Meet Me in the Middle: Climate Change Curriculum to Support Argumentation in Middle School

Sarah Pedemonte & Emily Weiss
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What is argumentation?

Argumentation in science education is a process of proposing, supporting, evaluating, and refining ideas in an effort to develop a better understanding. This process of scientific argumentation occurs when a claim, often a proposed explanation, is in doubt or is contested, thereby motivating participants to defend their own ideas and challenge or question alternatives.

"Secure knowledge and understanding is as much a product of knowing why some ideas are erroneous as why other ideas are correct."

- Osborne, Erduran, and Simon, 2004
What is argumentation?

According to the NRC Framework Students with Argumentation skills will:

- Construct a scientific argument showing how the data support the claim.
- Identify possible weaknesses in scientific arguments, appropriate to the students’ level of knowledge, and discuss them using reasoning and evidence.
- Identify flaws in their own arguments and modify and improve them in response to criticism.
M1. Make sense of problems and persevere in solving them
M2. Reason abstractly and quantitatively
M6. Attend to precision
M7. Look for and make use of structure
M8. Look for and express regularity in repeated reasoning

S1. Ask questions and define problems
S3. Plan and carry out investigations
S4. Analyze and interpret data
S6. Construct explanations and design solutions

E2. Build a strong base of knowledge through content-rich texts
E5. Read, write, and speak grounded in evidence
M3 and E4. Construct viable arguments and critique reasoning of others
S7. Engage in argument from evidence

S8. Obtain, evaluate, and communicate information
E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose

E1. Demonstrate independence in reading complex texts and in writing and speaking about them
E7. Come to understand other perspectives and cultures through reading, listening, and collaborations
Why is argumentation important?

- It’s what scientists do.
- It leads to improved learning outcomes.
- Helps students to be able to defend scientific views of how the natural world works.
Unit 1: How do the ocean and atmosphere interact?

- How ocean currents form
- How heat energy is distributed around the globe
- Water cycle
- How ocean-atmosphere connections drive weather and climate
Unit 2: How does carbon flow through the ocean, land, and atmosphere?

- Carbon flows among reservoirs on Earth
- Intro to processes of respiration, photosynthesis, combustion and decomposition as sources of carbon flow
- Combustion of fossil fuels throws carbon cycle out of natural balance
Unit 3: What are the causes and effects of climate change?

- Causes of climate change
- Effects of climate change (sea level, ocean currents, organisms)
- Possible solutions
Unit 1: Sessions 1.2-1.4

- 1.2: Water vs. Air
- 1.3 The Ocean as a Heat Reservoir
- 1.4 Temperatures around the World
Scientific Evidence

Evidence is a clue that helps answer a question or explain something

Evidence can come from…

- Our own investigations.
- Other people’s investigations.
- Reasoning, thinking, and discussing.

Scientific explanations are based on evidence.
What will happen to the temperature of the two bottles receiving heat energy? Which bottle do you predict will heat up faster?
Water vs. Air Molecule Model

Bottles at start

Air

Water

Bottles after 5 minutes of receiving heat energy

Air

Water
Simulation: Water vs. Air
Water acts as a heat reservoir. Water absorbs a lot of heat energy before it warms up, and it holds onto the heat for a relatively long time before the heat energy is released and the water cools down.
Session 1.3

The Ocean as a Heat Reservoir
Water acts as a heat reservoir. Water absorbs a lot of heat energy before it warms up, and it holds onto the heat for a relatively long time before the heat energy is released and the water cools down.
- Why did one balloon pop and the other one not?
- How might this balloon activity be similar to what happens on Earth?
Guiding Question:

How does the ocean affect climate on Earth?
How to Do Active Reading

• As you read…
  – Underline things you think are interesting or important.
  – Circle things you think are confusing, and write your questions in the margin.

• After reading…
  – Turn to your partner, and help each other as you try to answer your questions.
The Ocean: A Giant Heat Reservoir

Solar Energy Absorbed by Earth

Sunlight, or energy from the Sun, travels in straight lines through space at 186,000 miles per second. Only a tiny fraction of the energy that leaves the Sun reaches Earth, but still, a huge amount of energy reaches our planet.

When the Sun’s energy reaches Earth, it interacts with matter. Matter can be anything that has mass and occupies space, such as air, water, or land. Energy from the Sun has three main ways it interacts with matter on Earth: it can be transmitted, reflected, or absorbed. If the energy is transmitted, it passes through the matter. If energy is reflected, it bounces off the matter. If energy is absorbed, it is taken in by the matter, and the molecules of the matter move faster. When molecules move faster, the matter gets warmer. In fact, that is what temperature measures — how fast the molecules are moving.

Most objects have all three interactions, but the amount to which each occurs is different. Some kinds of matter, such as air, transmit most of the energy from sunlight. Other matter, such as ice, mainly reflects energy, and others, such as rock or water, absorb a lot of the Sun’s energy.

When the Sun’s energy strikes Earth’s atmosphere, some energy is absorbed, warming the air, and some is reflected back into outer space by clouds. But more than half the Sun’s energy transmits through the atmosphere, going all the way to Earth’s surface. A lot of this energy is absorbed by the land and ocean.

