How Does Your Garden Grow? (MS-LS1-5)

Conservation, Ecosystems, and Soil Health

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Grade Level	6th – 8th Grade	**Time Frame**	4-5 class period(s)
Subject	Science	**Duration**	300 minutes

Essential Question

Why should we care about soil health?

Summary

This lesson is a middle school adaptation of the high school "How Does Your Garden Grow?" lesson. Students will explore soil health principles, soil chemistry, nutrient cycles, and environmental impacts of soil quality and investigate optimal soil conditions in which to grow plants. Using the data and information collected throughout the lesson as evidence, students will create presentations to explain the relationship between soil health and plant growth.

Snapshot

Engage

Students will view pictures of healthy and unhealthy soils and crops and speculate on what has caused the difference in the images.

Explore

Students will test soil samples from a variety of locations to evaluate their nutrient levels and pH. Additionally, students will explore several sources to determine properties of healthy soil and practices that support it, followed by a whole-class discussion.

Explain

Students participate in a digital breakout to gather information about soil chemistry and nutrient cycles. The class will collaborate to make connections between soil health, management practices, and nutrient cycling.

Extend

Students will grow plants in a variety of healthy and unhealthy soils.

Evaluate

Students present the results of their soil health investigations and explain the relationship between soil health and plant growth.

Standards

Next Generation Science Standards (Grades 6, 7, 8)

MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Oklahoma Academic Standards (8th Grade)

8.LS1.5 : Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
8.LS1.5.1: Genetic factors, as well as local conditions, affect the growth of the adult plant.

Attachments

- Conventional Till Winter Wheat.jpg
- Explore-Resources-6-2 - Spanish.docx
- Explore-Resources-6-2 - Spanish.pdf
- Explore-Resources-6-2.docx
- Explore-Resources-6-2.pdf
- Flow-Chart-Soil-Hand-Texture-2-2 - Spanish.docx
- Flow-Chart-Soil-Hand-Texture-2-2 - Spanish.pdf
- Flow-Chart-Soil-Hand-Texture-2-2.docx
- Flow-Chart-Soil-Hand-Texture-2-2.pdf
- Lesson-Slides-How-Does-Your-Garden-Grow-MS-LS1-5-7th-grade-1.pptx
- No Till Winter Wheat.jpg
- Old World Blue Stem_July.jpg
- Soil-Conditions-Experiment-4-2 - Spanish.docx
- Soil-Conditions-Experiment-4-2 - Spanish.pdf
- Soil-Conditions-Experiment-4-2.docx
- Soil-Conditions-Experiment-4-2.pdf
- Soil-Investigation-Handout-3-1 - Spanish.docx
- Soil-Investigation-Handout-3-1 - Spanish.pdf
- Soil-Investigation-Handout-3-1.docx
- Soil-Investigation-Handout-3-1.pdf
- Tall Grass Prairie_June.jpg
- Window-Notes-Handout-2-1 - Spanish.docx
- Window-Notes-Handout-2-1 - Spanish.pdf
- Window-Notes-Handout-2-1.docx
- Window-Notes-Handout-2-1.pdf

Materials

- Soil samples
- Gloves
- Paper towels and/or disinfectant wipes
- Mineral-free water (e.g., DI water)
- Soil test kit or chemical test strips
- Devices with internet access
- Sticky notes
- Containers for growing plants
- Fast-growing plant seeds
- Posters, markers, etc. for creating presentations and for Anchor Charts
- Lesson Slides

Engage

Teacher's Note

There are three different versions of this lesson. The Engage through Explain are identical but the Extend and Evaluate activities address different standards. This version addresses MS-LS1-5, which is a 7th grade standard in Oklahoma.

Please follow the links to access the other versions as is appropriate for your class: MS-LS2-3 Version (OK 6th grade), MS-ESS3-4 Version (OK 8th grade).

Show slide 5. Show the series of photographs of soil and plants in different soil conditions:

- Healthy harvested wheat fields;
- Bare field;
- Plants growing in healthy soil;
- Plants growing in unhealthy soil.

Teacher's Note

All four photographs were taken in different places on the same property. Individual photos are included in attachments. Photo credit: Heather Shaffery.

Have students complete a Photo/Picture Deconstruction strategy. Ask students to reflect on (a) what they observe in each of the four (4) photographs, (b) the potential causes for differences they notice; and (c) what the healthy plants might have that the unhealthy plants do not.

Teacher's Note

If students do not conclude for themselves that soil is a critical component in growing healthy plants, guide the conversation toward what the plants are growing in (i.e., soil). While plants do not require soil to grow, in these cases, soil is the source of necessary nutrients for them.

Show **slide 6**. After the discussion, ask students to summarize in one sentence what they think they know about the images. Effective sentences should summarize the big takeaway each student gets from the conversation.

Explore

Assessing Soil Chemistry

- All of the tests require a soil solution. Prepare—or have students prepare—at least a day before to get better results due to nutrients leaching into the water.
- Have students analyze each soil sample, making sure to record the data for the most common soil chemistry tests: soil pH, Nitrogen level, Phosphorus level, and Potassium level.

Have students collect soil samples from possible garden sites around campus. Encourage them to collect soil from multiple sites, including samples from home, to use as comparison.

Show **slide 8.**

Preparing the Soil Samples:

1. Have students create a soil solution by adding 100 mg of soil and 200 mL of water to a beaker or other container.
2. Have students use a stirring rod or sticks to blend the mixture.
3. Ensure that students clean the stirring rod thoroughly or use a different stirring utensil for each soil sample.

