Why are There Seasons?

Target Grade Level: 1st-8th

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1. CONTRIBUTOR'S NAME: DAVID NICHOLAS

2. NAME OF INQUIRY: *WHY ARE THERE SEASONS?*

3. GOALS AND OBJECTIVES:
   a. Inquiry Questions: Why are there seasons?
   b. Ecological Theme(s): Seasonality is the driving force behind the majority of ecological cycles on the earth.
   c. General Goal: Student understanding of the causes of seasonality.
   d. Specific Objectives: Content learned.
   e. Grade Level: 1-8
   f. Duration/Time Required:
      → Prep time: 10-15 min
      → Implementing Exercise During Class: 30-50 min
      → Assessment: 1 hr

4. ECOLOGICAL AND SCIENCE CONTEXT:
   a. Background (for Teachers):
   Many, if not most aspects of ecological cycling are driven by the earth's seasonality. But, the cause of seasonality is commonly misunderstood. The earth exhibits an axial tilt of 23 ½˚. Thus, it is not perpendicular to its ecliptic, or the path that it travels around the sun. The earth's axis, as projected from the northern hemisphere, points toward the sun in the summer, and away from it in the winter. This cyclical change in declination of the sun results in three readily observable changes that drive seasonality.
   1) The altitude of the sun above the horizon changes. In Missoula, MT, the maximum altitude of the sun (at solar noon) on the summer solstice is 66.5˚, and on the winter solstice, 19.5˚. Thus, the northern hemisphere receives more incoming solar radiation in the summer than in the winter.
   2) The duration of daylight changes. In Missoula, MT, day length on the summer solstice is nearly 16 hours, and on the winter solstice, just over eight hours. Sunrise, sunset and solar noon times for any date and for any location in the world can be obtained from the US Navel Observatory's web site: http://aa.usno.navy.mil/data/docs/RS_OneDay.html.
   3) On the equinoxes, the sun rises and sets exactly east and west. On the summer solstice, it rises and sets much to the north of east and west, and on the winter solstice, much to the south of it. Altitude (the angle up from the horizon) and azimuth (the angle along the horizon, with east being 90˚ and west 180˚) information can be obtained from the US Navel Observatory's web site: http://aa.usno.navy.mil/data/docs/AltAz.html.

   b. Background (to present to Students): Same as for teachers.

5. MOTIVATION AND INCENTIVE FOR LEARNING:

6. VOCABULARY:
   Ecliptic- The celestial equator, or the path the earth travels around the sun.
   Altitude- The angle of the sun above the horizon. 90˚ is straight up.

Azimuth- The angle of the sun along the horizon. North is 0˚, east is 90˚, and west is 270˚.
Solar Noon- The time each day when the sun reaches its zenith, or highest point.

7. SAFETY INFORMATION:
   Don't look directly at the sun. You'll go blind.

8. MATERIALS LIST (including any handouts or transparency masters):
   -globe
   -flashlight
   -meter/yard stick
   -12-18'' length of sturdy dowel
   -string, scissors, permanent marker
   -compass (optional)

9. METHODS/PROCEDURE FOR STUDENTS:
   This inquiry is composed of two parts. First, sit in the center of the room and use the flashlight to represent the sun. Relinquish the globe to the students and have them figure out for themselves the cause of seasonality. Then have them demonstrate the concepts behind the three observations mentioned above. Encourage them to walk around you and interact with one another. You might have to remind them of the difference between the earth's rotation around its axis and its rotation around the sun. It may take 20-30 minutes, but eventually they'll figure out what causes the seasons, and when they do, they'll be quite proud of themselves. One thing you need to make sure of, however, is that they do not rotate the earth's axis as it travels around the sun. They can spin the globe all they want, but the axis must always be pointing in the same direction.

   Second, take them outside once a week or so to measure the length of the sun's shadow. A meter/yard stick and string make for a good sundial. Have them measure the length of the shadow with the string, then save the length of string by wrapping it around a piece of thick dowel. Be sure they write the date and time each measure was taken directly onto the dowel alongside where the day's string has been wound. While working outside, have them explain why the length of the shadow might change. Bending the stick away from and towards the sun will help to highlight the point. If a compass is available, and there is time to get outside more than once a day, also have the students measure the changing directions of shadows and the sun's position relative to a fixed position. At the end of the year, spend an hour or so having the kids measure each of the strings and record the data. Then have them graph this data, along with any positional data that they might have collected, out in a manner they think best. Remember that you'll want to take each of the measurements at the same time of day. As a reminder, daylight savings time begins the first Sunday of April and ends the last Sunday of October, so if just one particular time fits in well to your schedule, maybe consider starting in early November and going through March.

10. ASSESSMENT:
Obviously, assessment of this inquiry can be done by having the students explain, either in verbal or written form, the cosmological factors that lead to seasonality. Testing higher level thinking skills can be done by having students predict a few weeks to a month in advance what the position of the sun might be and how shadow lengths and directions might change.

11. EXTENSION IDEAS:
This lesson can provide a bridge from the earth sciences to the life sciences, and vice versa.

12. SCALABILITY: This inquiry can be conducted in 15-30 minutes with nothing more than a globe, or can last all school year long, taking the students outside to conduct measurements across the seasons.

13. REFERENCES:
PASACHOFF, JM AND DH MENZEL. 1981. *STARS AND PLANETS.* PETERSON FIELD GUIDES, HOUGHTON MIFFLIN CO., NEW YORK.

SCHAEFER, VJ AND JA DAY. 1992. *ATMOSPHERE.* PETERSON FIELD GUIDES, HOUGHTON MIFFLIN CO., NEW YORK.

WOODMENCY, J. 1998. *READING WEATHER.* A FALCON GUIDE. FALCON PUBLISHING, INC., HELENA, MT.

US NAVAL OSERVATORY, ASTONOMICAL APPLICATIONS DEPATMENT: HTTP://AA.USNO.NAVY.MIL/AAMAP.HTML

14. LIST OF EXPERTS AND CONSULTANTS: See REFERENCES.

15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:
This lesson has worked well at Florence Carlton. It also provides structure to our regular outside time as the students have a prescribed set of things to do at the beginning of each outing.