Eastern Oregon Middle School Math and Science Challenge

Challenge 2: Soil Temperature

This challenge encourages students to engage with real-world data and enhances their understanding of environmental science concepts. Ideally, this is an interdisciplinary unit that uses standards from a variety of core subjects, with specific focus on math and science. All activities and handouts are intended for adaptation and expansion by the instructor.

Background information: Temperature is a measure of the average kinetic energy. The more active the particles, the higher the temperature.

To view the Vocabulary Information Page click here.

Objectives:

- Measure and compare ambient air (Challenge #1), soil (Challenge #2), and water (Challenge #3) temperatures using a cordless temperature probe.
- Analyze and graph the collected data to understand temperature variations in different environments.
- Reflect on the relationship between temperature and environmental factors.

Prerequisites:

- Complete the Warm-Up Challenge

Materials Needed for All 3 Challenges:

- Cordless temperature probe
- Access to probe connected devices (computer, chromebook, iPad, etc.)
- Data collection software or app (compatible with the temperature probe)
- Soil samples (from different locations)
- Water samples (from various sources)
- Stopwatch or timers for each group
- Lab notebooks (if desired by instructor)
- MS Student Handouts (*This google doc may be copied and edited to meet your needs*.)
- Colored Pencils (*3 different colors for graphing purposes*)
- **Soil Challenge Only:**
    - Soil sample locations
    - small spade / shovel (if desired)

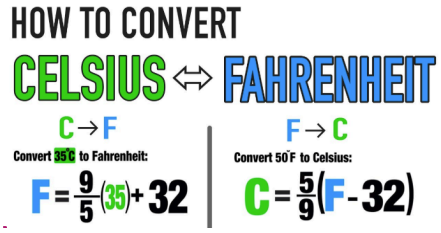
Procedures

1. **Setup:**
    - Watch the Soil Video on the EOREN webpage to give you a broad overview.
    - Put on any safety equipment required by your instructor (if applicable).
    - Use soil samples from three different locations (e.g. garden, playground, potted plant, etc.).
    - Make sure you and your students have completed the Challenge Warm-up to ensure familiarity with connecting and using the Vernier Temperature Probes.
    - Ensure the temperature probe is charged and connected to the data collection software.
    - Establish student groups and ensure access to all necessary materials.

- You could also mark out plots at different locations for students to sample or let them choose. (Hint: choose southern exposure ground to give your best chance for soil that is not frozen solid!)
- A possible adaptation would be to have students measure soil temperature at different depths. (Note: you will need a shovel and will want to consider frozen ground if you go with this option - may or may not be a doable option depending on your location.)
- Demonstrate to students how to properly and carefully measure soil in cold conditions without breaking the probes in the hard ground (small spades or shovels might be a good idea depending on your conditions). Remind students that the probe should be inserted fully (or as far as possible) in order to take a reading.

2. **Data Collection:**
   - Students will choose three locations to record soil temperature data (e.g. garden, playground, potted plant, pre-selected plots, etc.). You may determine locations or provide guidelines for your students to make their own location choice.
     - Encourage students to choose locations that they believe might be more likely to have different temperatures.
   - Students will record their chosen locations on the Student Handout.
   - Using the Student Handout (pages Soil 1-3), students will record the date, time, and description of the location and the soil for each sample. Students will also make note of the environmental conditions and any organisms present. (You might choose to discuss as a group why these conditions and the presence of organisms may or may not have any impact on their measurements.)
   - Students will insert the temperature probe into each soil sample.
   - Make sure to have students keep the probe in the soil for at least 5 minutes before recording the temperature.
   - Record the temperature readings for each soil sample on the Student Handout form.
   - Note: there is **no** regional submission google form for this challenge.

