TOWNGREEN2025
Lower School Climate-Change Curriculum

Unit

Ocean Acidification: Seeking Local Solutions to a Global Challenge

Fourth-Grade Climate Change Unit
Authors: Kellie Barrett and Noelle Cormier. Created for TownGreen2025, Summer 2018

CC Climate Change Curriculum

Unit Title:

Ocean Acidification: Seeking Local Solutions to a Global Challenge

Unit Description:

Throughout this unit, students develop an understanding of global climate change and the ways in which it is impacting our. Beginning with the basics, students will examine Earth as an interconnected system and how interactions across spheres occur and help to maintain the delicate balance necessary to support life. Learners engage in experiments to develop a deeper understanding of various cycles and how those cycles are influenced by human activity. Finally, students will extend their newly acquired insights to the ocean, analyzing how the ocean is being impacted by changes brought about by humans in other spheres of the Earth [would it be useful to define "spheres" in this context, or will this be clear enough?]. The culminating activity requires learners to research solutions that address the root causes of ocean acidification.

Theme: Ocean Acidification

Grade Level: 4
Number of Lessons for the Unit: 10
Authors: Kellie Barrett and Noelle Cormier

Unit Goals:

Students will be able to:

1. Explain what ocean acidification is and identify the factors that cause it.
2. Describe how ocean acidification impacts marine structures.
3. Gather and present information about the causes and effects of ocean acidification as well as potential solutions to address the issue.

Standards:

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*

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.

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Lesson #1

Earth as a System

Standard(s):

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

Lesson Objectives

Students will be able to:

- Identify features within each of Earth's four spheres

Materials:

- Plastic container with cover
- One cup of white distilled vinegar
- Sea shells
- Razor clam
- Sea urchin
- Mussel
- Clam
- Lobster claw/leg
- Two items that are safe to be tossed around a circle (balls, stuffed animals, etc.)
- Youtube videos (see attachments):
- *https://www.youtube.com/watch?v=VMxjzWHbyFM*
- *https://www.youtube.com/watch?v=UXh_7wbnS3A&t=92s*
- Poster paper for students
- Chart paper for teacher
- Science notebook
- Computer access

Essential Vocabulary:

- System
- Sphere
- Geosphere
- Hydrosphere
- Biosphere
- Atmosphere
- Relationship
- Interaction

Chalenges

Anticipated Challenges	Student Supports
The videos contain a lot of content-specific vocabulary.	Provide a graphic organizer for students to develop pictorial representations of vocabulary terms along with definitions.
Videos about Earth's systems move quickly through content.	Chunk videos into smaller pieces and insert questions to allow students time to process and discuss content with peers. Enable closed-captioning so that students can have multiple means of accessing content.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Vocabulary graphic organizer
- Evidence of Earth's spheres template
- Earth's systems poster

Methods:

Unit Hook

1. Explain to students that in order to conduct an experiment that will be relevant later in the unit, you are going to place shells of various marine organisms in vinegar.
2. Place shells in vinegar and ask students to make a prediction in their notebooks about what will happen to each shell over time.

Lesson Hook: group juggling activity

1. Explain to students that they will be engaging in a group juggling activity and it will be important for them to adhere to the following directions:
   - A. Form a circle where everyone is shoulder-width apart from both neighbors.
   - B. Before tossing the ball to someone within the circle, you must call the name of the person you intend to throw the ball to.
   - C. The person who receives the ball says "Thank you" to the thrower.
   - D. The process continues until the ball reaches the original thrower.
2. Debrief initial round of group juggling.
   - A. Ask students how the class worked together to be successful.
   - B. Ask students if anything could be improved upon to ensure greater success moving forward.
   - C. Explain to students that they will do the activity again, but this time with an additional object to pass around, following the same rules as before.
3. Students do second round of group juggling activity with the additional object.
4. Debrief second round of group juggling.
   - A. Ask students again how the class worked together to be successful and what new challenges arose with the added object.
5. Introduce lesson:
   - A. Today we are going to be exploring what makes the Earth a system. Later on, we will discuss how this activity related to the Earth as a system.

Lesson Body:

1. Explain to students that they will be watching two videos about Earth as a system. The videos contain prompting questions throughout, so students should be prepared to take notes in the provided vocabulary graphic organizer, as well as to discuss the questions with their partner.
2. Students view Crash Course Earth's Systems Part One up to 2:12 and Part Two up to 1:30 and take notes within their graphic organizers.
3. Explain to students that they will take a nature walk outside to find evidence of each of Earth's four spheres. As they find evidence of each sphere, they should record it onto the provided note-taking template.
   - A. Students record evidence of each of Earth's four spheres outside.
   - B. Share out examples of evidence of Earth's systems as a whole group and chart students' ideas.

