



Discovering the Science of the Environment

With Support from the National Resource Conservation Service



IUPUI SCHOOL OF SCIENCE

MATTER CYCLING AND SOIL FORMATION

Grade Level(s): High School (Earth Science, Environmental, APES, Agriculture Science)

Program Duration: 2-3 class periods

- Block Schedule (90 min)
 - Day 1:
 - Soil Formation & Matter Cycle mini lesson
 - Matter Cycle's activity and discussion
 - Soil & Agriculture Case Study
 - Day 2:
 - Soil layers mini lesson
 - Soil Layers lab
 - Discussion of lab questions
- 45-50 min class periods
 - Day 1:
 - opener (bellringer)
 - matter cycling & Soil formation mini lesson
 - Matter Cycles activity and discussion
 - Day 2:
 - Opener
 - Carbon on the Farm Case Study
 - Review question together
 - Soil Layers Mini Lesson
 - Day 3:
 - Soil Layer lab
 - discuss lab questions

Program Overview

This educational module is intended to be used to teach matter cycling and soil formation in the frame of sustainable agriculture. This module can be used in Earth Science, Environmental Science, APES, and Ag. The corresponding Essential Question, Student Outcome,

- **Essential Question:** How is soil a valuable resource and what are humans doing to change soil quality.
- **Outcomes: Students will be able to -**
 - Diagram how matter cycling creates soils and determines the nutrients available. Model soil layers and examine different soil types
 - How soil is formed
 - Rock cycle
 - Phosphorus cycle
 - Sulfur cycle
 - Nitrogen cycle
 - Mycorrhizal fungi

- Carbon cycle
- Soil layers
- Types of soils
- What is soil made of? Microorganisms etc.
- Humus
- Fertilizer effect on soils
- Nematode lab

Materials

Activity 1: Matter Cycles Discussion	Activity 2: Case Study	Activity 3: Soil Layer Lab
White Boards	Printed copies of the case study highlighters and writing utensils Extra paper to write the letter OR Digital annotation app such as Notability or Google Docs	Materials for creating soil layer tubes. Bottles, dirt, sand, clay, etc... Printed or digital copies of the lab Printed soil type cards Printed soil map and crop map.

Introduction - 10 min

Depending on how many days it takes your class to get through this module, you may need more than one bellringer. Below are a list of 4 possible bellringers/discussion questions to prime your class to think about the importance of soil.

1. When we hike through the woods, drive by a cornfield, or mow our lawns, we tend to focus on the plants: the blooming flowers, the tassel-topped stalks, and the green grass borders. But what about the dirt? It seems soil is one of the planet's most underappreciated natural resources. Brainstorm 3 ways we use soil as a resource (Hint: one is list in the paragraph above)
2. Show the following video: <https://www.youtube.com/watch?v=-dhdUoK7s2s>
 - a. Why are living organisms in soil important? What would happen if the living things in soils all died?
3. Where is the most nutrient rich portion of the soil? What can you tell me about soils that do not have this layer? How can we replenish the nutrients in soil?
4. How are the different types of soil formed? What type of soil might we find in [insert your state here]

Soil Formation & Matter Cycle Mini Lesson-45 minutes

Materials

- Soil Formation & Matter Cycle Google Slides PowerPoint and a way to project it
- Note sheet for students
- Whiteboards and markers

Instructions and/or Summary of Activity

Purpose: To give students direct instruction on how soil is formed and how soil is connected to the matter cycles. This is base knowledge students will need to know in order to understand the importance of soil to regenerative agriculture.

Instructions:

1. After the bellringer show the “What is Soil” video from Crash Course Geography. Have students work in groups to write down important vocabulary and main topics from the video. Crash Course videos move fast, so tell the students to raise their hand when they want the video paused. Also let them know they need to work together as a table to get as many vocab and main concepts as possible. Have students collaborate on a whiteboard so they can see what vocab and main concepts have already been written down.
2. Answer the discussion questions on the next slide. Encourage further discussion
3. After students discuss the questions, combine all of their vocab lists on to one main list either on a giant poster paper or on the main teacher whiteboard to reference throughout the module. Add words you know they might not know. For Example: they might know what the word horizon means, but not in the context of soil horizons. As you complete the module, write down definitions of the words, or have students write them down in their notes.
4. Present the section “How Soil is Formed”
 - a. you may need to spend more time on succession and the rock cycle depending on what your students have learned from other classes.
5. The Soil in Matter Cycle section can be accomplished two ways
 - a. If your students have never seen matter cycles:**
 - i. Go through each step of each matter cycle. Have them fill out note sheets with the steps. Depending on the rigor of your class will depend on how detailed you will want the notes.
 - ii. As you go through each matter cycle, have the students answer the discussion questions either outloud or in their notebook.
 - b. If you students are comfortable with most of the matter cycles and have seen them prior to your class:**
 - i. Split your class into 5 groups and assign each group a matter cycle.
 - ii. You may want to print out these slides to be able to give one to each group
 - iii. Have students answer the discussion question, brainstorming on their whiteboards.
 - iv. When all student groups are done, have them present their answers to the class. Make sure students can point out evidence from the matter cycle.

