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# K-12 Partnership Lesson Plan

# Brook Wilke

# *Winter Schoolyard Soil and Air Temperature*

## Overview

The causes and consequences of soil temperature in the winter is an important concept to understand. Human management activities in agriculture and conservation can have large impacts on soil temperature. In return, soil temperature has important impacts on the ecology of different ecosystem. The causes of soil temperature changes in the winter can easily be studied in the schoolyard. Students will explore the soil and air temperature in different habitats around the schoolyard that may be affected by different ecosystem properties, such as plant, litter or snow cover and human built structures. The patterns in soil temperature are then related to the consequences for the ecosystem around the school and extensions are made to consequences for fields and forests.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Take measurements of soil and air temperature
* Distinguish between temperature in Celsius and Fahrenheit
* Make keen observations of areas in the schoolyard that have warm and cold soil temperature as well as warm and cold air temperature
* Connect soil temperature with the habitat/snow cover/plant cover
* Identify ways in which humans have manipulated soil and air temperatures
* Form hypotheses regarding how soil temperatures impact plant and animal life
* Make connections between soil and air temperature

**Length of Lesson**

1-1.5 hours

**Grade Levels**

Elementary (5th)

**Standards covered (NGSS)**

Cross Cutting Concepts:

* Patterns
* Scale, proportion, and quantity
* Energy and matter in systems

Science and Engineering Practices

* Planning and carrying out investigations
* Analyzing and interpreting data
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **I.1.MS.2 (C 8):** design and conduct simple investigations
* **III.5.MS.6 (LEC 11):** describe ways in which humans alter the environment
* **I.1.MS.4 (C 10):** use measurement devices to provide consistency in an investigation
* **II.1.MS.5 (new):** develop an awareness of and sensitivity to the natural world

**Materials**

* 8 digital soil thermometers (mechanical soil thermometers will work too)
* 1 schoolyard
* 8 clipboards
* 8 writing utensils

**Background**

### *Strategy*: *Inductive or field inquiry*: techniques-observations-patterns-explanations (TOPE)

### *Introduction/Anticipatory Set*

As a class, give the students the following five question quiz. Each student votes for an answer by raising their hand. Tally the number of answers on the board beside the question.

1. Will the soil temperature under snow be colder or warmer than in areas without snow cover?
2. Will the soil temperature under growing plants be warmer or colder than areas without plants?
3. Will the air temperature and the soil temperature be the same?
4. Will the soil temperature be warmer on the north, west, east or south side of the school?
5. If you were a farmer, would you want the soil in your field to be warm or cold in the winter?

Go over the activities with the session with the students. Make sure to let them know how to properly insert the soil thermometers and to be very careful with them. They must not try to jam the thermometers into frozen soil. When inserting them, make sure to use the metal portion of the thermometer to push down rather than the top portion, at least until the thermometer is almost entirely in the ground.

### Activities of the session

1. Have the students count off into groups, starting with one and ending at eight, in order to form eight groups of two-three students. Students should take turns being temperature measurers, data recorders and habitat observers
2. Provide each student with a clipboard, datasheet and soil thermometer.
3. Identify the boundaries where the students are allowed to take measurements. Tell them to try and find some different areas to use of their data collection.
4. Each group will go out into the schoolyard and identify six different locations where they will measure the soil and air temperature, and observe the habitat where they are measuring.
   1. At each location, hold the thermometer out in front of you for one minute to measure the air temperature in degrees Fahrenheit. Record on the data sheet.
   2. Gently insert the thermometer into the soil using the metal end first. Only hold on to the metal part of the thermometer as you start to push it into the soil to prevent breaking the thermometer. Once you have the thermometer somewhat into the soil, gently push the thermometer in the rest of the way from the top until the entire metal portion is in the ground. After one minute, record the temperature and remove the thermometer from the ground gently.
5. Make observations of the habitat where you measured the temperatures. Is there snow, plant or litter cover? Are there buildings, statues or fences within 10 feet (four steps) of you? Which direction is the structure from you? How many steps away is it?
6. Repeat steps 1-3 above for five more locations in the schoolyard.

**Conclusion**

In the same groups of three, the students will answer the last questions on the worksheet.

* Where the air and soil temperatures the same in each location you measured?
* Where was the soil temperature the warmest?
* What was covering the ground at that location?
* Where there any buildings or structures nearby and which direction were they?
* Where was the soil temperature the coldest?
* What was covering the ground at that location?
* Where there any buildings or structures nearby and which direction were they?
* Did the air temperature change between different locations?
* Where was the air temperature the warmest?
* Where was the air temperature the coldest?
* If the soil temperature is 0 oC, what is the temperature in Fahrenheit?
* 32 oF
* If something is keeping the soil warm in the winter, will it also keep the soil warm in the summer?
* No, usually cover keeps the soil cooler in the summer, effectively buffering the soil from extreme cold and extreme warm temperatures.

Hopefully, the exercise will stimulate other questions that the students have about the causes and consequences of soil temperature in the winter

* *Should we have used a ruler or tape measure to measure the distance to the structures when we were collecting data?*
* Yes, accuracy in science is important
* *What impacts does the winter soil temperature have on plant and animal life?*
* Warm soils in the winter may speed up decomposition, but also stimulate plant growth in the winter
* Cold soils may cause winter injury to plants
* *What are the two major ways in which humans may directly or indirectly regulate soil temperature?*
* Changing the plant, mulch or snow cover on the soil. Soils with cover are buffered from extreme cold and extreme warm temperatures and do not fluctuate as much in either direction.
* High levels of soil moisture also buffer the temperature of soil, keeping it warm in the winter and cool in the summer.
* *If you were a farmer, would you want the soil temperature in your field to be warm or cold?*
* If you are growing perennial plants, you would want the temperature to remain fairly warm so that the plants survive the winter
* If you are not growing any plants over the winter, you would want the soil to be as cold as possible to prevent decomposition
* If you are planting in the spring, mulch or plant covers over the winter prevent the soil temperature from rising quickly in the spring, often making soils too cool in the spring to plant. Thus, you may have to delay planting until later when the soil has more time to warm.
* *What would happen to the soil temperature in a forest if all of the trees were cut down?*
* It would likely be much warmer in the summer and much cooler in the winter.

**Resources**

* Brady, N.C and Weil, R.R. 2002. The Nature and Properties of Soils: Thirteenth Edition. Prentice Hall, New Jersey: pg. 310-313.

**Extensions and Modifications**

As an additional small group or individual activity, students may find it interesting to test the soil temperature for different farmers in the area in their fields and then provide a report for the farmers on what they found.

**Assessment**

Students should be graded in two ways on this project

1. Willing participation in the activity
2. Completion of the worksheet. Answers need not be completely correct, but must be given some thought.

**Post-lesson Comments and Reflection**

*When we performed this lesson with the fifth grade, I did not plan enough time. To take all of the measurements and effectively go through the questions, 1.5 – 2 hours would be appropriate. On the day of the data collection, there was snow on the ground. Certain areas where there was not snow were frozen and could not be measured because the thermometers could not be pushed into the soil. Students found the warmest temperatures near the buildings and the coldest temperatures on the north side of structures where there was no snow.*

*Overall, it went quite well. I plan to repeat the activity in the summer when the soil temperature may really be affected by plant growth and litter.*