to the nearest 1/8 centimeter.

8. Record this measurement on a piece of masking tape. On this piece of masking tape, also write "Glacier." Then place the tape on the outside of the container.

Part Two

1. Measure how much of the island in the **iceberg** container is now underwater. Record this to the nearest 1/8 of a centimeter here: _____

   Compare this to the original measurement on the container's masking tape. Discuss: What do you notice? Why do you think this is the case?

2. Measure how much of the island in the **glacier** container is now underwater. Record this to the nearest 1/8 of a centimeter here: _____

   Compare this to the original measurement on the masking tape. Discuss: What do you notice? Why do you think this is the case?

3. Answer the Station One Questions on your Capture Sheet.

Station 2 Directions

1. Find a partner at your station. Together, read the *Oceans Have Been 'Taking the Heat' of Climate Change* article.

2. As you read, highlight:

    *   the effects of climate change on the ocean in one color.

    *   how the ocean could help combat climate change in a second color.

3. Answer the questions for Station Two on your Capture Sheet.

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Station 3 Directions

1. Find a partner at your station. Together, read the *Plastics Aren't Just Polluting—They're Making Climate Change Worse* article.

2. As you read:

    *   highlight the effects of plastic in one color.

    *   highlight steps that can be taken to lessen these effects in a second color.

3. Then use your annotations to begin to answer the questions for Station Three on your Capture Sheet.

4. Next, watch the video available on the top of this webpage: tinyurl.com/u8xowqm. As you watch, jot any additional answers to the questions for Station Three on your Capture Sheet.

5. If you have time remaining, brainstorm and discuss other ways humans may be able to reduce the amount of plastic that they use in their day-to-day lives.

Station 4 Directions

1. Work with one or two others at your station. First, discuss what you already know: What actions can individuals take to fight climate change and help protect our world's oceans? Jot these ideas in the Station Four box on your Capture Sheet.

2. Next, use the Internet to research additional answers to this question. Begin with the NBC News article available at tinyurl.com/relgauo before you search for other sources. Continue to add new ideas to your Capture Sheet.

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Directions: During your eco-adventure, humans will travel to a location of your choice. At this location, they will use an autonomous sea vehicle to learn about climate change's effects on the ocean, discover how they can help the environment, and have fun! With your group, follow the steps below to build your adventure.

Step 1: Where will humans travel to? Choose a coastal area so the autonomous boat will be easily accessible. Also think about where would be best for learning about climate change. Below, jot the location and explain why you chose this area.

Step 2: Brainstorm: What could humans do *and* learn on this eco-adventure? How could the autonomous boat help accomplish this?

Use your Capture Sheet to think about data, samples, or anything else that would help humans learn about climate change or help the environment. Brainstorm several ideas and record them in the chart below.

Eco-explorers could experience/learn/help/do:	The autonomous vessel could help with this by:

Step 4: When your brainstorming is complete, choose one or two ideas that you believe could have the largest impact on climate change. (This could be accomplished through education *or* action!)

Circle the idea(s) that your group will move forward with.

Step 5: There are many different STEM careers related to the ocean. Browse the list available at tinyurl.com/yb8a5vff. Then, choose at least one career that could help your eco-explorer learn more about the idea(s) you just selected. Write their title and what they could help eco-explorists learn below:

Step 6: Consider the impact: How will this eco-exploration experience help combat climate change?

Step 7: Your brainstorming is complete! Use this work to help you design your Eco-exploration Web Page.

Eco-exploration Web Page

Directions: Now that you have thought through your eco-exploration adventure, draw a mock-up (or design) of a webpage that tells humans about this experience and tries to persuade them to sign up!

Be sure to include: 1) Where humans will travel; 2) What humans will do; 3) What the autonomous boat will help them accomplish; 4) Who the humans will learn from, and 5) How the experience will benefit the environment.

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