C. Explain to students that they will be assigned a partner to work with to create an illustration of each of Earth's four spheres and at least two features within each sphere. Tell students that they should color-code their drawings so it is easy to determine which feature belongs to which sphere.

Lesson Closing

1. Ask students to turn and talk with each other to discuss how the group juggling activity connects to Earth's four spheres working together as a system.
2. Share out ideas.

Attachments

- *https://www.youtube.com/watch?v=VMxjzWHbyFM*
- *https://www.youtube.com/watch?v=UXh_7wbnS3A&t=92s*
- Vocabulary graphic organizer
- Evidence of Earth's spheres template

Lesson #2:
Creating a Model of Earth as a System

Standard(s):

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

Lesson Objectives :

Students will be able to:

- Develop a model to represent each of Earth's four systems and explain how they are dependent upon one another to support life.

Materials:

- Terrarium materials for each pair of students
- Two soda bottle terrariums
- Three cups of soil
- Five radish seeds
- 1/4 cup water
- Two recipe cards
- One package of aluminum foil
- Computer access

Essential Vocabulary:

- Model
- Dependent
- Terrarium
- Photosynthesis

Chalenges

Anticipated Challenges	Student Supports
Features of Earth's spheres are not all tangible or visible, so concepts may seem abstract to students.	Students are given the opportunity to develop two terrariums that model Earth's spheres. These models enable students to observe evidence of each sphere up-close.
Assembly of the terrariums involves the use of fine-motor skills.	Students will be placed into heterogeneous groups to allow for peer support.
Lack of background knowledge and content-specific vocabulary could make it difficult for students to demonstrate an understanding of newly developed concepts.	The use of Book Creator allows students to demonstrate understanding with the support of speech-to-text technology and drawing features. [Does Book Creator need to be explained?]

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Kahoot quiz
- Terrarium Venn Diagram
- Book Creator

Methods:

Lesson Hook

1. Students complete kahoot quiz as a review of Earth's four spheres and the features within each.

Lesson Body

1. Explain to students that today they will be working with a partner to create two models of Earth as a system. The objective of this project is to determine which terrarium better supports life and why. They will be provided with all of the materials they need to build the models as well as specific instructions that detail how to put the models together.
   - A. Define model and offer different examples of models. Ask for student input.
   - B. Discuss what plants need in order to grow.
   - C. Divide students into pairs.
   - D. Pass out recipe cards for two models to each pair of students.
   - E. Students read recipe cards to determine what they need to do in order to build their models.
2. Student pairs build two Earth's systems terrariums.
   - A. Provide each pair of students with necessary materials.
   - B. Students build terrariums using recipe cards to guide them.
3. Initiate class discussion about models.
   - A. Share with students that although one difference between the two models they create may be the absence of sunlight, the sun is not a part of our Earth's spheres. However, it impacts our system, as it is necessary for energy within the spheres.
   - B. Ask students how they will know whether or not the atmosphere is represented within the model, since features of the atmosphere are largely invisible.
4. Students analyze models.
   - A. Students use a Venn Diagram to compare and contrast terrariums based on the materials used.
   - B. Students identify the sphere that each material corresponds to.
   - C. Instruct students to make a prediction as to which terrarium will better support the biosphere or living things.

Lesson Closing

1. Students use Book Creator to draw a representation of each sphere and write one sentence that explains how the geosphere, hydrosphere, and atmosphere support life within the biosphere.

Attachments

- Terrarium overview
- Kahoot quiz
- Terrarium recipe cards
- Terrarium Venn Diagram
- Book Creator Link

Lesson #3:
The Water Cycle

Standard(s):

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.

