Water's Impact on Climate

Companion Lesson to X-STEM All Access Episode "Ambassadors of Conservation and the Climate"

Grade/ Grade Band 6-12	**Topic:** Climate Change	

Brief Lesson Description: Dr. Katharine Hayhoe loves to talk about climate change and, in her video, she discusses why it is important to talk about climate change. In the lesson, students will investigate the causes of climate change and discuss how the effects of climate change impact humans, animals, and the world.

Performance Expectation(s):
MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.
HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Specific Learning Outcomes:
Students will be able to describe the basic causes and effects of climate change.

Narrative / Background Information

Prior Student Knowledge:
Students should be able to define: atmosphere, weather, and climate.
Students should understand the weather and describe the causes and effects relating to weather patterns.

Science & Engineering Practices:
Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and redefine the design accordingly. (HS-ESS2-5)

Disciplinary Core Ideas:
ESS2.c: The Roles of Water in Earth's Surface Processes

- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosity and melting points of rocks. (HS-ESS2-5)

ESS2.D: Weather and Climate

- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)

Crosscutting Concepts:
Cause and Effect
Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Structure and Function
The functions and properties of natural and designed objects and systems cn be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5)

Possible Preconceptions/Misconceptions: Many students confuse the ozone-hole problem with the greenhouse effect and believe they are the same thing. This lesson will model the greenhouse effect which emphasizes how carbon dioxide concentrations are warming the atmosphere. Students also confuse climate with weather. This lesson will require the teacher to state the difference: climate is defined by average and extreme atmospheric conditions over at least a 30-year period whereas weather is the instantaneous condition that may range over a few days at most.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Begin this lesson with students writing what they know about climate change.

Then show students the video Ambassadors of Conversation and the Climate with Dr. Katharine Hayhoe . Ask students to take notes and write a summary of the advice Dr. Hayhoe gives.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: procure the following items:

- 10 jars with lids
- 10 thermometers
- 10 flashlights/lamps
- Sodium bicarbonate
- Vinegar
- Water (liquid)
- Ice cubes (dyed blue with food coloring)
- Small basin
- 5 cardboard tubes (paper towel roll)
- Funnel
- Tea kettle (electric)
- 5 Tablespoons
- Book of matches
- Scotch tape

Create 5 stations illustrating weather and climate experiments.
Station One: Cloud in a Jar
Materials:

- Jar with lid
- 50 ml hot water
- Glass rod/spoon
- Matches
- 1-2 ice cubes

Instructions:

1. Carefully pour 50 ml of hot water into the glass jar.
2. Gently stir the water with a glass rod/spoon.
3. Light a match with the assistance of an adult.
4. Drop the match into the jar and close the lid.
5. Place 1 ice cube on top of the lid.
6. Observe and draw an illustration of the formation of a cloud.

Station Two: Greenhouse Effect
Materials

- 2 Jars
- 2 thermometers
- Flashlight or lamp
- One piece of aluminum foil

Instructions:

1. Tape a thermometer inside of each jar such that the tip of the thermometer is not touching the jar.
2. Place foil over the opening of one jar.
3. Record the temperature.
4. Turn on the light source (flashlight or lamp) positioning it and pointing it at the jar.
5. Observe for a minimum of 6 mins and record the temperature.

Station Three: Rising Sea Levels
Materials:

- Basin
- Jar

- 1000 ml of water
- Six ice cubes (dyed)

Instructions:

1. Pour 1000 ml of water into the basin.
2. Place a jar in the basin upside down.
3. Carefully add 3 blue-colored ice cubes on top of the jar.
4. Turn on the light source (flashlight or lamp) positioning it and pointing at the ice on top of the jar.
5. Observe for a minimum of 6 minutes and record.

Station Four: Climate Change

Materials:

- 2 Jars with lids
- 2 thermometers
- 2 cardboard tubes (5 cm)
- 2 flashlights/lamps
- Funnel
- Scotch tape
- 1 tablespoon of sodium bicarbonate
- 15 ml vinegar

Instructions:

1. Label one Jar A and the other Jar B.
2. Tape each thermometer to the outside of a cardboard tube.
3. Add 1 tablespoon of sodium bicarbonate to Jar A.
4. Attach one cardboard tube with the thermometer to each of the jars so you can read the thermometer.
5. Place the funnel in Jar A and carefully pour 15 ml of vinegar (be sure not to get any vinegar on the thermometer or the tube).
6. Quickly close the lids of both jars.
7. Shine the light sources on the jars.
8. Observe and record the temperature every 2 minutes for 6 minutes.

Station Five: Carbon Footprint

Materials:

- 5-10 Laptops

Instructions:

1. Go to the 8 Billion Trees website at 8billiontrees.com
2. Calculate your carbon footprint by completing the survey.
3. Record your carbon footprint, how many earths we would need if everyone lived like you, and how many trees you need to plant to offset your carbon footprint.
4. Select 3-5 things you can do and will do to offset your carbon footprint.

Students rotate through the stations in small groups. After completing all five stations, give students 5 minutes to reflect on their observations and ask them to write a description explaining how these experiments relate to climate change.