Soil & Agriculture Case Study- 45 min

Materials

- Digital copies of the case study students can download and annotate digitally through Notability or some other note taking app
 - OR
- Physical copies of the case study students can highlight and write on with partners

Instructions and/or Summary of Activity

Purpose: To have students read about current events and connect them with the concepts learned in the mini lesson. This activity is especially important in the light of scientific information being presented to the public. Students (and some adults) struggle with unpacking scientific information when reading a news article. This aligns with SEPS.8: Obtaining, evaluating, and communicating scientific information.

Instructions:

1. Pass out the Case study to students - either by digital means or actual paper copies
2. Using the methods in the teacher directions, or your own annotation methods, teach/remind the students how to annotate text and read critically.
 - a. It may be useful to practice with your students on a couple of paragraphs before setting them loose. Especially if they have done very little of this type of reading and annotating in your class or their English class.
3. Students can answer the discussion questions individually or as a group
4. Question 10 asks students to compose a letter using Claim, Evidence, Reasoning. If you have never taught this skill or had your students practice it, you may need to review the skill and help your students compose the letter.
 - a. You can have students brainstorm their letter with a group, and write it individually
5. **NOTE:** There are going to be many more opportunities in this and other modules to practice this skill. The purpose is to have students get better at it over time so they can do really well articulating thoughts and using evidence to back up their claim by the time they do the project and take the assessment.

Soil Layers Mini Lesson and Lab - 90 min (2- 45 min classes)

Materials

- Supplies to make soil layer tubes
 - 2 liter bottles, glass candle votives, large graduated cylinders
 - soil, sand, clay, and rocks of various size and color
- A printed or digital copy of the student lab sheet
- Printed copies of the Types of Soils Cards - from the Soils Types and Profiles PowerPoint
 - Print the types of soils cards 4 to a page
- Printed copies of the soil map and crop map - - from the Soils Types and Profiles PowerPoint

- Print these as large as you can - 1 map per page

Instructions and/or Summary of Activity

Purpose: To give direct instruction about soil layers and characteristics of each layer. To give students a hands-on lab experience observing soil layers, analyzing maps, and coming up with solutions related to soil types and agricultural issues. This lab will reinforce for students that not all soils are the same and they can be used for different crops and engineering purposes.

Instructions:

1. Create the Types of Soil Tubes
 - a. The instructions for this can be found in the lab document.
 - b. NOTES: If you make these in a plastic bottle, you can pour resin in the bottle to keep the tubes forever.
 - c. Another Note! For added fun, and less work on your end, have each student group take a soil type and create the tube before the lab. This way they can get their hands dirty and you, the hard working teacher, don't have as much to prep.
2. Present the Soil Layers mini lesson
 - a. This concept was in the "What is Soil" Crash Course Video, but the video moves so fast students may have missed that concept. It's always great to review.
3. Have students complete the lab
 - a. The student lab sheet walks students through a pre-lab, part 1 and part 2. All instructions are there.
4. Questions 6 & 7 of Part 2 are Claim, Evidence, Reasoning discussion questions
 - a. You can have students work on them individually or create a classroom discussion opportunity for them.
 - b. You may also have students read this article and have more information on the issues of soils in the Amazon -
<https://www.dw.com/en/the-amazon-nutrient-rich-rainforests-on-useless-soils/a-5013963>
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Wrap-up

Depending on how many days it takes your class to complete the module, you may need more than one wrap up activity. Below are 4 possible wrap up activities to get your class processing what they learned that day.

1. When doing the Case Study or the Lab Questions, always feel free to use those questions as classroom discussion. Especially the Claim, Evidence, Reasoning questions. Have students Think, Pair, Share their responses. Ask for alternate responses.
2. 3, 2, 1 Exit Ticket - Have students write three new words they learned and their definitions, Describe 2 main topics from the day, and ask 1 question they still have
3. Have students write a Newspaper Headline and 1 paragraph article incorporating something they have learned from class that day and how it affects their life. Make sure to tell them about appropriate reading levels for newspapers and discuss audience
4. Vocabulary work - reference the list of vocab words you took down at the beginning of the module. Can we define any more. Do we have words we need to add to the list?

Possible Vocabulary/Terminology

<ul style="list-style-type: none">● Soil● Dirt● Igneous Rocks● Metamorphic Rocks● Sedimentary Rock● Rock Cycle● Erosion● Weathering	<ul style="list-style-type: none">● Soil Horizon● Top Soil● Elluviation● Leaching● Percolation● Humus●	<ul style="list-style-type: none">● Nitrogen Fixation● Assimilation● Runoff● Ground Water●
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Additional Resources:

<https://cees.iupui.edu/education/discovering-science-environment>

<https://www.uidaho.edu/cals/soil-orders>

<https://www.youtube.com/watch?v=ntJouJhLM48&t=783s>

The fate of nitrogen in grain cropping systems: a meta-analysis of ¹⁵N field experiments (Ecological Applications, 19(8), 2009)

https://www.youtube.com/watch?v=yp1i8_JFsao

https://drive.google.com/file/d/1izWqV1BC50ij6p_KDtIB6-uRs4SuR-_-/view?usp=sharing

Additional Comments

This module is intended to be used with the Weathering & Erosion module and the Human Impact & Soil Conservation Module found on [insert CEES website here]