



LESSON TITLE:

The Tilted Truth: From Equator to Poles

Grade: 7

Lesson Duration: 2 Weeks

Course Name: 7th Grade Honors Earth Science

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BIG IDEAS

There are *predictable temperature variations* moving away from the Equator and towards the Poles. These temperature variations change with the seasons.

DRIVING QUESTION

Why are there temperature variations in the United States throughout the year?

EDUCATION STANDARDS

Science Performance Expectations (or state Science standard):

- MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. *[Clarification Statement: Examples of models can be physical, graphical, or conceptual.]*
- MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]*

Science and Engineering Practices:

Develop and use a model to describe phenomena.

Disciplinary Core Ideas:

ESS1.B: Earth and the Solar System

- Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric

Crosscutting Concepts:

Patterns

- Patterns can be used to identify cause-and-effect relationships.

Systems and System Models

- Models can be used to represent systems and their interactions — such as inputs, processes and outputs—and energy, matter, and information flows within systems.

Common Core State Standards:**Math:** MP.4 Model with mathematics**ELA:**

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest

E5. Read, write, and speak grounded in evidence

E3. Obtain, synthesize, and report findings clearly and effectively, in response to task and purpose

MEASURABLE STUDENT LEARNING OBJECTIVES

1. Students will interpret a choropleth map of monthly air temperatures in the United States to ask questions about the temperature variations throughout the year.
2. Students will develop and interpret a model of Earth's tilt.
3. Students will construct a model to investigate sunlight distribution at different latitudes of Earth, specifically, at the Equator, in New York, and at the Poles.
4. Students will construct an explanative model of patterns in the temperature variations in the United States and the cause of the temperature variation.
5. Students will interpret a model of temperature variation in Yonkers collected from myNASAdata to discuss the reason for the pattern observed in the data.
6. Students will interpret an isotherm model of temperature variations in the United States and compare Yonkers, NY, and Miami, FL, to write a scientific argument about how temperature is affected by its latitude.
7. Students will provide evidence for one of three claims about the temperature variations experienced throughout the year in Yonkers.

MATERIALS NEEDED

- [NOAA's Monthly Air Temperature in the United States Animated Map](#)
- [11 static maps](#)
- [The Tilted Truth: From Equator to Poles Students Activities](#)
- Computer
- PowerPoint Plugin: [PollEverywhere](#)
- Tabloid paper (11 x 17)
- Tape
- Ruler

ENGAGING CONTEXT/PHENOMENON

A culturally responsive anchoring phenomenon is local or community-based, observable, puzzling, complex, and engages students in the STEM disciplines using the science and engineering practices crosscutting concepts, and disciplinary core ideas (Penuel & Bell, 2016; Vasquez, 2015). In essence, it “spark[s] curiosity and wonder” (Bozeman Science, 2019, July 9) for three reasons. First, the phenomenon—temperature variation in the United States

throughout the year from the Equator to the Poles—sparks curiosity because the cause is not intuitively obvious. It is rather surprising. Second, the phenomenon is observable to students in their community of Yonkers and the broader community of the United States. Third, the sense-making process of figuring out why this process occurs requires an elaborate explanation due to its complexity.

REAL-WORLD CONNECTIONS FOR STUDENTS

Focusing on temperature variation in the United States provides students with a sense of place. (Doering & Veletsianos, 2008) that is, a broader perspective of their country. According to Doering and Veletsianos 2008, a “sense of place is considered a constituent of cultural identity” (p. 219). In addition, the students have the opportunity to include Yonkers data in the engage, explore, elaborate, and evaluate phases which narrows the perspective to make the lesson personally meaningful and contextually significant.

DATA INTEGRATION

In the explore phase of the lesson, students are presented with [NOAA's Monthly Air Temperature in the United States Animated Map](#) (National Centers for Environmental Information, 2024) to interpret patterns in the map and ask open and closed questions about air temperature in the United States. In one of the engage phase activities, students are given an incomplete model of Earth's tilt, a NASA-constructed diagram (NASA, n.d.), to modify the model and interpret guided questions to eradicate misconceptions about Earth's distance with respect to the Sun and its role in seasonal temperature variation. In the explain phase, students revisit [NOAA's Monthly Air Temperature in the United States Animated Map](#) in a form that is deconstructed into [11 static maps](#) to construct an explanative model from 3 of the maps. In the elaborate phase, students use graphs generated from myNASAdata (My NASA Data, 2023) of Yonkers to interpret the pattern in the data and to discuss the reason for the observed pattern. In the evaluate phase, students are given a current isotherm map of the United States (American Meteorological Society, 2024, November 4) generated by the American Meteorological Society to write a scientific argument about how the impact of latitude on the air temperature of Yonkers, NY, and Miami FL.