EXPLAIN: Concepts Explained and Vocabulary Defined: Begin by asking students the difference between weather and climate.
Tell students that when we talk about the climate we are talking about long-term averages of daily weather, and how the atmosphere "behaves" over relatively long periods of time. Weather is what conditions of the atmosphere are over a short period of time, think days not years. Ask students how they would define **climate change**. Explain that climate change refers to long-term shifts in weather patterns (i.e. the average temperature in the US in December 1895 was 31.7°F, in Dec 1925 it was 32.5°F, in Dec 1985 – 28.8°F and in Dec 2015 it was 38.6°F according to NOAA). Ask students what they think was the biggest difference between 1985 and 2015 (possible ans.: more people, computers, mobile phones, internet, globalization).
Tell students that some causes of climate change are greenhouse gas emissions, deforestation, and fossil fuel consumption. Explain that the effects of climate change may include rising sea levels, increased amount of severe weather events, and changes in ecosystems.
Then define greenhouse gases as gases like methane, hydrofluorocarbons, and CO_2 that trap heat in the atmosphere. Ask students to identify some sources of greenhouse gases (possible ans.: cars, planes, gas-burning stoves, humans (breathing), cows/livestock, farms, and household appliances like the refrigerator). Be sure to explain that CO_2 emissions make up the vast majority of greenhouse gases and it enters our atmosphere through burning fossil fuels, solid waste, and trees. Methane (CH_4) is emitted during the production and transport of coal, natural gas, and oil as well as from livestock and agricultural practices and the decay of organic waste (like in landfills).
Lead students in a discussion about their thoughts on climate change, what concerns them, and what actions they think they can take to address the issue. Remember to refer to the experiments, be sure to explain that clouds need particles in order to form, and how CO_2 is released when baking soda and vinegar are combined to serve as a model of the greenhouse effect.

Vocabulary:
Weather- the state of the atmosphere at a particular place and time as regards to heat, cloud cover, dryness, sunshine, wind, and precipitation

Climate- the average weather in a given area over a long period
Greenhouse gases- gases that trap heat in the atmosphere
Carbon Footprint- a measure of the amount of carbon dioxide released in the atmosphere as a result of the activities of an individual, an organization, or a community
Climate Change- refers to the long-term shifts in temperature and weather patterns

ELABORATE: Applications and Extensions:
Prior to starting the elaboration section of this lesson, you will need to gather the following materials (per student): computers, access to a video camera (on computer or smartphone), Flipgrid account

Students are going to create their climate change story. As Dr. Hayhoe suggests: we must determine what people think about climate change - we have to talk about climate change, and to talk about it we need to find what we have in common that is impacted by climate change, in order to make a difference.

In small groups, students will identify a common interest. Then they will research how that interest may be impacted by climate change. Here are a few resources by topic:
Sports: earth.org, Washington Post, asics
Fashion: The Eco Hub, The New York Times, Teen Vogue
Video Games: One Green Planet, Cosmos, Games for Change
Careers: Green Citizen, Sci Journal, indeed
Animals: National Park Service, WWF, CDC

Encourage students to visit the links for more stories on the subject. They need to gather 5 facts about how climate change is impacting their area of interest.

Then students will create a script for their Public Service Announcement talking about their climate change story.
After students write their scripts, they may use their smartphones or the web camera on the laptop to create a Flipgrid video.

Flipgrid is a free video discussion and sharing app that allows teachers and students to create a grid about a specific topic. It's an opportunity for students to find their voices and share them with others. Click on Flipgrid to set up your account and create the assignment for this activity.

EVALUATE:

Formative Monitoring (Questioning / Discussion): Data collected from mini-investigations, discussion on climate change, stating causes and the effects

Summative Assessment (Quiz / Project / Report): PSA on Climate Change

Elaborate Further / Reflect: Enrichment: As a class, plan the school's Earth Day Celebration. It should be an opportunity to educate the staff and student body on climate change, its impact, and what people can do to make a difference.

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: Relationship Skills
The ability to establish and maintain healthy and supportive relationships requires good communication and collaboration. Dr. Hayhoe explained that in order to ask folks to do something about a big idea like climate change, you need to start small and discuss things you have in common. Basically, you need to build a relationship. This activity called HOT SEAT, is a fun way to build community in the classroom. It requires students to work together, listen carefully, communicate clearly, and think creatively.

Directions:
1. Divide the class into two groups.
2. Place two empty chairs aka "hot seats" at the front of the room facing away from the board.
3. Take one volunteer from each team to sit in the "hot seat" facing their teammates.
4. Using a prepared list of vocabulary words, write one word on the board.
5. Each team will take turns trying to get their teammate in the "hot seat" to guess the word, using synonyms, antonyms, and definitions as clues. (Be sure the team members are working together positively)
6. When the term is correctly identified, that team earns a point, and a new set of students enter the "hot seat".
7. A new term is written on the board and the teams begin to share their clues.

After a few rounds, lead a discussion with the class asking them the following: what they learned from this activity, how do you communicate clearly, why was it important to listen and to be creative?

INTERDISCIPLINARY CONNECTIONS/IDEAS

ELA/Literacy

RST.6-8.1 - Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-5)

RST.6-8.9 - Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-5)

WHST.6-8.8 - Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS2-5)

Mathematics

6.NS.C.5 - Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)

MP.2 - Reason abstractly and quantitatively. (MS-ESS2-5)

Materials Required for This Lesson/Activity

Quantity	Description
Per student	Laptops
10	10 jars with lids
10	10 thermometers
10	10 flashlights/lamps
1 box	Sodium bicarbonate
1 bottle	Vinegar
1 gallon	Water (liquid)
2 trays	Ice cubes (dyed blue with food coloring)
1	Small basin
5	Cardboard tubes (paper towel roll)
1	Funnel
1	Tea kettle (electric)
5	Tablespoons
1	Book of matches
1	Scotch tape

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