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LESSON

Educate Others to Inspire Action

Students, in their role as scientists, create and finalize a collaborative model of the global carbon cycle. As a class, they use the model in a presentation aimed to inform and inspire an invited audience to think more carefully about the impacts of fossil fuel use. This lesson is part of the *Carbon Trackers* unit.

GRADES

6 - 8

SUBJECTS

Earth Science

CONTENTS

2 Activities

In collaboration with

educurious
learning that connects

ACTIVITY 1: FINAL CARBON CYCLE MODEL CREATION | 50 MINS

DIRECTIONS

This activity is part of the Carbon Trackers unit.

1. Reorient students to the scope and focus of the *Carbon Trackers* unit as they prepare to create the final project.

- Remind students of the unit's driving question: *Where does the energy in fossil fuels come from and where does it go?*
    - Ask each student to take five minutes to write down their response to that question (using a diagram if needed).
- Follow up with a class review of the *Know & Need to Know* chart and the initial carbon cycle model from the *Tracking Down the Carbon* activity.
    - Direct students to evaluate their collective learning through this unit by asking: *Have we learned all we needed to know and resolved all of the initial questions from the model?*
- Explain that the goal for the activities in this lesson is to use all of the information and knowledge the students have gathered to prepare a presentation for the target audience. This is reflected in the lesson driving question: *How can we use our models to educate and inspire others to understand the importance of matter and energy cycling on Earth?*

2. Introduce parameters for building the final collaborative model of the carbon cycle.

- Review class notes from the end of the *Matter and Energy Cycles: Modeling* activity about how to combine all of the cycles, as well as students' ideas from the *Greenhouse Effect* activity about how the greenhouse effect should be incorporated into their model.
- Review the *Cycle Model Rubric* and explain that it will be used to assess the success of the final model and the associated presentation.
    - As the rubric states, the goal is to create a thorough, complete model of the carbon cycle with all processes labeled properly, with arrows in the correct direction(s), with all reservoirs included, and with all sub-cycles clearly integrated.
    - The model should be organized and be used to simplify a complex process for the audience. It needs to be visually appealing and effective to help others easily understand the information.

3. Break the class into groups to construct the final model.

- Split the students into four groups, each one representing one of the reservoirs: lithosphere, atmosphere, biosphere, and hydrosphere. If your class is large, you can assign

the same reservoir to two groups and then have them collaborate to compare and check their work.

- Each group should spend 5-10 minutes sketching or listing the major processes and components of their assigned reservoir. Their illustration will include components and processes of one or more of the sub-cycles researched in *Matter and Energy Cycles: Research* and other processes and components from the initial carbon cycle model from *Tracking Down the Carbon*.
- Based on their sketch or list, direct each group to create their portion of the model in about 30 minutes, remaining cognizant of how their section will visually and conceptually link to the others. If you've doubled up on groups, have the groups combine about halfway through the allotted time to compare and agree on a single model.
- When students have completed their segment, assist the groups in connecting the reservoirs.

    - You may want to start with pairing two reservoirs first before connecting them all.
    - This will require some additional work, depending on the medium students use to construct their model, such as drawing arrows to connect reservoirs and adding labels.
    - Keep in mind that this part of the activity will be complex and will require thinking on your feet and adapting for your particular class size and students.

4. Prompt students to collaboratively review their final model.

- Display the final model for the whole class to: 1) critique how the ideas are visually displayed and communicated, and 2) use the *Cycle Model Rubric* to ensure that the model meets the first row of criteria.

    - This is not intended as a way to grade individual students or groups, but for the purpose of collaboratively refining and polishing the final piece to be optimally successful for the presentation.
    - If students notice any mistakes or missing pieces, provide time for the class to discuss and correct those now so that the model is complete at the end of this activity.

5. Have students respond to the questions below for homework, as an opportunity for their own reflection, to prepare and explore ideas for the final presentation, and to use as a formative assessment.

- Ask students to provide one to two ideas in response to the following questions:

- *Describe what matter and energy cycling is, and why matter and energy cycles are important for the Earth as a system. Why are they important to living things?*
- *What are fossil fuels? Where do they come from? How are they made?*
- *How are they extracted and used? When used, where does the energy and matter in them go?*
- *How does the use of fossil fuels by humans impact the normal matter and energy cycles?*
- *How does carbon move through the large Earth system?*
- *Why is understanding Earth's matter and energy cycles important?*
- *The driving question for this lesson: How can we use our models to educate and inspire others to understand the importance of matter and energy cycling on Earth?*
- *What are the limitations of our class model?*

Tip

Step 1: Depending on your local context and community, decide ahead of time if the target audience will be assigned, or, if possible, engage students in choosing who the target audience will be. This will help them to make the model specific to the audience. Examples: younger students, community members, visitors to an art or science museum, students on a field trip to a nature center, environmental groups, or fossil fuel industry executives.

