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The Cause of the Earth's Seasons

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After an instructor-led discussion, students use a globe and a lamp to determine the cause of the Earth's seasons.

This lesson attempts to correct the common misconception that the Earth is closer to the Sun during the summer in the Northern Hemisphere. Sometimes, in order to correct science misconceptions, it is necessary to confront them head on. This lesson encourages students to voice this misconception at the beginning of the lesson and then attempts to correct it—first, by exploring the reason for it, and then by presenting an alternate explanation.

Materials:

Small globe – 1 for each group of 4 or 5 students

Small lamp with no shade – one for each group of 4 or 5 students

Blank overhead transparency and overhead marker – one for each group of 4 or 5 students

Overhead grid transparency – 1/2" divisions or smaller (e.g., graph paper)

Large ball, basketball size or preferably larger, like a beach ball

Launch:

Questions: What causes summer and winter? (*Accept all responses*)

During which season is the Earth closest to the Sun? (*Accept all answers*)

(*It is assumed that some students will say the summer is caused by the Earth being closer to the Sun than in winter.*)

Have two students stand up. Have one student be the Sun. Have another student be the Earth. Say: "Assume it is now winter. Where would the Earth be during the summer?" *Look for the student modeling the Earth moving closer to the Sun.* Say: "So you are saying that the Earth is closer to the Sun in the summer?" (*Yes*) "Does anyone know what season they have in the Southern Hemisphere when we have summer in the Northern Hemisphere?" (*Winter*) "Go back to where the Earth is during the winter." (*Student*

moves back.) “What season is it in the southern hemisphere?” (*Summer*) “Shouldn’t the Southern Hemisphere be closer to the Sun?” (Accept all responses.)

“Why would you think the Earth is closer to the Sun in the summer? What can you think of from your own experience that might cause you to assume this?” (*Look for answers like standing next to a stove, sitting by a campfire, etc. Select one such response to follow up on.*)

Have the students stand up and move to one side of the room. *Assuming you are following up on the example of a fire in a fireplace:* “Pretend that it is winter and is very cold outside. You’ve been playing in the snow and you now come indoors. On the opposite side of this room is a fireplace with a nice warm fire in it (or wood stove, or campfire on a cold night, depending on which example you are using). You’ve just walked through the door. How do you feel?” (*Warm*) “Now take one step closer.” *Students should all take one step forward.* “How much warmer are you?” (*Not very much*) “Even though the Earth’s orbit is an ellipse, it is nearly circular, and the distance between the Earth and the Sun does not vary that much between summer and winter. In fact, the Earth is actually *farther* from the Sun during the Northern Hemisphere’s summer than the winter.

Have students return to their seats. Use the overhead projector to project the grid on a flat screen. “Pretend the Earth is flat like this screen, and this overhead lamp is the Sun. What can you tell me about the amount of sunlight in each of these little boxes?” (*They are the same*) “Since each box gets the same amount of sunlight, what can we conclude about the amount of heat each square gets?” (*It’s the same.*)

Place the large ball directly in front of the screen so the image of the grid is now projected on to the ball. “Look what happens when we shine the light on a sphere like our Earth. What do you notice about the squares?” (*They are different sizes*) “We agreed earlier that each square gets the same amount of heat and sunlight. Which part of the ball is getting the most heat?” (*The part in the center, the part with the smallest squares, etc.*) “Which part of this ball do you think is currently having summer?” (*The center*) “Why do you think that?” (*The light is most direct there, it is getting the most heat, light, etc.*)

Distribute lamps and globes, one of each per group. Lamps can be left off initially. In this next section you will have students move the globes around the lamps and observe where the light shines most directly. It is important that students move the globes correctly, so you should take a moment to explain to the students how to position the globe as they move it around the lamp: “Now assume the lamp is the Sun. Show me how the Earth moves around the Sun.” (*Students should move the globe around the lamp in a circle.*) “Show me half a year. How does the Earth move?” (*Globe is moved half way around the lamp.*) “Show me one day.” (*Students should rotate the globe one time.*) “Show me half a day” (*Half a turn*) “Does anyone know why the globe is tilted?” (*Because the Earth is tilted relative to the Sun*) “Has anyone heard of the North Star? Does anyone know why it is called that?” (*Because the North Star is directly over the North Pole, therefore, the tilt of the Earth is pointing toward the North Star.*)

“This next part is very important. As the Earth moves around the Sun, the direction of the tilt doesn’t change.” *Mark a point on the ceiling in the front of the classroom.* “Pretend that this point is the North Star. Turn your globe so that the Earth is tilted toward it” *(Check to see that all globes are adjusted properly.)* “Without changing the direction of the tilt, move the globe so that it shows the position of the Earth six months later. Which way is the Earth tilting now?” *(The globes should still be tilting toward the “North Star.” Take a moment to check that all groups have their globes pointing correctly. If they don’t, show each incorrect group individually how the tilt of their globe should be pointing and then ask the group to move the globe all the way around the lamp in a complete circle, making sure that the tilt of the globe doesn’t change direction. It may take a few minutes to check every group, but it is important to do this.)*

“We decided earlier that the part of the globe where the Sun is shining on most directly is having summer. Turn on your lamps now.” *(Students should turn on lamps.)* “Move your globe around the Sun. Stop every now and then to show a day. Keep checking to determine which season each hemisphere is having, or in another words, which part of the globe is getting the most direct sunlight. When you think you’ve figured it all out, draw a diagram on your overhead transparency showing the positions of the Earth and Sun, including the Earth’s tilt, for each of the four seasons in the Northern Hemisphere.”

When all groups have completed their diagrams, have them share them with the rest of the class. Check for understanding as they present. The Northern Hemisphere should be pointing toward the Sun in the summer, away from the Sun in the winter and oblique to the Sun in the spring and fall. Many students have difficulty creating two-dimensional representations of three-dimensional phenomena, and showing in a drawing the tilt of the Earth for all four seasons make be particularly difficult for some students. It is important that teachers listen to their students’ explanations of their diagrams when checking for understanding.