The Challenge - Feeding Over 8 Billion People

Grade(s): 9
Lesson Duration: Class 7 class periods, 50 minutes each
Course Name(s): Biology Honors
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BIG IDEAS

The lithosphere is an integral part of feeding the 8 billion people that will inhabit the earth. This is a challenge and solutions to feed so many people must be addressed and developed. This lesson focuses on the soil, its role in sequestering carbon dioxide, its role in producing crops to feed the population and its importance to life on earth. A healthy soil not only sequesters more carbon dioxide (reducing threat of global warming) but also maintains a healthier soil for greater crop production. Water's role is also explored. These are the main ideas that my students will explore in this lesson. My previous lesson explored the hydrosphere and global warming and effects on humans.
This lesson focuses on the lithosphere, does include CO2 (atmosphere) and biosphere in terms of crop production and water. They are so intimately linked.

NGSS Performance Expectation(s):

- HS-:S2-5 Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
- HS-ESS2-2 Earth's Systems: 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-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environement
- HS-ESS3-3 The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Science and Engineering Practices:	Disciplinary Core Ideas:	Crosscutting Concepts:
Analyzing and Intepreting Data	Feedback effects exist within and among Earth's systems. ESS2A The biosphere and Earth's other systems have many interconnections that cause a continual coevolution of Earth's surface and life on it. ESS2E Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies. ESS3C	Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. Cause and effect: Mechanism and explanation : A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated

Common Core State Standards:

Math: HSS.ID.A.1 Represent data with plots on the real number line(dot plots, histograms, and box plots)
MP2 Reason abstractly and quantitatively

and/or

ELA: RST.9-10.3 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 text and topics.

State Standards: We do not use these

ITEEA Standards:

Other Standards: The Diocese decided to implement the NGSS Standards

MEASURABLE STUDENT LEARNING OBJECTIVES

A student will be able to explain how human activities change the atmosphere and climate

A student will be able to describe how changes in the atmosphere drive climate and other changes in global systems

A student will be able to explain how human land use can cause changes in global systems

A student will be able to plan, using evidence, a possible call to action that he/she can implement.

A student will be able to explain their thinking when creating an action that can improve soil quality in their area.

A student will be able to identify some important ecosystem services.

A student will be able to represent data using a bar graph.

MATERIALS NEEDED

iPad - each student has access to an iPad

Hunger banquet supplies, including plates, food, cups

Lab materials- soil, liter bottle, basin, water

ENGAGING CONTEXT/PHENOMENON

Staging a hunger banquet:

DATA INTEGRATION

TEACHER BACKGROUND KNOWLEDGE: Miller,K.R., and Levine, J.S.(2019), Miller and Levine Biology. Pearson. Chapters 4, 6 and 7

I use the book and websites to review the information and learn the details about agriculture, soil, and different climates,

This Biology Book is a source of Information for the teacher and the students. Students use this

book, the Interactives provided, and the Simulations.

DIFFERENTIATION OF INSTRUCTION The students are leveled in this class. All should participate. It is only a short lesson for a day, so there should be no objections.

REAL-WORLD CONNECTIONS FOR STUDENTS

This lesson is culturally responsive. The challenge of feeding 8 billion people is real and daunting. Food prices are high and students are aware of a growing population that frequent food banks. Our Thanksgiving drive is a reminder of the need in our town (100 full baskets are collected), many students volunteer at food banks, and some participate in projects to help low income families with food or babysitting services.

This is also a time for student reflection - to think of a personal action plan that one can implement in their area or home to either improve the quality of soil or help in feeding the hungry. Students are encouraged and required to perform service projects. This is a realistic introduction to service learning.

POSSIBLE PRIOR or MISCONCEPTIONS

Poverty is not caused by individual choices. Resources are a contributing factor such as the climate one inhabits, the pollution generated by outside sources, and extreme weather events. The soil, water cycle, temperature, and CO_2 levels are all interconnected. Where one lives determines if they have access to clean water, healthy and plentiful crop production and good growing conditiosns. The data generated from satellites is an important, real time source of information to show students that various areas in the world have poor climate, poor soil, and little water. Students may be unaware of all the data that can be collected and analyzed, and the various conditions that exists around the world.

