The Trip Around the Sun

Summary

The activities in this lesson will help students understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Group Size

Large Groups

Materials

- *"Why Do We Have Seasons" song*
- *Seasonal Landmark Cards*
- Polaris & circumpolar stars poster
  String
  Meter sticks
  Styrofoam
  Four skewers
- *Earth Models*
  Tacks
  Protractor
  Art paper
- *Sunlight Through the Year*
  Rulers
  Markers
  Glue
- *Reasons for Seasons Assessment Choices*
- *Seasons Pictionary Cards*

Additional Resources

Books

The Seasons of Arnold's Apple Tree, by Gail Gibbons, ISBN 0-15-271246-1
Sun Up, Sun Down, by Gail Gibbons, ISBN 0-15-282782-x
The Reasons for Seasons, by Gail Gibbons, ISBN 0823411745
The Little Island, by Golden MacDonald and Leonard Weisgard, ISBN 0-440-40830-x
Sunshine Makes the Seasons, by Franklyn M. Branley and Michael Rex, ISBN 069004481X
The Real Reasons for Seasons, Great Explorations in Math and Science (GEMS), ISBN 0- 924886-45-5

Media

Bill Nye the Science Guy. Earth's Seasons; ISBN 1932644342 9781932644340

Background for Teachers

There are many misconceptions about what causes seasons. When people think about Earth's revolution around the sun, many picture a very oval, elliptical shape. Actually, Earth's orbit is a slightly elliptical circle. Thus, the distance between the sun and Earth does not change significantly throughout the year.

Earth spins on its axis, which is what causes day and night. The axis is tilted so that the North Pole points at the North Star, Polaris, all of the time. Because of Earth's tilt and revolution around the sun, each of Earth's poles is tilted towards the sun for part of the year. Consequently, each pole is tilted away from the sun for part of the year. When the Northern Hemisphere is tilted towards the sun, the result is more hours of daylight and more direct sunlight. These two factors create warmer temperatures for the Northern Hemisphere, resulting in the season of summer. When the days are shorter and the sunlight is much less direct, it is the season of winter.

Intended Learning Outcomes

1. Use science process and thinking skills.
2. Manifest scientific attitudes and interests.
3. Communicate effectively using science language and reasoning.

Instructional Procedures

Invitation to Learn

Sing the song *"Why Do We Have Seasons"* with students. This is a simple echo song to the tune of "Charlie Over the Ocean". The teacher sings each line and the students echo back. This simple song includes all essential elements on why Earth has seasons throughout the year.

Instructional Procedures

Part One: The Earth's Movements

Find an open area where all students in class can stand in a circle so that everyone can see and hear the teacher and each other easily.

Show students a length of string that has been previously measured to be about 2 meters in length. This string represents the distance from the sun to Earth. (The average distance of Earth to the sun is 150 million kilometers, which scientists call an 'astronomical unit'.) Refer to the string as one astronomical unit.

Instruct students to stand around a central point. Choose an object or a student to represent the sun in the center of the circle. Students should face the center of the circle. Use the string to help students create an even, almost circular shape by stretching the string from the central point to each edge of the circle. The students are now in the shape of Earth's yearly revolution around the sun. Explain to the students that they are modeling Earth at various points in its yearly revolution. Ask students to explain to their neighbor and then to the whole group the apparent shape of Earth's orbit in space. (circle) Make a point of noticing that Earth does not appear closer to the center point anywhere in the circle. (Actually, Earth is slightly closer to the sun in January and slightly farther away from the sun in June. However, these slight distances in the huge scale of space do not make any significant differences in Earth's temperature.) When the teacher gives the signal to "Revolve!" the students should start walking in a counter-clockwise motion around the classroom sun.

Ask students to demonstrate what Earth does in space each day by turning counterclockwise in place to show rotation. Identify day and night by turning towards and away from the sun. Each time the teacher says "Rotate!" from now on, students should turn around in place once in a counter-clockwise motion.

Have students return to their seats and record findings from the model. Pose the following questions to the students: What was the model trying to show? What key vocabulary words need to be used? What does this model help us understand?

Students should draw a picture in their science journals of Earth's circular revolution around the sun, and define the words rotation and revolution. Add drawings and helpful reminders to clarify these terms.

Part Two: The Tilt

Draw students' attention to the pre-hung poster of the North Star (Polaris) on the wall. Ask students if they know anything about the North Star. Explain to students that one of the reasons the North Star stays in one place throughout the year and can be used as a navigation tool is because Earth's axis is always tilted towards it. Explain to students that no matter where Earth is in its trip around the sun, the Northern Pole of Earth is always tilted 23.5 degrees towards Polaris.