Tip

Step 2: Students may need additional time to finalize their model, which can be provided now or at the beginning of the next activity. The final model could be a digital creation, a visual on paper using markers and/or pictures cut from magazines, or a clay or other 3D material model. The final format depends on what resources you have available and can easily have your students use. How you divide this final bit of work will also depend on what medium students are using. Remind your students that the goal is to create a model that helps others easily understand matter and energy cycling, with artistic representations helping to do so.

Informal Assessment

Collect the responses to the homework questions and return your feedback the following day at the start of the next activity. That will enable students to have feedback before they do the final presentation.

OBJECTIVES

Subjects & Disciplines

Earth Science

Learning Objectives

Students will:

- Collaborate to create a digital or analog model of matter and energy cycles on Earth (specifically the carbon cycle, rock cycle, water cycle, and photosynthesis and respiration)

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Visual instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
  - Life and Career Skills
    - Leadership and Responsibility
    - Productivity and Accountability
    - Social and Cross-Cultural Skills

- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Creating
- Science and Engineering Practices
  - Developing and using models
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.7.4:**
Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
• **CCSS.ELA-LITERACY.SL.7.5:**
Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**
Cause and Effect
• **Crosscutting Concept 4:**
Systems and system models
• **Crosscutting Concept 5:**
Energy and matter: Flows, cycles, and conservation
• **ESS2.A: Earth Materials and Systems:**
All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.   The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a

second to billions of years. These interactions have shaped Earth’s history and will determine its future.

• **MS-ESS2-1:**

Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.

• **Science and Engineering Practice 2:**

Developing and using models

• **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information.

Preparation

BACKGROUND & VOCABULARY

Background Information

Prior Knowledge

["Matter and energy cycles (including carbon cycle, water cycle, rock cycle, and photosynthesis and respiration)","Types of fossil fuel resources","Greenhouse effect"]

Recommended Prior Activities

- Greenhouse Effect
- Matter and Energy Cycles: Modeling
- Matter and Energy Cycles: Research
- Putting the "Fossil" in Fossil Fuels
- Researching Fossil Fuels
- Tracking Down the Carbon

Vocabulary

TermPart of SpeechDefinition

ACTIVITY 2: CARBON CYCLE MODEL PRESENTATION | 1 HR 40 MINS

DIRECTIONS

This activity is part of the Carbon Trackers unit.

1. Provide time for students to finalize their collaborative carbon cycle model.

- Give students access to the class model that they created in the previous activity, *Final Carbon Cycle Model Creation*, as well as the relevant supplies that they used to create their model.
- Prompt students to finish creating or add their final creative touches to the model.
- Emphasize yet again who their audience will be and what the ultimate goal is: to effectively explain the carbon cycle and the importance of understanding fossil fuels.

2. Introduce the presentation format and criteria.

- Tell students that everyone will have a short time (20-30 seconds) to speak in their collaborative presentation. Each student is responsible for planning what they will say and coordinating with their team and class to ensure that, collectively, they adequately explain the model during the presentation, and do so in an inspiring way.
- Review the second row of the *Cycle Model Rubric* that is focused on presentation skills and the *Model Presentation Audience Feedback Form* so that students are clear on guidelines.
    - Emphasize the criterion that students need to "Describe the flow of energy and matter in the global carbon cycle to the audience, using appropriate eye contact, adequate volume, clear pronunciation, while effectively utilizing the model to guide and enhance your presentation."
- You may want to show a short video clip or two of powerful presenters, and/or model elements of effective presentation skills. One example could be Felix Finkbeiner's presentation, *Plant-for-the-Planet Initiative: The Trillion Tree Campaign* (he begins at minute 3:00).

3. Assign roles for the presentation and review the presentation format with students.

- Choose specific students to do the following: one student to introduce the whole presentation and another to conclude the presentation.

- Of the remaining students, divide them into the same teams from the *Matter and Energy Cycles: Modeling* activity, representing the lithosphere (including rock cycle), the atmosphere (including greenhouse effect), the hydrosphere (including water cycle), and the biosphere (including photosynthesis and respiration).
- The order of speaking can be set up in many ways (after all, this is a cycle!), but one option is:

    1. Introduction - one student
    2. Biosphere - team
    3. Lithosphere - team
    4. Atmosphere - team
    5. Hydrosphere - team
    6. Conclusion - one student

- Students should know the order of the presentation so they can effectively show the connections between movement of matter (with a focus on carbon) or energy from one reservoir to another.
- Explain that in addition to teaching their audience about the global carbon cycle and the supporting sub-cycles, students also need to answer the questions in their presentation that they previously completed for homework. You may wish to share general feedback you gleaned after grading the classes' answers and also hand back your feedback to their individual responses. The questions can be integrated into the presentation as follows:

