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BASIS Lesson Plan

Lesson Name: "Driving the Ocean's Future": Ocean Acidification

Grade Level Connection(s)
NGSS Standards: NGSS Grade 5: ESS3-1: Protecting Earth's Resources
Environmental Principles and Concepts Principle II, Concept A

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

The world and oceans around us are sensitive environments that interact deeply with human presence and activity. Have you ever stopped to think about what your individual impact is on the oceans and how you can change it? With "Driving the Ocean's Future", your students can learn about all of this and more!

Lesson Objectives

- Students will discover the various impacts that ocean acidification has on marine ecosystems (shell dissolution, changing pH, coral bleaching).
- Students will gain a personalized and holistic perspective about climate change and how their actions directly impact the ocean (specifically fossil fuel use from driving).
- Students will learn how to make scientific observations and generate hypotheses about ocean acidification and shell dissolution.

Vocabulary Words

- **Ocean Acidification**: The process in which CO2 is absorbed by the ocean, changing the seawater's chemistry and habitats that animals live in.
- **Climate Change**: Changes in Earth's ecosystems and natural processes caused by human actions and resource use.
- **pH**: How acidic or basic something is

- **Carbon Footprint**: the amount of carbon emitted due to the consumption of fossil fuels by a person or group
- **Carbon Emission**: The release of carbon into the atmosphere

Materials

Scientist Volunteers will bring:

- pH strips (15 per lesson)
- Pipettes (30)
- Shells (5)
- Food coloring (1 set)
- Vinegar (1 container)
- 15 Cups (mason jars)

Materials teachers should provide:

- **Projector and screen, laptop**
- **Water (sink is fine)**
- **Whiteboard and whiteboard marker**
- **Pencil and Paper for each student**

Classroom Set-Up

Introduction will start at the front of the classroom with a PowerPoint presentation. We will need access to a projector and whiteboard/chalkboard for this. Then, we will break into 3 groups. Within those groups, have the kids pair up and give each pair a mason jar that will be filled with water, so we will need access to a sink as well.

Classroom Visit

1. **Introduction** (20 minutes)

Role Model Introduction:

Being a role model for students is an important part of being a BASIS volunteer. Begin your lesson by introducing yourselves! Every team member should take a moment to explain who they are and what they study/do as a scientist. A bonus will be to tell your "story," as if giving an elevator pitch to 8-year-olds: Why did you become a scientist? What made you interested in your topic? Why should students relate to you, or be interested in you? Feel free to draft a

script of what you will say, here. And remember, you can also weave your story throughout your lesson through examples from your own life, and/or return to it with Q&A at the end.

Topic Introduction:

Climate change is everywhere around us. It affects the air we breathe, the sky above us, and the oceans we swim or fish in. However, not everyone takes care of our environment the way we should. There are a lot of problems in the world concerning **carbon emissions** and the impact we personally make on the environment. Many things we use every day release carbon dioxide into the atmosphere like driving cars, using electricity, and using water in our houses or at school. Usually, trees work by absorbing carbon dioxide from the atmosphere. However, when there is too much carbon dioxide in the atmosphere, it can start going into places it doesn't belong. **Ocean acidification** is one of these large issues and is something that drastically affects the habitats of the animals that call the ocean their home. It results from the absorption of the atmosphere's carbon dioxide in the water, creating unfavorable acidic conditions.

Today we are going to explore the impact you have by emitting carbon into the atmosphere, what happens with that carbon in the ocean, and how it affects the lives of the ocean animals in a bad way sometimes.

- Ask the students: Has anyone ever heard about climate change? What does that mean to you?
- Follow-up question: Given our ideas about what climate change is, what do you think ocean acidification means? How does it relate to climate change?
- Why do we think this is important to learn?
- How do the fish and ocean animals cycle back to affect you? Think about the cycle of nutrients on Earth. You emit carbon, the ocean becomes acidic, fishes die, you need fish to eat as nutrients but if the fish are dead, what will you eat? - Negative effect on your lifestyle in the end.

ACTIVITY: Calculation of Driving Footprint:

- How many of you drive to school? How long is that drive?
  200 grams of C02 per minute of driving (~25-30 mph assumed), [400g/mile]
- Pick one person's answer and write out a calculation on the whiteboard/chalkboard.
- Multiply the minutes driven by the 200g to see how many grams overall were exhausted in the drive to school. Multiply this by 2 if they drive to and from school, then multiply that by the number of days in the school year. (probably around 180) This equals the carbon footprint of <u>only driving</u>
- 1 Metric Ton = 1,000,000 grams = 2,000 pounds
- This is only one small part of the impact you make. Your **carbon footprint** encompasses a lot of other things you use that emit carbon.

- What are some ideas of other things that may make the atmosphere carbon emission problem worse that we haven't already talked about? (If they don't have ideas, suggest things like planes, cutting down trees [deforestation])

Now that we've learned about the amount of carbon we emit with a drive to school, let's turn to seeing what it means to create acidic conditions for the sealife and how that affects some of their homes. (This leads into the pH and shell activity, you'll need to now split the class into 3 groups)

2. Learning Experience (25 minutes)

Activity 1: pH Testing (done in pairs in the three groups)
Our first activity will be students learning how water becomes more acidic when it absorbs carbon, displaying to the children how the ocean is reacting to climate change.