Ask students to imagine that the upper half of their bodies represents Earth. Next, ask students to demonstrate estimating angles by bending their bodies at the waist to degrees called out by the teacher. Start with 90 degrees, go to 60 degrees, 30 degrees, and 0 degrees, the angle measures used in the previous sunray lesson. Make sure students are turned towards the North Star as they are bending, pointing their head (North Pole) consistently at Polaris. Last, students should demonstrate an estimated 23.5-degree tilt towards Polaris. Agree as a group what this tilt might look like.

Draw students' attention back to the central object in your model. What is the object that holds Earth in place during its revolution? (The sun.) What force keeps Earth from flying away into space? (The gravitational force from the sun.) Discuss the limitations of the classroom model you are creating. (The scale is not accurate and no energy is coming from our classroom sun.)

Students should draw a picture of Earth's tilt towards Polaris in their science journal. Pose these final questions to students: What questions do you have about Earth and the sun in space? Where could the answers to these questions be found? Ask students to meet in teams of three to discuss their journal sketches and wonderings.

Part Three: The Seasons

As the students are standing in their spots around the sun, explain to students that the sun's energy travels through space and reaches Earth. Ask students to demonstrate the sun's tilt towards Polaris. What part of our circle is tilted towards the sun in the most direct way? Having all students tilt 23.5 degrees towards Polaris and identify the students whose heads are tilted towards the sun. This is the summer section of our circle. Hand one student in the summer section the landmark sign labeled "summer solstice". Briefly describe the summer solstice (June 21st-22nd) as the longest day of the year. This is the day when Earth receives the most hours of daylight from the sun. The sun appears high in the sky as it makes its long trip across the sky. What kinds of temperatures do we experience on summer solstice? What activities would we be doing on summer solstice?

Go to the opposite side of the circle from the summer solstice. Ask students to demonstrate Earth's tilt again and point out that this side of the circle is tilted away from the sun (for the Northern Hemisphere). Ask students what season they think it would be if we were tilted away from the sun's energy. (winter) Hand one student the landmark sign labeled "winter solstice". Briefly describe the winter solstice (December 21st-22nd) as the shortest day of the year when Earth receives the least hours of daylight from the sun. The sun appears much lower in the sky as it moves across the sky. What kinds of temperatures do we experience on winter solstice? What activities would we be doing on winter solstice?

Ask students to infer what seasons the southern half of Earth is experiencing during the Northern Hemisphere's summer and winter. (The seasons are the opposite because the tilt towards and away from the sun is opposite.) Allow time for students to share personal experiences and connections involving time spent in countries in the Southern Hemisphere.

After the summer and winter solstice have been identified and labeled, show students the landmark signs titled "spring equinox" and "fall equinox". Explain to students that spring and fall are in-between seasons, in which the weather is changing from one season to another. Earth is neither tilted towards or away from the sun during these times. Ask students to demonstrate their tilt again, and find the areas of the circle where students are tilted sideways, and not towards or away from the sun. Hand one student the 'spring equinox' sign, and another the 'fall equinox' sign on the opposite side. Briefly explain the dates and the fact that daylight hours will be equal on the equator during these days. If one Earth day is 24 hours, and day and night are equal, how many hours of daylight would Earth experience on an equinox day? Ask students to describe first to a partner and then to the larger group the weather, signs in nature, and activities of spring and fall.

Many of the students are not holding signs yet. Ask students to look carefully around the circle at the four identified seasonal landmarks. Show students the stacks of cards labeled for the transitional time between seasons. Instruct all students who do not yet have a card to carefully decide which sign would best describe the seasonal time they represent. (summer to fall, fall to winter, winter to spring, & spring to summer) Students should make their decision and then move to collect their sign and return to the circle. As students hold their cards up in front of their chests, it is easily assessed whether any mistakes have been made and can be corrected.

This demonstration can be quickly replicated on numerous days throughout the school year by using the cards and a central point. With practice, students will be able to quickly and accurately create a model of Earth's orbit around the sun, demonstrate earth's constant tilt towards Polaris, and identify the seasons throughout the year.

Students should sketch a picture of Earth revolving around the sun with the four seasonal landmarks labeled and described in their science journals.

Part Four: Creating a Paper Seasonal Model

After creating the human model of Earth's yearly revolution, students will next work in teams of four to create a smaller scale model in which the four seasonal landmarks are identified using the Styrofoam board and skewers from the sunray lesson, along with four paper models of Earth.

Students should lightly make a line diagonally from opposite corners of their Styrofoam board to identify a central point. At the central point, students should place a tack.