LESSON PROCEDURE

5E	**Details of 5E Lesson Implementation** *(Visit BSCS to learn more about the 5E instructional model)*

Engage	**Lesson Objective:** A student will be able to plan, using evidence, a possible call to action that he/she can implement. A student will understand the inequality of food distribution in the world **Procedure:** To stage a Hunger Banquet. During this phase the students will engage in a hunger banquet, listen to a short explanation of a hunger banquet, and discuss the meaning and why we are participating in a hunger banquet. https://docs.google.com/document/d/1aZufDBKXaKmbKWlYLIhOhJk3P8KXh6rRQ-v428P7PGU/edit?usp=sharing **Modifications: All students will participate in the hunger banquet. The foods used do not present an allergic response to anyone. I modified the scenario by giving 3 groups a card representing three different areas of the world - one with plenty of food, moderate, and little amount, based on climate, soil, water availability. All students are excited to participate. Whether they eat is another story.** **Standards Addressed** ● HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment ● HS-ESS3-3 The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. **Formative/Summative Assessments** The assessment will be formative. Each student will participate in this activity, and discuss how they feel with the amount of food they are given compared to the person next to them. This will be used to begin the unit on the importance of soil and why there is a such disparity among the different parts of the world in food availability. This is the Hook for students to think about the importance of soil in growing our crops. This is a formative assessment - participation and completing the unit activities for the Poster Project **Resources:** I will purchase the food: water, juice, pasta, rice, salad, cookie. A room in the school with a large table and chairs will be used, along with cards that give a short scenario on the area and problem growing food.

Explore	**Lesson Objective:** A student will be able to explain how human activities change the atmosphere and climate A student will be able to describe how changes in the atmosphere drive climate and other changes in global systems A student will be able to explain how human land use can cause changes in global systems **Procedure: Students will watch the video to learn about soil and the carbon dioxide draw, they will also complete a simulation "Model my watershed" to explore runoff and compare soil in different ecosystems, and lastly complete a mini lab on soil erosion while observing different types of soil composition. I will facilitate the activity, help with the lab, and lead the discussion. Of course, I will clean up.** 1*https://www.youtube.com/watch?v=xv-n54NTd9M* - video by the UTD Geoscience Studio titled Carbon Dioxide Drawdown - where should the water go? Students watch this video to understand the critical zone - the soil depth that supports plant growth. They learn the connection between the ratio to draw down CO_2 and water. After they watch the video there will be a discussion about the major points - soil depth, transpiration, CO2, plants roots, and critical aone. They will sketch a diagram, which will be used for their poster, of the processes that are occurring. The teacher will facilitate the discussion. Students watch the video on their own device or together on the white board. They will be allowed to choose the method of watching the video. https://stroudcenter.org/virtual-learning-resource/runoff-simulation/ This site "Model my watershed" provide a simulation for the students to actively explore how much water is runoff or how much infiltrates the ground in various land covers - forest , grassland, pasture, crops, wetlands, developed. Students also use the Hydrologic Soil Groups (1-4) to compare how much difference in infiltration and runoff there is between the different types of soil. To assess this portion, students will fill in a data table and then graph information using a bar graph. This is the simulation: https://runoff.modelmywatershed.org/ The Data Table for the information from the simulation is attached : https://docs.google.com/document/d/1Trde41Z9YaAT3CNMzau9EnG2AIBRjR6hGme2lxXxEEg/edit

Students will orgaize the data into a graph (on noteabiligy), compare the results and discuss in a round table discussion.

The students will also perform a soil erosion experiment. Each group will receive a clump of soil that will fill a liter soda bottle about ½. One bottle will contain bare soil, another soil covered with dry leaves, another covered with green grass, another soil from a woodland, and last soil from a wetland. There are 5 groups of 4 students, each group will receive one clump of dirt. Water 1 liter) is poured over the dirt and collected into a basin. This lab experiment is to determine the more or less soil erosion based on the covered, uncovered soil, and health of the soil due to microbes and roots. We will discuss the results and determine the best type of soil that does not erode.

https://keelingcurve.ucsd.edu/videos/ Students will observe the Keeling curve and relate the levels of CO_2 to the importance of the soil in sequestering such a large amount. After learning about the carbon dioxide drawdown, and also water that erodes soil, the rising carbon dioxide levels in the graph emphasizes the importance of the CO_2 drawdown. The video explains how CO_2 is measured - it gives the students the opportunity to understand the importance of technology and engineering in determining CO_2 levels. We will discuss the curve, why the graph fluctuates. The attached questions will be answered for assessment.