Lesson Objectives:

Students will be able to:

- Describe the water cycle
- Explain how the water cycle involves interactions between Earth's spheres
- Discuss the effects of the water cycle on ecology and the environment

Materials:

- Cardboard tray for each pair of students (box cover works well)
- One sheet of 9X13" paper for each pair of students
- Yellow, blue, and red markers
- Spray bottle filled with water
- Chart paper
- Computer access
- Plastic bowl (mixing-bowl size)
- Cling film
- Mug
- Large rubber band
- Water
- Chart paper for teacher

Essential Vocabulary:

- Cycle
- Evaporation
- Condensation
- Precipitation
- Absorption
- Runoff
- Minerals
- Watershed
- Pollution
- Sediment

Chalenges

Anticipated Challenges	Student Supports
Video contains content-specific vocabulary.	Students organize vocabulary terms into a diagram with pictorial representations and a word box.
Water-cycle video moves at a brisk pace.	Chunk videos into smaller pieces and insert questions to allow students time to discuss content with peers and fill in a diagram. Enable closed-captioning so that students can have multiple means of accessing content.

Not all parts of the water cycle are visible or tangible, so concepts may seem abstract to students.	Students observe a model of the water cycle to illustrate what the steps of the cycle actually look like on a smaller scale.
Lack of background knowledge and content-specific vocabulary could make it difficult for students to demonstrate an understanding in writing.	Flipgrid video response enables students to rehearse their response before recording and to demonstrate knowledge orally.
Assembly of mountains involves the use of fine motor skills.	Students will be placed into heterogeneous groups to allow for peer support.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Water-cycle diagram
- Runoff experiment
- Flipgrid exit ticket

Methods:

Before the start of the lesson, prepare model of water cycle.

1. Place mug in center of plastic bowl.
2. Fill the bowl with hot water 2/3 of the way up the side of the mug, making sure no water falls into the mug.
3. Cover the entire bowl with cling film, pulling it taut and extending down the side of the bowl.
4. Stretch the rubber band around the bowl, sealing and holding the film directly against the bowl.

Lesson Hook

1. 1. Define "cycle" and instruct student pairs to brainstorm cycles that they are familiar with.
   - A. a. Share out examples.
   - B. b. Explain that students will be exploring the water cycle and the interaction between spheres that it involves.

Lesson Body

1. Tell students they will be watching a video about the water cycle. The video contains prompting questions throughout, so students should be prepared to discuss questions with their partners as they view the video.
2. Show students the wate-cycle model and discuss students' predictions in response to these questions:
   - A. What do you think will happen when this bowl is placed in sunlight?
   - B. How will this model illustrate the water cycle?
3. Place model outside in sunlight, explaining that students will revisit the model at the end of the lesson.
4. Provide students with a diagram of the water cycle. Instruct them to work with a partner to use the terms in the word box to label the diagram. Review as a whole group.
5. Explain to students that, now that they have a basic understanding of the water cycle, they will be conducting an experiment in order to develop an understanding of what happens to water after precipitation falls.
6. Students conduct runoff experiment.

7. Debrief experiment in a whole-class discussion and chart responses
   A. What happened to the watersheds after precipitation fell?
   B. What are the differences between the watersheds?
   C. What does this pollution mean for the environment as a whole?
   D. Using your knowledge of the water cycle, how might polluted oceans affect all of Earth's spheres?
8. Revisit the water-cycle model and have students work in pairs to create a Flipgrid video response to explain how the model replicates the water cycle in real life. Remind students that they should use their diagrams to support their responses.
9. Students submit video response.
10. Share out.

Attachments

1. Video link
2. Water-cycle diagram
3. Runoff experiment directions
4. Flipgrid

Lesson #4:

Carbon—The Building Block of Life

https://www.calacademy.org/educators/lesson-plans/carbon-cycle-role-play

Standard(s):

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment..

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Lesson Objectives:

Students will be able to:

- Explain that carbon comprises all living things and many non-living things on Earth.
- Identify the processes by which carbon cycles through the Earth
- Define carbon sink and carbon source
- Identify a human activity contributing to the imbalance of CO_2 in atmosphere

Materials:

- Coal
- Pencil
- Plant
- Seashell
- Carbonated water
- Cotton t-shirt
- Computer access
- Video one→ *https://www.youtube.com/watch?v=WKRV8cM6-kk*
- Video two→ *https://archive.epa.gov/climatechange/kids/flash/1-2-3/carboncycle.html*
- Carbon sink versus source T-Chart (one per student)
- Exit ticket (one per student)

Essential Vocabulary:

- Carbon
- Carbon dioxide
- Carbon footprint
- Transfer
- Photosynthesis
- Respiration
- Combustion
- Dissolve
- Decomposition
- Carbon sink
- Carbon source
- Fossil fuels

Anticipated Challenges	Student Supports
Students lack relevant background knowledge about carbon.	Carbon video helps students to gather ideas about what carbon is and begin to develop a mental image of what it can look like. Moreover, students can watch the video as many times as they need to in order to understand content.
Videos contain content-specific vocabulary.	Chunk videos into smaller pieces and insert questions to allow students time to process and discuss content with peers. Enable closed-captioning so that students can have multiple means of accessing content.

