SOIL PHENOMENA - MODULE INTRODUCTION

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

Program Duration: 90 min

Program Overview

According to the Next Generation Science Standards, “Natural phenomena are observable events that occur in the universe and that we can use our science knowledge to explain or predict. The goal of building knowledge in science is to develop general ideas, based on evidence, that can explain and predict phenomena.” Anchoring learning in explaining phenomena supports student agency for wanting to build science and engineering knowledge. Students are able to identify an answer to "why do I need to learn this?" before they even know what the “this” is. Starting a unit with phenomena allows students to anchor their learning to a real life situation. Throughout the unit, you can relate back to this activity and ask students to re-evaluate their original observation in the light of the new content they are learning.

This activity is intended to be used prior to teaching the Soil Conservation Unit found on the CEES website. It will allow the students to see phenomena related to soil formation, soil health, types of soil, and how humans are using soil as a resource. This activity relates to the following essential question.

Essential Question: How is soil a valuable resource and what are humans doing to change soil quality.

Introduction -15-20 min

Materials

- Projector
- Maybe white boards for students to write on for discussion

Instructions and/or Summary of Activity

Show the following three videos to all of the students

- https://www.youtube.com/watch?v=Esz6ne9x9yM (Australia)
- https://www.youtube.com/watch?v=RD5I9UhbRgg (Arizona)
- https://www.youtube.com/watch?v=1OdDieuD1OA (Kansas)

Have students make observations about what they see in the video:
Consider the following discussion points - students can discuss in groups or as a whole class

- What is the same in all three videos
- How are the dust storms different in each of the videos
- Where are the dust storms located?
- What creates a dust storm?
- What do you think the dust storm is made of? Is there more than just dust?
- Can we create a dust storm and study its properties?

Create a Dust Storm Inquiry Lab - Part 1 - 45 min

Materials

- Cardboard boxes - paper boxes with lids or a long skinny box like a pop can case
- Black construction paper
- Hair dryers or fans - may want a variety of things to simulate different wind speeds
- Variety of particulate matter (light in color so it shows up on the black paper)
    - sand
    - flour
    - powdered sugar
    - chalk
    - soil
    - silt
    - small rocks
- tape, glue, scissors; any other craft supplies for students to create wind tunnels

Instructions and/or Summary of Activity

Purpose: Students will see if they can recreate the conditions necessary to make a dust storm. This is going to allow the students to discover the different sized particles that make up soil and to see how wind erosion can affect soil

Instructions:

1. TEACHER: Watch the video on this website. At 2:00 she shows how lighter and heavier particles affect dust storms. She has a larger wind tunnel design, but this can be modified for students. https://www.open.edu/openlearn/science-maths-technology/wild-weather-kitchen-experiments-dust-storms
2. After the Intro discussion with students, show them the array of supplies and ask them to design and construct a model dust storm. They are wanting to get as close as possible to that signature dust storm look.
3. With inquiry based exploration, it is very important that you don't give the students too much instruction. Let them figure it out, fail, and try again.
4. As students figure out how to get a dust storm, have them collaborate with others telling students that scientists collaborate all the time. Science research is a community.

5. Have students draw their design and document their observations and findings in a lab notebook to keep for later.
    a. These observations and concepts will be important as students discover more about soil, erosion, and sustainable agricultural practices related to soil.

Create a Dust Storm Inquiry Lab - Part 2 - 45 min

Materials

- Same as above but add the following items for students to use
    - sod with plants in it
    - water
    - little model trees
    - legos

Instructions and/or Summary of Activity

Purpose: To have students discover what humans can do to prevent soil erosion and dust storms

Instructions:

1. Once you have the students figure out how to make a dust storm pause for discussion
2. Project the following map and ask the discussion questions
    a. 

    b. One of the dust storms was from Arizona, one from Australia, one from Kansas. How were the dust storms in Arizona and Australia similar. Are these two places the same?
    c. Based on the map, how does Arizona compare to Kansas?
    d. Do we get dust storms in Indiana? Why or why not?
    e. Based on the map, could you guess why we might not get dust storms in the midwest?
3. After the discussion, have the students create a scenario that prevents the soil from blowing away in their wind tunnel.
4. Ask them about what they are using and how it compares to where they live.

5. What was the best method for preventing erosion?
6. Have students write down their lab design and observations in a notebook to keep for later.
    a. These observations and concepts will be important as students discover more about soil, erosion, and sustainable agricultural practices related to soil.

Wrap-up

Have a classroom discussion on the following questions:

- Does everywhere in the world get dust storms? Based on what you did today, where in the world probably has the most and where has the least?
    - students will probably say the most are in the desert
- Is there a way to prevent dust storms in the deserts?
- So if more dust storms happen in the desert, is there a way to make a place less of a desert?
    - What about can a place become a desert?
- Does the dust that blows away "grow back?" Can a region regain its soil after it blows away?
- Why should we care?

Indiana Science Standards (2023)

- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection
- HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
- HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity
- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change

and associated future impacts to Earth systems.

- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- HS-ENV1-2.* Use a computational representation to illustrate that humans are part of Earth's ecosystems and how human activities can, deliberately or inadvertently, alter ecosystems.
- HS-ENV1-3. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- HS-ENV1-4.* Analyze data regarding differences between systems in equilibrium and systems in disequilibrium. Use corresponding data to support how steady state is achieved through negative and positive feedback loops.
- HS-ENV1-5.* Evaluate, measure, and communicate biological, chemical, and physical (abiotic and biotic) factors within an ecosystem.
- HS-ENV2-1.* Construct and revise an explanation based on evidence for the cycling of matter through sources and sinks and how energy is transferred
- HS-ENV2-2. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (These mathematical representations may include ecological pyramids of number, biomass, and energy.)
- HS-ENV4-2. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Additional Resources:

https://cees.iupui.edu/education/discovering-science-environment
https://www.open.edu/openlearn/science-maths-technology/wild-weather-kitchen-experiments-dust-storms
https://indiana.pbslearningmedia.org/resource/introduction-dust-bowl-video-9009/ken-burns-the-dust-bowl/
https://www.knowatom.com/blog/5-steps-to-effectively-use-phenomena-in-your-classroom
https://www.nextgenscience.org/sites/default/files/Using%20Phenomena%20in%20NGSS.pdf

Additional Comments

This module is intended to be used with the Matter Cycles & Soil Formation, Weathering & Erosion, and the Human Impact & Soil Conservation Modules found on https://cees.iupui.edu/education/discovering-science-environment