Next, measure and cut a piece of string or yarn that approximately 15 centimeters long. This length will represent one astronomical unit. Poke the tack through one end of the string and hold it in place at the center of the Styrofoam. Use the string to guide the pencil around the central point to make a model of Earth's elliptical, circular revolution through space around the sun.

Now, color and cut out the four models of Earth. Tape each model to the end of each skewer.

By placing a protractor on the Styrofoam, students measure a 23.5-degree angle towards the classroom 'Polaris' and poke the skewers into the Styrofoam in the four seasonal landmark positions around the sun. Which Earth is tilted towards the sun (tack in the center) with its Northern Hemisphere? Label this skewer 'summer solstice'. Label the opposite Earth model, which has its Northern Pole tilted away from the sun 'winter solstice'. Review dates and attributes of these days. Have groups identify the correct position for their 'spring equinox' and 'fall equinox' Earth models and label them. Review dates and attributes of these days.

Students should write descriptive sentences about the four seasonal landmarks in their science journals. Include the vocabulary words direct and indirect sunlight in descriptions.

Part Five: Graphing the Sunlight

Lay a piece 9" x 13" art paper horizontally so that it forms a long, thin strip. Starting on one edge, measure and make a mark with your pencil at every 3 centimeters. These marks will be the months of the year. Label each mark with the abbreviation of each month. The extra space at the end of the paper will be used later as a tab to glue the paper into a circle.

Using the *Hours of Sunlight Data Chart*, measure a line straight up from each month's tick mark. Make one centimeter equal to one hour of sunlight. After all lines are complete, connect the tops of each line. Shade in the area below the line with a yellow color. The shaded space represents the hours of sunlight that Earth receives throughout the year.

Finally, glue the edge of the paper to the opposite side to make the paper into a circle. Stand the circle of graphed sunlight in the center of the Styrofoam model of the seasons. As students look at their model from the side, turn the circled paper so that the months on the paper correspond

correctly with the models of Earth on the skewers. Ask students to generalize as a group what they notice about how the hours of sunlight change throughout the year and how this affects Earth's seasons.
Students should record the hours of sunlight graphing activity in their science journals.
Pose questions to students for discussion and journaling: What does your graph of the sunlight show? How does the hours of sunlight Earth receives connect to the seasons?

Extensions

Curriculum Extensions/Adaptations/ Integration

For advanced learners, pose 'what if' questions to students to stimulate hypothetical thinking. What if Earth were not tilted? What if Earth revolved every 100 days? What if Earth did not rotate?
For learners with special needs, ask students to create a simple foldable which shows the position of Earth in the four seasons throughout the year. Each picture should be labeled with the correct heading and with at least three descriptive phrases underneath. (summer solstice: hot, long days, more sun)

Family Connections

Students should ask 5 adults if they can explain the real reason for Earth's seasons. Bring data collected to school and compile as a class the number of adults who have misconceptions. Add this information to the classroom compare/contrast board.
Students and families should plan a significant way to 'celebrate' one of the seasonal landmarks. (Get everyone in your family to say "Happy Winter Solstice!" on December 21st.)

Assessment Plan

Students will write on an index card to explain the reasons for seasons. Post cards on the compare/contrast board involving accurate information and misconceptions.
Students will make a choice from the *Reasons for Seasons Choice* Board to demonstrate their scientific knowledge of seasons.
Students will participate in a game of 'scientific pictionary' to demonstrate key seasonal vocabulary and concepts.

Bibliography

Research Basis

Huitt, W. (2003). Constructivism. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. Retrieved [date], from http://chiron.valdosta.edu/whuitt/col/cogsys/construct.html
The constructivist approach to teaching states that when a student feels safe and secure in his/her learning environment, the processing of new thoughts and ideas will take place. Advocates of constructivism state that it is the stimuli of the environment, rather than the stimuli themselves that most greatly impact student achievement. In most curriculums, knowledge and skills are taught separately and then connected, versus the constructivism-oriented classroom in which students acquire content while carrying out tasks that require higher- order thinking. For example, scientific knowledge is usually taught by working students through information piece by piece, rather than looking at new knowledge from a holistic viewpoint. Teachers need to first consider the knowledge and experiences students bring with them to the lesson. Then, the instruction should be built so that the students can expand and develop new knowledge by connecting it to previous experiences and learning. Teachers should provide a mixture of direct instruction, active practice of the new skill, and feedback. The constructivist approach is centered on a student's pre-existing experiences, filling the gaps and providing ample time, space, experiences, with choice and differentiation for students to display their new knowledge.

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