Evaluation/Assessment: (directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End-of-Lesson Assessment)

- Carbon sink versus source t-chart
- Exit ticket

Methods:

Lesson Hook

1. Present the following items and ask students to record a prediction about one thing all of the items have in common.
   - A. Coal
   - B. Pencil
   - C. Plant
   - D. Seashell
   - E. Carbonated water
   - F. Cotton t-shirt
   - G. All of us

Lesson Body

2. Tell students that they will be watching a video about carbon and the carbon cycle. The video will provide an overview of what carbon is and how it cycles through the Earth.
   - A. Students watch video.
   - B. What is one important takeaway?
3. Initiate whole-group discussion.
   - A. How is the carbon cycle similar to the water cycle? How is it different?
     1. Project visuals of both cycles on the board.
     2. Review water cycle.
     3. Discuss similarities and differences between the two cycles.
4. Differentiate between carbon sink and carbon source.
   - A. Define carbon sink and carbon source.
   - B. Tell students they will watch another video about the carbon cycle, but this time the focus will be on identifying different carbon sinks and sources.
   - C. Students watch video and fill in T-chart with partner.
   - D. No text for item d. Delete?

Lesson Closing

5. Exit Ticket: What is one human activity that is contributing to an imbalance of CO_2 in the atmosphere? Do you have any ideas for a potential solution?

Attachments

- Carbon sink versus source t-chart
- Exit ticket

Lesson #5:
The Carbon Cycle

Standard(s):

4-ESS3-1. Obtain and combine information to describe how energy and fuels are derived from natural resources and how their uses affect the environment.

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Lesson Objectives:

Students will be able to:

- Explain that there is a finite amount of carbon on Earth
- Model how carbon moves around in the environment, from one place to another
- Identify how humans influence the carbon cycle

Materials:

- Seven dice
- Seven station signs
- Seven movement directions
- Data-recording sheets
- Three gallon buckets
- Duct tape/electrical tape
- Two solo cups
- One dixie cup
- Hose
- Large graph paper (chart size)

Essential Vocabulary:

- Greenhouse gas
- Emissions
- Respiration
- Photosynthesis
- Combustion
- Decomposition
- Dissolve

Anticipated Challenges	Student Supports
The carbon cycle is not tangible or visible, so concepts may seem abstract to students.	The carbon cycle role-playing activity illustrates the cycle so students can see what the cycling of carbon actually looks like.
The carbon cycle is a complex process that moves in multiple directions.	As students role-play, they trace their paths through the cycle, so they can see many of the different ways that carbon can move.
The carbon cycle role-play requires students to read directions that involve content-specific vocabulary.	Discuss vocabulary before beginning the activity. Directions include pictorial representations to aid with comprehension.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Role play
- Video question discussion
- Exit ticket

Methods:

Lesson Hook:

1. Water activity
   - A. **Before lesson, prepare activity materials.
   - B. Divide class into two even teams.
   - C. Explain that students are going to be partaking in a relay race.
   - D. Team A's objective is to fill the group bucket above the marked line within the given amount of time.
   - E. Team B's objective is to keep the water below the marked line within the given amount of time.
   - F. Each team should form a line. The person in the front of the line begins the relay, and the next person may carry on only once the first person has handed off the cup. Remind students that Team A should be scooping water out of their team bucket and pouring it into the group bucket. Team B should be scooping water out of the group bucket and pouring it into their team bucket.
   - G. Round one→ provide Teams A and B with the same size cup.
   - H. Round two→ provide Team A with a larger cup than Team B.
     1. Debrief activity. What happened when Team A was given a larger cup than Team B? What did Team B need to do to keep the water line below the marked line?