    - Describe what matter and energy cycling is, and why matter and energy cycles are important for the Earth as a system. For living things? (*presentation introduction*)
    - What are fossil fuels? Where do they come from? How are they made? (*lithosphere group and biosphere group*)
    - How are they extracted and used? When used, where does the energy and matter in them go? (*lithosphere group and atmosphere group*)
    - How does the use of fossil fuels by humans impact the normal matter and energy cycles? (*each team will contribute to this*)
    - How does carbon move through the large Earth system? *(each team will contribute to this)*
    - Why is understanding Earth's matter and energy cycles important? *(each team will contribute to this)*

4. Prepare for model presentation.

- Provide time (30 minutes) for each team or individual to develop and finalize their parts of the presentation. Students should share speaking time roughly equally and practice their presentation several times during class in their teams, if possible.
- Each team can determine what order their members speak in that makes the most sense.
- Ask students to write their 20-30 seconds of information on an index card to use as a reminder while they speak.
- While students work on their presentation, circulate to review their ideas, ensure the sequence they have decided on makes sense, and provide support.
- If some groups finish early, they should practice and provide one another with feedback based on the *Cycle Model Rubric*.
- Be sure to have the first and last student of each reservoir compare notes to ensure the transitions are fluid.
- If time permits, have the whole class read through each of their parts and practice using the model as they will in the final presentation.

5. Facilitate presentation of the collaborative carbon cycle model.

- Welcome audience members and introduce the project and goal of the unit and presentations. You may want to give a basic definition of a "model" so the audience is familiar with what students attempted to construct in this project.
- Pass out copies of the *Model Presentation Audience Feedback Form*.
- Prompt audience members to ask questions after students present.

6. Guide students in reflecting on their learning during the Carbon Trackers unit.

- Collectively revisit the unit driving question. Students will likely have a much deeper response to this than in Lesson 1.
- Ask students to respond individually to some of the following prompts:

    - *What will you remember about creating this model? Why?*
    - *How is this model like Earth's actual cycles and how is it different?*
    - *What would you change about this unit and the project? What would you keep the same?*
    - *How was your experience of working with various teams in this unit?*
    - *What could your team have done better?*
    - *What is the most important thing you learned during the* Carbon Trackers *unit?*

- Use a collaboration rubric (such as this one from the Buck Institute for Education) for students to assess themselves and/or their peers on their collaboration skills.

7. Extend the impact of the *Carbon Trackers* unit by engaging students in an Opportunity for Action.

- Consider extending this project to larger audiences by having students display or create their artistic representations of the global matter and energy cycles to both inspire and inform others about how these cycles interact. These art pieces can be displayed in a science museum, an art museum, a local energy company's lobby, a local gallery, or coffee shop, depending on local possibilities.

Tip

Step 5: Consider having students reflect collectively, after they present their model to the audience.

Tip

Step 5: Depending on the size of your audience, you may need to reserve another space, such as a dining hall, auditorium, or other larger area, for this presentation.

Tip

Step 5: Depending on where you have students present and what form their final model takes (poster, digital, clay, etc.) you may need to use a document camera, have other students hold up the model during the presentation, or determine an alternate way to display the model.

Tip

Step 1: If students completed their collaborative model in the previous activity, this step can be skipped.

Rubric

Use the *Cycle Model Rubric* to assess students' content knowledge, as well as modeling and communication skills, for the final product for the *Carbon Trackers* unit.

The audience feedback forms, student responses to the unit driving question, and/or the collaboration rubric, can all be used to inform your final assessment of each student's individual understanding and contribution to the project.

Extending the Learning

Opportunity for Action: Consider extending this project to larger audiences by having students display or create their artistic representations of the global matter and energy cycles to both inspire and inform others about how these cycles interact. These art pieces can be displayed in a science museum, an art museum, a local energy company's lobby, a local gallery, or coffee shop, depending on local possibilities. Some great examples of artistic representations of real science can be found here and here.

OBJECTIVES

Subjects & Disciplines

Earth Science

Learning Objectives

Students will:

- Engage in public speaking with confidence and clarity.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Reflection
- Visual instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
  - Life and Career Skills
    - Leadership and Responsibility
    - Productivity and Accountability
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- Critical Thinking Skills
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• **Crosscutting Concept 2:**
Cause and Effect

• **Crosscutting Concept 4:**
Systems and system models
• **Crosscutting Concept 5:**
Energy and matter: Flows, cycles, and conservation
• **Crosscutting Concept 7:**
Stability and change
• **ESS2.A: Earth Materials and Systems:**
All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.   The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future.
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- Researching Fossil Fuels
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Informal Assessment

Cycle Model Rubric: Student performance during the presentation and the creation of the model will be assessed using this rubric.

Cooperative Learning Group Interaction (Critical Thinking, Problem Solving, Communication, Teamwork)

The teacher, acting as a team facilitator when necessary, will informally assess students' cooperative learning skills as demonstrated within their pairs and/or small groups for the duration of the unit. Students will be evaluated based on their individual and group performance; that is, their ability to collaborate, listen attentively, and show willingness to take on various research and sharing roles as they investigate global matter and energy cycling.