https://docs.google.com/document/d/1b8t3gCkGcyButZ6HgZBpyx6zzGtSDqbYCFy55bHOdTA/edit?usp=sharing

Modifications Each student has an ipad and earbuds. All students will participate in the lab. Students will help their fellow classmates who may have difficulty with plotting the graph. Their math skills are on the same level and all have experience graphing. The teacher will answer questions and circulate to each student to help anyone who needs assistance.

Standards Addressed

- HS-ESS3-3 The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

Formative/Summative Assement: The answers to the questions on the worksheets and the completion of the data table and graph**Resources:**

https://www.youtube.com/watch?v=xv-n54NTd9M -
https://keelingcurve.ucsd.edu/videos/
https://stroudcenter.org/virtual-learning-resource/runoff-simulation/
https://docs.google.com/document/d/1Trde41Z9YaAT3CNMzau9EnG2A

	IBRjR6hGme2lxXxEEg/edit I will provide all the soil types for the experiment, the liter bottles, water, and collection basins.
Explain	**Lesson Objective:** A student will be able to explain how human activities change the atmosphere and climate A student will be able to identify some important ecosystem services. **Procedure:**https://escholarship.org/uc/item/4d76p54r this is a cartoon that details the importance of soil as a CO_2 sink. The students will read this Cartoon and take notes. After the they read the cartoon we will watch the video prepared by Asmeret Asefaw Berhe, who created the cartoon: https://www.ted.com/talks/asmeret_asefaw_berhe_a_climate_change_solution_that_s_right_under_our_feet The students watch the video and read the cartoon. They will have an opportunity to discuss the video and cartoon. As they read cartoon the students will write on white board what they learned about soil from the cartoon. I will facilitate a discussion on the video and cartoon. We will discuss why soil is so important, and what are the functions of the soil in growing. After our discussion we will list all the contributions soil provides for growing crops a Poster, hanging on the wall. **Modifications** I will provide shite boards for the students to write. Students have iPads to watch cartoons and video.. **Standards Addressed** *:* **Formative/Summative Assessments** This is a formative assessment where we will discuss the cartoon and video. Students will write their thoughts about the role of soil and the function of soil.after the discussion on a Google docs and submit to Classroom. **Resources** https://escholarship.org/uc/item/4d76p54r https://www.ted.com/talks/asmeret_asefaw_berhe_a_climate_change_solution_that_s_right_under_our_feet