Lesson Body

1. Review concepts from previous lesson
   - A. What is carbon?
   - B. What are some examples of carbon sinks? What are some examples of carbon sources?
2. Provide overview of role-playing activity.
   - A. Tell students that they are going to be carbon atoms moving through the carbon cycle.
   - B. Categorize the places carbon can be found into these stations: Atmosphere, Plants, Animals, Soil, Ocean, Deep Ocean, and Fossil Fuels. Point out the areas of the room that are labeled with each station and contain the directions for movement from that station.
   - C. Assign students to each station randomly and evenly. Have students identify the different places carbon could go from that given station. Discuss the processes that allow for the transfer of carbon between stations.
3. Role-play
   - A. Students should make a line and roll the die individually to follow the directions for movement from (or retention at) each station. Remind them that they are representing atoms of carbon moving through the carbon cycle and that they should record their movements on the data sheet.
   - B. Students will realize the routine movements (or non-movements) in the carbon cycle.
   - C. Once the carbon atoms (students) have had a chance to roll the die ten times, have each student create a bar graph using the data they collected. The bar graph should represent the number of times the carbon atom (student) was at each station.

D. Using graph paper, create a large bar graph recording the number of carbon atoms (students) at each station.

4. Debrief activity, being sure to highlight human influence in terms of increased CO_2 in the atmosphere.

A. Explain that students role-played the natural carbon cycle; however, human activities are influencing the cycle.

B. Pose the following scenarios and ask students to turn and talk about how these would influence the cycle:

1. Family uses gas to fuel car.
2. Family uses oil to heat house.
3. Farmer burns trees to make room for planting.
4. Rancher cuts down trees to make room for animals.
5. Family orders packages from far away online and has them shipped to their doorstep.

5. Watch Video→ https://archive.epa.gov/climatechange/kids/flash/1-2-3/carboncycle.html; start at 2:05 and stop at 2:47.

A. Ask students how human influence on the carbon cycle connects to the water activity at the start of the lesson.

6. Exit Ticket: Students complete fill-in-the-blank carbon cycle paragraph .

Attachments

- Role-play station directions and role-play recording sheet
- Video link
- Exit ticket

Lesson #6:
Food Webs

Standard(s):

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Lesson Objectives:

Students will be able to:

- Build a marine food web that accurately represents the transfer of energy in the ocean
- Identify the human impact on marine food webs

Materials:

- Computer access for each student
- Online article
- Article vocabulary list
- Food web tag cards

Essential Vocabulary

- Energy
- Ecosystem
- Food chain
- Food web
- Trophic level
- Phytoplankton
- Zooplankton
- Herbivore
- Carnivore
- Predator
- Prey
- Decomposer
- Producer

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Anticipated Challenges	Student Supports
Article contains a large amount of content-specific vocabulary.	Students will read the article online so that they can utilize the text-to-speech feature to enable deeper comprehension. Furthermore, students will be provided with a vocabulary list that includes definitions and pictorial representations before reading so that content-specific words do not inhibit their comprehension.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Reading annotations
- Food web tag
- Food web tag discussion

Methods:

Lesson Hook

1. Review vocabulary list with students

Lesson Body

2. Students read and annotate article
   - A. Debrief article and illustrate food web on chart paper, labeling where parts of food web live and critical roles of each trophic level.
3. Food web tag
   - A. Explain to students that they will be playing a game of tag that models an aquatic food web.
   - B. Provide an overview of roles:
     1. Teacher→ human (apex predator)
     2. Two students→ pollution and overfishing
     3. Three students→ sharks
     4. Remainder of class→ sardine, snapper, or squid
   - C. Explain rules of the game
     1. Each of the students assigned to roles will be provided with life cards. When you run out of life cards, you're out of the game.
     2. The teacher is the apex predator; therefore the teacher can take a life card from any of the roles, including pollution and overfishing.
     3. Pollution and overfishing are given only one life card. These individuals may take life cards from sharks as well as sardines, snappers, or squid.
     4. Sharks are given two life cards. Sharks may take life cards from sardines, snappers, and squid.
     5. Sardines, snappers, and squid are given three life cards. Their responsibility is to collect the food cards that will be scattered around.

Lesson Closing

4. Debrief tag, being sure to discuss human impact on marine food web and transfer of energy .
   - A. What happened?
   - B. How did human activities (pollution and overfishing) impact the food web overall?
   - C. What would happen in a real food web if an entire trophic level was lost?