- To set up, give each pair a mason jar filled about halfway with water and a cup of vinegar (that is dyed black to symbolize the pollution and carbon we add to the ocean via the burning of fossil fuels). Explain that the dark liquid represents the carbon emission from the topic introduction.
- Each pair will then use pH strips to take the pH of the regular water. BASIS instructors will demonstrate how to use the pH strips and lead a brief introduction into what pH is and how it impacts ocean life. They can mention how many sea animals rely on very specific water conditions to survive and how even the smallest changes to things like temperature and pH can cause a big change.
- In their pairs, the students will pipette vinegar (that is dyed black with food dye) into cups of water. After pipetting, they will test the pH of the water using pH strips. The students will repeat this process 3 times so that they can see the progression of acidification and understand that more CO_2 absorption causes more acidification.
- The BASIS instructor will then explain that this is the exact process that occurs in the ocean when it absorbs CO_2 and describe how the more acidic conditions cause changes to ecosystems and habitats (e.g. coral bleaching, changes to available food, water temperature…). This will act as a segway into the next activity of shell dissolution.

Activity 2: Shell Dissolution
The next activity will exemplify how animals in the ocean are reacting to their changing climate. Instructors can compare this to how humans are reacting to our changing climate (e.g. drought, higher temperatures…) and lead a discussion. This activity will be a demonstration of what happens to calcium carbonate shells when the ocean becomes more acidic.

- First, the BASIS instructor will ask the students to make a hypothesis of what will happen when they drop a shell into the acidic solution (vinegar). The students will write their hypothesis on the same page as their carbon footprint calculations.
- Then, each BASIS instructor will place a shell into a mason jar filled with vinegar (that is not dyed so kids can see into the jar) and ask the students to record their observations of the shell. Note: The shell should slowly bubble away—ask students what they observe

Note: Shells are made of Calcium Carbonate ($CaCO_3$)—can ask students where they may have heard about Calcium before—for bone growth

- Then, one BASIS instructor will play a youtube video on the projector at the front showing how the shell dissolves when put into the vinegar. The shell takes hours to dissolve so the kids will not be able to watch the shell dissolve completely during the lesson.
- The instructors will then lead discussions in each of their individual groups about the implications of shells dissolving (e.g. crabs will not have a home).

Activity 3: 4 Corners of the Oceans

The final activity will be a game of 4 corners to simulate the loss of marine biodiversity due to ocean acidification. This will act as a wrap up activity to bring these ideas to life, allowing children to simulate the experience that marine wildlife are going through because of climate change and ocean acidification.

- The class will come together and the BASIS instructors will explain a scenario in which the US has greatly increased fossil fuel usage, causing intense ocean acidification.
- The instructors will then start a game of 4 corners, having one volunteer student pick the corners being called. At the end of each round, the student will choose a corner, explaining how this anthropogenic climate change destroyed that habitat, causing the animals in that corner to die. Each of these will be real life scenarios of habitats destroyed by ocean acidification (Great Barrier Reef death, crabs losing shells, mangrove forests collapsing due to lack of nutrients …).
- After playing, the class will move to their seats to have the closing discussion about how this "habitat loss" makes them feel and set the stage for the closing discussion.

3. Wrap Up: Review and Discuss the Learning Experience (10 minutes)

It's important to leave time to **review** and **discuss** the learning experience at the end of the lesson. This might take the form of discussing conclusions from an experiment; or review of the take-away of the lesson

- Can anyone summarize what we learned about today?
- How did this lesson change your perspective on how big of an impact you can have as an individual person?
- Does anyone have ideas about immediate changes they might make to their lifestyle to decrease their footprint?
- Does anyone still have questions that haven't been answered or new questions?

4. Connections & Close (5 minutes)

Connections to the real world around students:

The BASIS instructors will facilitate a discussion centered on how the children think that they can reduce the amount of ocean acidification they cause. Instructors can also discuss

the importance of coral reefs and fisheries by explaining that roughly three billion people rely on fish for their main source of protein and asking kids if they eat seafood.
Possible Discussion Questions

- How can you reduce your fossil fuel usage and carbon footprint at home?
- What are the pros and cons of renewable energy? Is it the perfect solution to this?
- What are the 5 R's (reduce, reuse, recycle, refuse, rot) and how can you implement them?
- How can you help reduce climate change? What solutions to these issues (e.g. coral farming, clean energy…).

Close:
Wrap up as a role model by leaving a few minutes for students to ask questions about science, about being a scientist, and about becoming a scientist. Then, thanks and goodbye!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove
- http://www.crscience.org/educators/SpanishResources

Standards Connections

NGSS Standards: NGSS Grade 5: ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment

Environmental Principles and Concepts Principle II: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human society.
Concept A: Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.