Elaborate	**Lesson Objective:** A student will be able to explain how human land use can cause changes in global systems *1.Suitable agricultural land is limited and is affected by many factors. In this module, which is one of five, students use data showing how humans have changed Earth's land. This information will be used to create a poster as they evaluate what we have done to harm agricultural land and think about ways in which they can contribute positively to the challenge of feeding so many people.* **https://activity-player.concord.org/?runKey=9f462fb1-f5c1-4855-8db2-b9a669dd223e&sequence=https%3A%2F%2Fauthoring.concord.org%2Fapi%2Fv1%2Fsequences%2F654.json&sequenceActivity=activity_12587** **Students will have 45 minutes to complete this module in Concord Consortium** 2. Students will also use the NASA site Eyes on Earth to compare soil moisture, water storage, air temperature, precipitation, and Carbon dioxide levels in the particular area that was assigned during the Hunger Banquet. The site that will be used from NASA Eyes on Earth: **ps://climate.nasa.gov/earth-now/#/vitalsignhtt?vitalsign=sea_level&altid=0&animating=f&showOnGlobe=f&start=&end=** **Students will collect and analyze data from this site. Instructions are in the link. I plan on working together with the class to help them navigate the website, compare soil moisture, carbon dioxide data etc. They will write the data about the area they were assigned for the Hunger Banquet. We will then compare the sites and understand why certain areas of the world are more productive and have healthy soil.** **https://docs.google.com/document/d/1nUAhtyyPeikcKnsBI4432HAyHrMIptJYrSExr7NPR3Y/edit?usp=sharing** **Procedure:** The students will be observing the globes and writing the temperature data, **Modifications** The teacher will facilitate the students as they collect data from Nasa. They will compare the data in the area they were assigned to each group at the humder banquet. There are three groups for comparison. I will have a map or the world posted on the wall to show the students the location of Hatii, Africa, and the US. They will be able to observe the locations on a large mpa. **Standards Addressed** ● HS-ESS2-2 Earth's Systems: 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-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. Cause and effect: Mechanism and explanation : A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated **Formative/Summative Assessments** **Resources** **https://activity-player.concord.org/?runKey=9f462fb1-f5c1-4855-8db2-b9a669dd223e&sequence=https%3A%2F%2Fauthoring.concord.org%2Fapi%2Fv1%2Fsequences%2F654.json&sequenceActivity=activity_12587** **ps://climate.nasa.gov/earth-now/#/vitalsignhtt?vitalsign=sea_level&altid=0&animating=f&showOnGlobe=f&start=&end=** **https://docs.google.com/document/d/1nUAhtyyPeikcKnsBI4432HAyHrMIptJYrSExr7NPR3Y/edit?usp=sharing**
Evaluate	**Lesson Objective:** A student will be able to plan, using evidence, a possible call to action that he/she can implement. A student will be able to explain their thinking when creating an action that can improve soil quality in their area. A student will be able to identify some important ecosystem services. **Procedure:** Students will assess their understanding by creating a Slide Presentation, which highlights the quote by Hugh Hammond Bennett, a conservationist: "Out of the long list of natural gifts to man, none is perhaps so utterly essential to human life as soil". The Slide Show will have images or photos with captions explaining the meaning of the quote. Students will use the information from their NASA data, Concord activity, Cartoon, Simulation and book to showcase their understanding of soil u=functions and importance. Include: 1. A Call to Action piece - what are you personally able to do to improve soil quality. Think of the ways you personally can help 2. What is land use and how has it changed over time

	3. Is crop growth linked to soil quality - Does a crop (corn) grow equally well in each area around the world. 4. Diagram natural ways to pull down atmospheric CO_2 5. Compare the agricultural area in the Hunger Banquet activity in Growing crops in an area in the US that is ideal. They will collect materials to create their SlideSHow project at home and finish in class. They will have one class period for this activity. Teacher will be facilitating, answering questions, and helping students. Students will refer to the notes and activities and information received during the week. They will be able to access all the videos. **Modifications** Each student hasaccess to PowerPoint. The information was presented to each one. The students are leveled in the class, so they work independently very well. I will visit each student to help them in their progress and answer questions. **Standards Addressed** ● HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environement ● HS-ESS3-3 The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. **Formative/Summative Assessments: The attached rubric will be used.** **https://docs.google.com/document/d/1n_d5X_X2aHe0QNj-vM4KlliSOny_CA-QJsag3fSXWJo/edit** **Resources: Students will use their iPad to create a Slideshow. They will use the Materials provided in the lesson - videos, Concord activity, lab, hunger banquet, NASA data, Concord activity, Map of the world on the classroom wall.** **I will facilitate, walk around the room and answer questions and aid them in their organization.**

REFERENCES:

Using the Land. Activity player. (n.d.). https://activity-player.concord.org/?runKey=9f462fb1-f5c1-4855-8db2-b9a669dd223e&sequence=https%3A%2F%2Fauthoring.concord.org%2Fapi%2Fv1%2Fsequences%2F654.json&sequenceActivity=activity_12587

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Berhe, A. A. (n.d.). *A climate change solution that's right under our feet*. Asmeret Asefaw

Berhe: A climate change solution that's right under our feet | TED Talk. https://www.ted.com/talks/asmeret_asefaw_berhe_a_climate_change_solution_that_s_right_under_our_feet

Google. (n.d.). Google accounts. https://docs.google.com/

I modified the Hunger Banquet to one class of 20 students, around 3 groups of students, each group will receive the same card with information about a particular Country, specifically about the crop productionor food availability. We will discuss different food production capabilities of various areas based on what the students learned in NASA data, the videos, Concord activity, Cartoon on soil.

List all references using APA formatting. In addition, use a highlighter color to highlight the above content in your lesson borrowed from elsewhere and provide the citation below. In the lesson, describe how it was modified for your audience.