If so much of the Sun’s energy is absorbed by Earth’s surface, why don’t we heat up to unbearable temperatures and fry? Something else must be going on to keep Earth’s temperature from being too hot to support life.

<table>
<thead>
<tr>
<th>Solar Energy Absorbed</th>
<th>Solar Energy Reflected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clouds 9%</td>
<td>Clouds 20%</td>
</tr>
<tr>
<td>Atmosphere 16%</td>
<td>Atmosphere 6%</td>
</tr>
<tr>
<td>Land and ocean 51%</td>
<td>Land 4%</td>
</tr>
<tr>
<td>TOTAL ABSORBED 70%</td>
<td>TOTAL REFLECTED 30%</td>
</tr>
</tbody>
</table>

- Why did one balloon pop and the other one not?
- How might this balloon activity be similar to what happens on Earth?
London and Voronezh

Which city do you think would be...

- warmer in summer?
- colder in winter?
What's Up with Temperatures in London and Voronezh?

London is near the ocean. Voronezh (Vuh-ROH’neesh) is not near the ocean. The chart shows average temperatures in each city in the summer and winter.

<table>
<thead>
<tr>
<th>Location</th>
<th>Average winter temperature</th>
<th>Average summer temperature</th>
<th>Difference between average winter and summer temperatures</th>
</tr>
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<tbody>
<tr>
<td>London, England</td>
<td>6°C</td>
<td>18°C</td>
<td>12 degrees</td>
</tr>
<tr>
<td>Voronezh, Russia</td>
<td>11°C below zero</td>
<td>22°C</td>
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Explaining the Difference between London and Voronezh

London is near the ocean. Voronezh (Vuh-ROH’-nee-sh) is not near the ocean.

The chart shows average temperatures in each city in the summer and winter.

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How can the ocean affect temperatures in London? Use evidence to back up your explanation.
The ocean covers 70% of Earth’s surface, and all this water has a huge impact on temperatures on Earth.
Session 1.4
Temperatures around the World

Alaska

Bakersfield

Morro Bay

Singapore
Earth is Heated Unevenly

- The sun heats Earth unevenly.
- Places near Earth’s equator are generally warmer than the poles.
- Places near Earth’s equator change less in temperature from winter to summer than places near the poles do.
- When it’s summer north of the equator, it’s winter south of the equator. When it’s winter in the north, it’s summer in the south.
example: Mystery Locations

Which average temperatures are for Hawaii? Alaska?

☑️ What is your evidence?
Scientific Evidence

Evidence is a clue that helps answer a question or explain something.

Evidence can come from…

- Our own investigations.
- Other people’s investigations.
- Reasoning, thinking, and discussing.

Scientific explanations are based on evidence.
What's wrong with this explanation?

Explanation #1:
"I think Location 1 is Alaska. I don't know why. I just think that!"
What's wrong with this explanation?

Explanation #2:

"The second one is Hawaii, because of the evidence."
What's wrong with this explanation?

Explanation #3:
"I went to Hawaii once, and it was really warm there that week. I haven't been to Alaska, but my grandma has, and she said it was really cold. Also, when I've seen pictures of Alaska, it looks cold. That's why the first one is Alaska, and the second one is Hawaii."
What's wrong with this explanation?

Explanation #4:
"On the world map, Alaska is near the North Pole, which means days are long in summer and short in winter. There would be a bigger difference between summer and winter temperatures. The graph shows a huge difference from winter to summer at the first location. That's why I think Location 1 is Alaska."
What makes a good scientific explanation?

- The evidence supports the explanation.
- The evidence is based on carefully collected data and information, not just one casual observation.
- The evidence is from a reliable source.
Mystery #2: Which location is Singapore; which is Noosa Heads, Australia; and which is Birdsville, Australia? Explain your answers on the opposite page.

Location X is

Location Y is

Location Z is

Australia and Nearby Islands

Singapore

Equator

Birdsville

Noosa Heads

Student Sheet — Ocean Sciences Sequence 1.4
Mystery Locations (continued)

What evidence did you use to solve the mystery of location X?

What evidence did you use to solve the mystery of location Y?

What evidence did you use to solve the mystery of location Z?
The ocean warms cold air and cools warm air. The ocean keeps temperatures more even all over the planet.
OSS 6-8 Online Resources

- [http://mare.lawrencehallofscience.org/curriculum/ocean-science-sequence/oss68](http://mare.lawrencehallofscience.org/curriculum/ocean-science-sequence/oss68)

**Session Resources**

**Session 1.1: Heat Energy and Moving Molecules**
- Simulation: Rising Temperatures (Mac)
- Simulation: Rising Temperatures (PC)
- Simulation: States of Matter

**Session 1.2: Water vs. Air**
- Simulation: Heat Reservoirs (Mac)
- Simulation: Heat Reservoirs (PC)

**Session 1.3: The Ocean as a Heat Reservoir**
- Video: Oceans of Climate Change
Questions????

Sarah Pedemonte and Emily Weiss: spedemonte@berkeley.edu and weisse@berkeley.edu

90-minute hands-on argumentation session from 2:00-3:30PM today in the Convention Center (room 103).

For product information contact: Kristen Mayfield, Product Manager, Carolina Curriculum (kristen.mayfield@carolina.com)