Attachments

- Article vocabulary list
- Article link
- Food web tag cards

Lesson #7:
Creating a Healthy Aquatic Environment

Standard(s):

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Lesson Objectives:

Students will be able to:

- Identify necessary features within a healthy aquatic environment
- Explain the role that such features play in maintaining a healthy aquatic environment
- Explain that the survival of a single species is dependent upon the health of the entire food chain

Materials:

- Computer access
- One 20-to-30-gallon tank
- Large plastic bucket
- Heater
- Floating thermometer
- Undergravel filter the size of the tank
- Plastic air tubing
- Medium-sized gravel
- Clean rocks
- Tropical fish food
- Plastic screen (large enough to cover the top of the tank)
- Air valve
- Air pump
- Plant grow light
- Log book or chart
- Two guppies or swordtails
- Three or four rooted water plants
- Test kits for nitrates, pH, dissolved oxygen
- Air lift columns

Essential Vocabulary:

- Misconception
- Substrate
- Salinity

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Anticipated Challenges	Student Supports
Cost and upkeep.	Creating a freshwater system instead of a saltwater marine tank is less expensive.

Evaluation/Assessment:

- Quiz
- Aquarium sketch

Methods:

Hook

1. Students answer true/false quiz.
2. Watch video and discuss misconceptions connected to quiz

Lesson

1. Discuss what will need to be in the marine tank and the role features play in a healthy ecosystem
   - A. Light source
   - B. Substrate
   - C. Plants
   - D. Fish
   - E. Fresh water
2. Partnered, students will design a freshwater habitat on paper that includes the features necessary to maintain a healthy ecosystem.
3. Create the aquarium with your students.
   - A. Rinse the tank with warm water and non-iodized salt. (Do not use soap of any kind because it will kill the fish.)
   - B. Choose a location for the tank that is away from heat and not in direct sunlight, and that has an electrical outlet close by.
   - C. Put the undergravel filter into the tank and the airlift columns.
   - D. Put the gravel in the plastic bucket and rinse it with water. Pour off the water and carefully spread the gravel over the undergravel filter, making it about one inch deep. If you have some gravel from an established aquarium, it would be a good idea to add about one cup of the gravel to the aquarium you are setting up.
   - E. Gently add the water so as to not make a hole in the gravel. (It needs to be water that has been open to the air for at least twenty-four hours.) Fill the tank about half full.
   - F. Add the clean rocks.
   - G. Connect the plastic air tubing to the airlift columns and air pump, then plug the pump in.
   - H. Add water until the top of the airlift column is covered, and adjust so that there is an even air flow.
   - I. Now it is time to put in the heater and floating thermometer. (If you are using freshwater tropical fish, they will need to have a temperature of 76 degrees, or if you are using temperate freshwater fish, they will need to have a temperature of 65 degrees.
   - J. Allow the aquarium to sit for a day while you monitor the temperature from time to time and adjust the heater if needed.
   - K. Allow the tank to sit with the air pump running for at least twenty-four hours to be sure the water is clean and clear.
   - L. When the temperature is at the required level, add three to four guppies or swordtails, two crayfish, and three to four snails.
   - M. After two weeks, check the nitrate level, then drain off about one-third of the water and add water that has aged in the bucket for at least two days. You can also add some more fish or animals to the aquarium.
   - N. Wait two more weeks, then add some plants (such as Anacharis) and some more fish and animals such as algae-eaters. At this point, the amount of water changed weekly should be reduced to about one-fourth of the total amount in the tank.
   - O. Remember to feed the fish daily with just a small amount of food (about what they will consume in five minutes) and remove any dead or dying organisms.

P. Check the temperature daily and record it in the log book or on the chart. You will need to log the time of feeding, temperature, and any changes that are observed.

Q. It is a good idea to measure and record the data from the test kits before changing the water change each week.

Lesson Closing

1. Turn and talk:
   - **A.** How does the ocean support marine life?
   - **B.** How does the system maintain balance?
   - **C.** How does the balance of the sytem impact marine life?

Attachments:

- True/false quiz
- Video link
- Fish tank resource

Lesson #8:
Effects of Ocean Acidification Part One

Standard(s):

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Lesson Objectives:

Students will be able to:

- Identify the pH scale as a measure of acidity
- Identify tools used to measure acidity

Materials:

- Milk
- Cherries
- Water
- Lemon juice
- Dish soap
- Vinegar
- Litmus strips
- Litmus drops
- pH scale graphic organizer

Essential Vocabulary:

- pH
- Acid
- Base
- Neutral
- Litmus paper

Chalenges

Anticipated Challenges	Student Supports
Students lack background knowledge related to pH scale.	Students are given the opportunity to measure the pH of everyday items, helping to make the content less abstract.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- pH sorting activity

Methods:

Lesson Hook

1. Students watch video about acids and bases.

Lesson Body

1. pH scale sorting activity
   - A. Divide students into small groups.
   - B. Provide each group with the following materials:
     1. Milk
     2. Cherries
     3. Distilled Water
     4. Carbonated water
     5. Lemon juice
     6. Dish soap
     7. Vinegar
     8. Litmus strips
   - C. Instruct students to make a prediction about which solution will be the most acidic and which will be the most basic.
   - D. Students test acidity of solutions using litmus paper and sort items in pH scale graphic organizer, from most acidic to most basic.
   - E. Students discuss whether or not their predictions were correct.