4. **Data Calculations:**
   - Students will practice converting between Fahrenheit and Celsius. You can have students collect the data in either measurement, and then have them convert their measurements in order to complete the table within the handout. Something like the following graphic might be helpful to post for student reference:



**Hint: If you are not working on fractions and would like to make it easier for students, consider converting the fractions to decimals for your students.*

5. **Graphing:**
   - Remind students that in an experiment's line graph, the independent variable goes on the x-axis (horizontal) and the dependent variable goes on the y-axis (vertical). Help students identify the independent (temperature) and dependent variables (location).

- Students will plot the recorded temperatures on the provided graph (Student Handout page Soil-4) comparing the temperatures at their three locations. Make sure students label both axes, use different colors for the different locations, give their graph a title, and create a legend/key for their graph. You can also have students graph class data as a whole group in addition, or instead, as you prefer.

6. Data Analysis:

- Students will look at the data compiled. Provide instruction, as needed, to assist students in identifying central tendencies (ie. mean, median, mode) for the collected data from their group / from your school.
  - To calculate **mean**:The mean is the average. To find it, you add up all the temperatures and divide by how many locations.
  - To calculate **median**:The median is the middle value. To find it, you arrange the numbers in order and pick the one in the middle. If there are two middle numbers, you find the average of those two.
  - To calculate **mode**: The mode is the number that appears the most often in a set of numbers. If no number repeats, there is no mode.
- Using the graph they created on the Student Handout Soil-4, students will discuss and answer the following questions:
  - Can you determine which location has the most energy and why?
  - Do the measures of central tendency (mean, median, and mode) make sense? Any discrepancies? Why do you think this is?
  - Did soil temperatures vary significantly between locations? Why or why not?
- Follow-up group discussion ideas:
  - Use student generated data to discuss how soil temperature changes due to many factors. Some ideas might include:
    - Discuss how soil texture can impact soil temperature (For instance, sandy soils tend to heat up and cool down more quickly than clay soils because they have lower heat capacity and thermal conductivity.)
    - Discuss how soil moisture content can impact soil temperature (For instance wet soils have a higher heat capacity than dry soils, making it easier for them to absorb and release heat more slowly, resulting in less temperature fluctuation. Conversely, dry soils heat up and cool down rapidly at night due to their heat capacity.)
    - Discuss whether or not the soil had shade cover impacting the amount of solar radiation reaching the soil surface; or discuss how vegetation can influence soil moisture content, and therefore temperature.
    - Discuss how climate and weather impact the soil temperature. How might the air temperature contribute to the soil temperature? Explain that solar radiation is a primary driver of soil temperature changes, especially at the surface area. For soil samples not showing variation, you might discuss how air temperature has a significant impact on soil temperature at the surface level.
    - Remind students that soil can hold heat much better than air. Discuss how soil depth impacts soil temperature, with topsoil fluctuating much more than soils at deeper layers within the soil profile.

7. Extension Challenge:

- Have students graph or map their data as a whole group and compare their findings.
- What happens to soil temperature when you measure the same location at different depths?

- Design different coverings (plastic, metal, cloth) for your soil samples. Which soil sample coverings retain their temperatures best?
- Have students explore soil types in their region using online resources. (example: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx)
- Create your own - Have fun and be creative!

To view all 6-8 resources click here.

Standards:

Matter and its Interactions

MS-PS1-4 Matter and its Interactions

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Energy:

MS-PS3-1 Energy

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-3 Energy

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*

Engineering Design

MS-ETS1-3 Engineering Design

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

NGSS Practices:

- **Asking Questions and Defining Problems**
- Developing and Using Models
- Planning and Carrying out Investigations
- **Analyzing and Interpreting Data**
- **Using Mathematics and Computational Thinking**
- Constructing Explanations and Designing Solutions
- **Engaging in Argument from Evidence**
- **Obtaining, Evaluating, and Communicating Information**

Math Standards

Data Reasoning (DR)
DR.B Collect and Consider Data
DR.C Analyze, summarize, and describe data.
DR.D Interpret data and answer investigative questions