TEACHER BACKGROUND KNOWLEDGE

Teachers are encouraged to read Thomas (2011) to grasp a detailed understanding of the science of Earth's tilt in causing seasonal temperature variation and the pedagogy for diminishing students' misconceptions.

DIFFERENTIATION OF INSTRUCTION

In the *engage phase*, the teacher provides 2 versions of the activity. For students new to interpreting choropleth maps, guided questions are provided to support their interpretation/thinking. For more experienced students, they will use the see, think, wonder graphic organizer.

In the *explore phase*, students are provided with guided questions to aid in the analysis of the model in the activity titled “Developing and Interpreting a Model of Earth's Tilt.” In the second activity, students are provided with pictures

to aid in the development of the models during the investigation. In addition, a graphic organizer/data table is provided to guide the data collection and analysis processes.

In the *explain phases*, using small group instruction, the teacher provides sentence stems to students who need more scaffolding in generating an explanation. In the whole class instruction, the teacher guides students in developing a checklist of features that the explanative model should contain. In addition, students are given the choice to choose 3 maps from a set of 11 static maps. Also, a 3-stage graphic organizer” and “must haves” are also provided to make this a successful experience for all students.

In the *elaborate* and *evaluate phases*, the teacher provides students with an evidence-based claim and a CER graphic organizer to scaffold the argumentation process.

POSSIBLE PRIOR or MISCONCEPTIONS

According to Thomas (2011), students believe that the cause of seasonal temperature variation is due to Earth’s distance from the Sun.

LESSON PROCEDURE

5E	Details of 5E Lesson Implementation <i>(Visit BSCS to learn more about the 5E instructional model)</i>
<u>Engage</u>	<p>Lesson Objective: Students will interpret a choropleth map of monthly air temperatures in the United States to ask questions about the temperature variations throughout the year.</p> <p>Standards Addressed: Science: ESS2.D: Weather and Climate ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest</p> <p>Materials & Resources:</p>

	<ol style="list-style-type: none"> 1. NOAA's Monthly Air Temperature in the United States Animated Map 2. The Tilted Truth: From Equator to Poles Students Activities 3. Computer 4. PowerPoint Plugin: PollEverywhere <p>Procedure: In this phase, the teacher elicits students' local/funds of knowledge and curiosities about temperature variation in the United States and Yonkers. Using the LMS, the teacher distributes The Tilted Truth: From Equator to Poles Students Activities to each student.</p> <p>Students are working collaboratively in completing the activity titled "Monthly Air Temperature in the United States."</p> <p>Formative Assessment: Students share their open-ended questions in the Poll Everywhere app. The teacher "looks for" questions addressing the cause of temperature variation in the United States and Yonkers.</p> <p>Modifications: In the <i>engage phase</i>, the teacher provides 2 versions of the activity. For students new to interpreting choropleth maps, guided questions are provided to support their interpretation/thinking. For more experienced students, they will use the see, think, wonder graphic organizer.</p>
<p><u>Explore</u></p>	<p>Lesson Objective:</p> <ol style="list-style-type: none"> 1. Students will develop and interpret a model of Earth's tilt. 2. Students will construct a model to investigate sunlight distribution at different latitudes of Earth, specifically, at the Equator, in New York, and at the Poles. <p>Standards Addressed: Science: ESS1.B: Earth and the Solar System Math: MP.4 Model with mathematics ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest E5. Read, write, and speak grounded in evidence E3. Obtain, synthesize, and report findings clearly and effectively, in response to task and purpose</p>

Materials & Resources:

1. [The Tilted Truth: From Equator to Poles Students Activities](#)

Procedure:*Teacher Station Introduction:*

1. The teacher divides the class into heterogeneous groups of 3.
2. The teacher shares the 2 stations with students in a PowerPoint file and also a printed file.
3. The teacher informs the groups that they can work on the activity in any order.
4. The teacher informs the students that they must complete both stations in 1 week and discuss their findings with the teacher in their small group conference.

Students' Station Engagement:

Students are completing the activities in their collaborative group. They consult with the teacher or a knowledgeable peer if additional clarification is needed.

Formative Assessments

1. In the activity titled "Developing and Interpreting a Model of Earth's Tilt," the teacher "looks for" students' responses that show that Earth is closest to the Sun during the winter and farther away in the Summer. Students' drawings should show Earth tilted toward the Sun during the Summer and away from the Sun during the winter, in the Northern Hemisphere.
2. In the activity titled "Modeling Sunlight Distribution," the teacher "looks for" students' responses that show:
 - a. A decrease in intensity/brightness moving from the Equator to the Poles.
 - b. An increase in the length of the sunlight path from the Equator to the Poles.
 - c. More area covered moving from the Equator to the Poles
 - d. Students should make the connection that as latitude increases the intensity of the sunlight decreases.
 - e. Students should also make the connection that as the angle of the sunlight increases, the path covered decreases.
 - f. Students should also make the connection that the closer to the Equator, the temperature of a given area increases.

