TRB 6:2 - Activity 1 - Reasons for the Seasons

Summary

In this activity students will learn how Earth's axis of rotation affects the angle of sunlight and the length of day.

Materials

- " Season Survey ", 2-3 copies per student
- meter sticks or measuring tapes
- lamp or flashlight
- dark room
- outdoor thermometer (a minimum/maximum thermometer would be ideal)
- graphing paper
- sunrise/sunset and temperature dates for Salt Lake City

Additional Resources:

Gould, Alan, Carolyn Willard and Stephen Pompea. The Real Reasons for Seasons Sun-Earth Connections. GEMS Lawrence Hall of Science, University of Berkeley, CA, 2002.

Background for Teachers

Have you ever run laps on a track? When you complete one lap you are back in the same place you started. Earth moves around the sun in a path that nearly repeats itself (like running a track) about every 365.25 days. Earth's path around the sun is called its orbit.

Earth's axis of rotation is an imaginary line that passes through Earth's North and South poles. Earth rotates around this axis, which causes day and night. Earth's axis of rotation is not straight up and down with respect to its orbit, but is tilted by about 23.5 degrees with respect to this up and down direction.

If you have ever watched the North Star, you may have noticed that it seems to stay in the same place in the sky all of the time. It is almost directly above Earth's North pole. This shows that Earth's axis of rotation points in the same direction while Earth both rotates on its axis and moves in its orbit around the sun. About June 21 every year, Earth is at a place in its orbit where the northern side of its axis is tilted toward the sun. Six months later, about December 21, Earth is on the other side of the sun where its northern axis is tilted away from the sun.

When the northern side of Earth is pointed away from the sun in December, the sun appears low in the sky and the angle of the sun's rays is small. In June when the northern side of Earth is pointed toward the sun, the sun appears high in the sky, and the angle of the sun's rays is large. In the spring and fall the angle of the sun's rays is half way between the angle in winter and the angle in summer.

The days with the least amount of daylight are not the coldest days, nor are the days with the most amount of daylight the warmest days. This is because some materials can be heated and cooled quickly (especially metals). Other materials can absorb heat without changing their temperature very much, so it takes a long time to heat and cool them. Water is a good example of this. About 3/4 of Earth's surface is covered by water which causes the heating and cooling of Earth to take place slowly. Although the maximum amount of heat received by the sun in the Northern hemisphere occurs on June 21, the highest average temperatures occur about one month later. Similarly, the lowest average temperatures occur after the date when the Northern Hemisphere receives the least amount from the sun.

Intended Learning Outcomes

1-Use science process and thinking skills

2-Manifest scientific attitudes and interests
3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning
5-Demonstrate awareness of social and historical aspects of science
6-Understand the nature of science

Instructional Procedures

Invitation to Learn:

Give each student 2 or more copies of the "Season Survey." Have each student complete a copy of the survey. Have them ask a family member or friend (not a member of the class) to complete the other(s). When all the surveys have been completed, together as a class, tally the number of responses for each answer choice for each survey question. Discuss with the class to determine which answers are correct. If a particular answer had the highest number of responses, does that mean that it is the correct answer? Explain that historically the majority of people have believed incorrect ideas. Ask if they can think of any examples? (Earth is flat; Earth is center of the universe) Explain that the best way to find out the correct answers is to research the problem. This will be done by making observations and by learning what other scientists have discovered.

Instructional Procedures:

In this activity students will learn how Earth's axis of rotation affects the angle of sunlight and the length of day. Students will first learn the relationship between the height of a light source and the length of the shadow cast by an object in the path of the light source. Next they will record shadow lengths to infer changes in the sun's angle over at least a 3-month period. They will also record the high temperatures on the days where shadow lengths are recorded. Finally, students will compare day length with the high temperatures.

In a darkened room have a student hold a meter stick upright where everyone will be able to see the shadow. Move the lamp or flashlight up and down to show that when the light source is high, the shadow cast by the meter stick is short. When the light source is low, the shadow is long. Have another student sit near the meter stick and have them point to the light source with their extended arm. The angle of the student 's arm is large when the light source is high and smaller when the light source is low.

Sun Shadow Observations

WARNING!

Never look directly at the sun!

Begin shadow measurements on a sunny day. Select a straight up and down object on the school grounds such as a flagpole, tetherball pole, or basketball standard. Choose a time of day when students will be able to consistently make measurements (perhaps a recess break). It is very important that the shadow be measured at the same time of day each time it is measured. With the whole class watching, demonstrate how to measure the shadow cast by the object. It is also important that it is measured consistently each time.

Before going outside to measure, decide on a format for keeping track of the records in student science journals. Have students record the date, time and length of the shadow in their science journals.

Arrange for an outdoor thermometer to be placed outside your classroom (not in direct sunlight). Have students record the high temperature for the days they observe the sun's shadow. You will need to work out a system for finding the high reading. Thermometers are available with a remote sensor so they could be read inside. Or, if you use a minimum/maximum thermometer it will automatically register the high (and low) temperature each day. An alternative to tracking and recording the actual temperatures is to find and record the official weather temperatures in

the newspaper or on the Internet. See "Materials" for Internet sites.
Continue to make observations with the whole class for about a week. Little change will be noticed, but it will set the pattern for further observations.
Organize the class in teams of two or three to continue making observations. Arrange a schedule for the class observations and a method for sharing information with other class members. Continue to make records for a period of at least 3 months. Ideally it would be best to keep records through the school year so students could see the seasonal changes.
Periodically discuss with your class what is happening to the length of the shadow. Have them note what is happening to the amount of daylight. This is a good time to discuss sunrise and sunset times. Discuss why this is happening. Be sure students know that Earth's axis of rotation is the reason for the sun's changing position in the sky.
Have students calculate the length of daylight for two days each month. Or you may have students gather information from newspaper or Internet sources or from class observations.
After sufficient data is collected, organize students in small groups to make the following series of graphs: a graph showing the shadow changes, a graph showing temperature highs, and a graph showing length of daylight. Compare the similarities and differences of the three graphs.
Students may notice that the coldest days are not the days with the shortest shadow or the least amount of daylight. Help them understand that one reason for this discrepancy is because the materials Earth is made of take time to cool and warm.

Extensions

Students locate and use Internet sources to keep track of sunrises and sunsets and daily temperatures.
Have students make two or three graphs on the same graph paper to show comparisons.
Use this demonstration to show students how water heats and cools relatively slowly. Fill a pan with water and place it on a hot plate, turned on high. Help students notice that the pan heats up quickly, but the water does not. Monitor the temperature of the water through out the experiment. Turn the hot plate down slightly to medium-high. Observe whether the water becomes immediately cooler. It does not. Actually the water temperature may go up. The water temperature does not respond quickly to temperature changes. Relate this to how the earth's surface (3/4 water) does not heat up or cool down immediately.

Assessment Plan

Refer to the original survey students took at the beginning of the unit. Have them take the survey again. Discuss the correct answers.
Have students choose one misconception about the way people erroneously think about the seasons and write why the misconception is false and what the correct answer is.

Bibliography

This lesson is part of the Sixth Grade Science Teacher Resource Book (TRB3) http://www.usoe.org/curr/science/core/6th/TRB6/. The TRB3 is designed to be your textbook in teaching science curriculum to your students. This book covers all the objectives of each standard and benchmark. If taught efficiently, a student should do well on the End-of-Level (CRT) tests. The TRB3 is designed for teachers who know very little about science, as well as for teachers who have a broad understanding of science.

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