Lesson Closing

1. Group debrief: What are some of the differences between more acidic solutions versus more basic solutions?

Attachments:

- Video link
- pH scale graphic organizer

Lesson #9:
Effects of Ocean Acidification Part Two

Standard(s):

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Lesson Objectives:

Students will be able to:

- Explain that increased CO_2 in the atmosphere leads to a more acidic ocean
- Explain that CO_2 in theocean impacts shell-building animals' ability to build shells.
- Describe the effects that acidification has on marine food webs

Materials:

- Computer access
- Science notebook

Essential Vocabulary:

- Carbonate ions
- Hydrogen ions
- Mollusks

Chalenges

Anticipated Challenges	Student Supports
Homework assignment is dependent upon adult support and technology.	Student should be given ample advanced notice and ample time to complete assignment.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Chalk experiment prediction/description sheet
- Prediction about ocean acidification
- Video notes
- Reexamine shells in vinegar
- Exit ticket

Methods:

Hook

1. Explain to students that you will be placing chalk into two different solutions, one acid (vinegar) and one base (water).
   - A. Students make prediction about what will happen.
   - B. Students observe and discuss results.
   - C. If the ocean were to become more acidic, do you think the change would have a positive or negative impact on marine life? What marine life do you think would be most impacted? (Be sure to refer students to aquatic environment). Explain your thinking.
2. Reexamine shells in vinegar from lesson one
   - A. Students revisit predictions.
   - B. Students observe the outcome and discuss results and whether or not their initial prediction was accurate.
   - C. Whole-group discussion:
     1. What happened to the shells?
     2. Which creatures seem to be most impacted by the acidic solution?
3. Students watch ocean acidification video and take notes about negative impacts of the issue in their science notebooks.
   - A. Share out negative impacts and discuss how one issue leads to a host of other issues.
4. Students take part in Lego shell-building activity in pairs.

Lesson Closing

5. Exit ticket→ Whole Group Discussion
   - A. Describe the difference in shell-building in a healthy ocean versus in an acidified ocean.
   - B. How would the difficulty of building shells in an acidified ocean impact the survival of marine life?
6. Assign homework
   - A. Students work with adults at home to complete carbon-footprint calculator activity and record notes about how to shrink the carbon footprint

Attachments:

- Video link
- Lego shell-building activity overview
- Homework link

Lesson #10 (ongoing):
Solving the Problem of Ocean Acidification

Standard(s):

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*

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.

Lesson Objectives

Students will be able to:

- Describe ways in which human activities are contributing to increased carbon dioxide in the atmosphere
- Present information about the root causes, effects, and potential solutions to ocean acidification

Materials:

- Computer access
- Chart paper
- Criteria for success
- Poster board for each pair of students
- Assorted art materials; (Crayons, Markers, Colored pencils, and Glue)

Chalenges

Anticipated Challenges	Student Supports
Project involves independent, self-directed research.	Students are given the opportunity to work in pairs for peer support. Additionally, students should be allowed to choose [okay as edited here?} how they would like to present their knowledge.

Evaluation/Assessment:

(directly linked to the goals, i.e., Formative/Ongoing Assessment or Summative/End of Lesson Assessment)

- Project

Methods:

Hook

1. Watch climate change video
   A. Whole group discussion: i.
      1. What is the root cause of increased CO_2 in the atmosphere?
      2. Why is increased CO_2 such a big problem today?

Lesson body

1. Discuss and chart essential questions as a whole group
   A. What are some of the factors causing ocean acidification?
   B. Why is ocean acidification a problem?
   C. What are some of the actions humans can take to help solve te problem of ocean acidification?
2. Share out carbon=footprint calculator results.
   A. What did you find?
   B. What changes were suggested?
3. Pass out criteria for success.
4. Students conduct research.

Attachments:

- Video link
- Criteria for Success