	<p>Modifications: In the <i>explore phase</i>, students are provided with guided questions to aid in the analysis of the model in the activity titled “Developing and Interpreting a Model of Earth’s Tilt.” In the second activity, students are provided with pictures to aid in the development of the models during the investigation. In addition, a graphic organizer/data table is provided to guide the data collection and analysis processes.</p>
<p><u>Explain</u></p>	<p>Lesson Objective: Students will construct an explanative model of patterns in the temperature variations in the United States and the cause of the temperature variation.</p> <p>Standards Addressed: ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest</p> <p>Materials & Resources:</p> <ol style="list-style-type: none"> 1. The Tilted Truth: From Equator to Poles Students Activities 2. 11 static maps 3. Tabloid paper (11 x 17) 4. Tape 5. Ruler <p>Procedure: In this phase, students synthesize the information they learned in the two explore-it stations to demonstrate their understanding of the cause of temperature variation in the United States.</p> <p>The teacher distributes the tabloid paper and the printouts of students' selected maps to each student.</p> <p>The teacher should revisit the anchoring phenomenon and driving question with the students.</p> <p>Teachers should brainstorm a checklist with students of what should be included in the explanations of what they learned in the previous stations.</p> <p>The teacher should provide a 3-stage framework for explanative drawing construction. See the section titled</p>

	<p>“Explanative Model of Temperature Variation in the United States.</p> <p>On the tabloid paper, students use the ruler to create a 3-frame model as illustrated. Students tape the selected static drawings on the tabloid paper. Students are independently constructing explanation on tabloid (11x17) paper.</p> <p>Formative/Summative Assessments Students' explanations should reflect that seasonal temperature increases moving towards the Equator and this is attributed to Earth’s tilt.</p> <p>Modifications: In the <i>explain phases</i>, using small group instruction, the teacher provides sentence stems to students who need more scaffolding in generating an explanation. In the whole class instruction, the teacher guides students in developing a checklist of features that the explanative model should contain. In addition, students are given the choice to choose 3 maps from a set of 11 static maps. Also, a 3-stage graphic organizer” and “must haves” are also provided to make this a successful experience for all students.</p>
<p><u>Elaborate</u></p>	<p>Lesson Objective: Students will interpret a model of temperature variation in Yonkers collected from my NASA data to discuss the reason for the pattern observed in the data.</p> <p>Standards Addressed: Math: MP.4 Model with mathematics Science: ESS1.B: Earth and the Solar System ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest</p> <p>Materials & Resources 1. The Tilted Truth: From Equator to Poles Students Activities</p> <p>Procedure: In this phase, students apply their learning to a graphical data set of Yonkers. The goal is to see if students can still interpret and explain the cause of the pattern in the data</p>

	<p>when the type of model has changed. The teacher elicits from the class the pattern in the data. The teacher discusses with students the cause of the observed patterns.</p> <p>Students complete the graphic organizer based on the class discussion and knowledge of the earlier activities.</p> <p>Formative/Summative Assessments The teacher “looks for” students' responses that show the temperature is cyclic or has repeatedly fluctuated. Students attribute the cause of this pattern to uneven heating of the atmosphere and lithosphere caused by tilt of the Earth throughout the year</p> <p>Modifications: In the <i>elaborate phase</i>, the teacher provides students with an evidence-based graphic organizer to scaffold the argumentation process.</p>
<p><u>Evaluate</u></p>	<p>Lesson Objective:</p> <ol style="list-style-type: none"> 1. Students will interpret an isotherm model of temperature variations in the United States and compare Yonkers, NY, and Miami, FL, to write a scientific argument about how temperature is affected by its latitude. 2. Students will provide evidence for one of three claims about the temperature variations experienced throughout the year in Yonkers. <p>Standards Addressed Math: MP.4 Model with mathematics Science: ESS2.D: Weather and Climate ESS1.B: Earth and the Solar System ELA: SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest</p> <p>Materials & Resources:</p> <ol style="list-style-type: none"> 1. The Tilted Truth: From Equator to Poles Students Activities <p>Procedure: In this phase, students are demonstrating mastery of the standard.</p>

The teacher provides the students with the quiz in which they must write a scientific argument based on interpreting an isotherm model or choosing a claim that can be supported with evidence and reason.

Summative Assessments

In the isotherm quiz, students claim that the temperature of Yonkers is cooler than the temperature of Miami on November 4, 2024, and use the numerical evidence from the isotherm for both locations. Students reason that the difference in temperature data for both latitudes is a result of the Earth's tilt affecting the intensity of the sunlight heating the lithosphere and atmosphere.

Modifications:

In the *elaborate phase*, the teacher provides students with a CER graphic organizer to scaffold the argumentation process.

REFERENCES

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