Show **slide 9.**

Testing the Soil Samples: Once students understand that soil may be important to plant health, have them test the soil types to determine the level of the nutrients present.

1. Hand out the **Soil Investigation** handout**.**
2. Provide each group with a soil test data sheet OR have each group create their own data table (See Soil Sample Test Table below).
3. Based on the specific directions for the soil test kit you have purchased, review the procedure for soil testing with your students.
4. Have students document their process and results using tablets or their phone's camera if it is a "Bring Your Own Device" (BYOD) approved environment. These pictures can be incorporated into their final presentation.

Show **slide 10**. This slide contains information about clean-up for the Soil Chemistry Investigation. Add any material- and classroom-specific instructions you may have to this slide.

Extra step for test strips

If you are using test strips that require a color comparison, it might be necessary to filter the water sample before collecting data. This is particularly true for nitrogen test strips. Depending on how murky the soil makes the water, it is usually clean enough after 2-3 rounds of filtering through a double or triple layer of coffee filters.

Teacher's Note: Texture

Give students the **Flow Chart Soil Hand Texture** handout to guide them through the texture portion of the Soil Chemistry Investigation.

Investigating Soil and Soil Health

Students explore several sources to develop a basic understanding of soil properties and components of soil health.

Show **slide 12**. This slide is a place for you to provide any class-specific instructions for conducting the research regarding soil and soil health.

Show **slide 13**. Have students work in groups to gather information about general soil science, soil health, and soil functions. Give students the Window Notes handout. Each student should record important details in the Window Notes graphic organizer. Have them leave the *Nutrient Cycle* box empty for now.

If students have regular access to technology, ask them to use Google Apps (e.g., docs, slides) to collaboratively fill out the notes.

Explore Debrief

As a class, summarize the key points to create an Anchor Chart for each Window Notes box. The soil chemistry information can be incorporated into *Soil Properties* or *Soil Health*. Diagrams or drawings of soil horizons and details would also be helpful on an Anchor Chart.

Share digitally the **Explore Sources** attachment with students.

Have students create an Anchor Chart summarizing their findings for each of the three boxes they have filled in on their Window Notes box. Ask students to summarize the key points to create an Anchor Chart for each Window Notes box.

Encourage them to incorporate information from the soil chemistry data table into *Soil Properties* or *Soil Health.* Diagrams or drawings of soil horizons and details would also be helpful on an Anchor Chart.

Show **slide 14**. Some questions to guide the summary discussion could include:

- What is soil? How do we describe it?
- What criteria factor into soil health?
- What are the benefits of having healthy soil?
- What soil management practices or strategies improve soil health?

Explain

Teacher's Note: How Does Your Garden Grow? Breakout

Once students have a general understanding of soil health, transition them into developing concepts about soil nutrients specifically.

Show **slide 15**.

Have students work together in groups to complete the How Does Your Garden Grow? Breakout.

After they have completed the Breakout activity, have them summarize the information they learned in the breakout in the *Nutrient Cycles* Window Notes box. Have them make additional notes in the other "windows" as necessary. Advise students that they may work collaboratively on this assignment.

How Does Your Garden Grow? Breakout Answers

Following are the answers to the breakout: Number Lock: **18**, 4 Letter Lock: **CNOP**, Picture Lock: **6.5**, Color Lock: **GBORYWP**.

Show **slides 16-17**. Ask students to use the 3 Sticky Notes strategy in their small groups or individually.

At this point only have them complete the Word = ___ and Phrase = ____ notes.

Have students repeat the process they used for the previous Anchor Charts to develop one for *Nutrient Cycles*. Ask students to share out their Words and Phrases as part of the summary conversation. If necessary, add any new information students discovered to the other three charts as well.

Misconceptions, Vocabulary, Notes

If the entire class is struggling with content details or missed important information during their Explore activities, this is an appropriate place for direct instruction. To fill gaps or misconceptions, providing a brief lecture, having students take notes over specific concepts, or developing content-specific vocabulary.

Show **slide 18.**

Encourage students to synthesize the conceptual pieces for themselves. Have them complete the *Sentence* part of the 3 Sticky Notes activity. Guide them to construct sentences that emphasize the connections from the information they've gathered during the Explore and Explain activities and discussions.

There are other ways to direct students' knowledge construction, but they should at least work out the following connections:

- The relationship between nutrient cycles and soil health (e.g., how cycles support healthy soil; how unhealthy soil might disrupt cycles);
- How soil management practices support or supplement natural nutrient cycles;
- The impact of soil management practices on soil health.

Several alternatives to class discussion or a written assignment for this portion of the Explain are suggested below.

Concept (Card) Mapping

This strategy can be done physically or digitally. Have students create hand-drawn or digital (e.g., MindMeister, Cmaps) concept maps. Recommend they consider using physical cards, either pre-made or class-generated, that they glue/tape down and draw lines to connect ideas. Have them use string to physically connect concepts found on the four anchor charts.

Metaphorical Thinking

Have students create metaphors based on their personal experience to help explain the connections they are making.

Cognitive Comics

Have students use either a predetermined structure (e.g., three panels) or choose their own format. Ask students to draw their conceptual understanding as a comic. Have them share out using gallery walks or brief class presentations.

Extend

Teacher's Note

Slide 23 has been reserved for you to incorporate guidelines and instructions for class investigations.

Have students grow plants in several types of soil to determine (1) optimal soil conditions for a specific type, and/or (2) the effectiveness of a specific soil health strategy for plant growth. Select plants with short growing times and try to find plants that can grow in local conditions. The initial setup will take one class, but analysis may be extended over weeks during growth cycle of plants.

Student investigations can be informal comparisons or controlled experimental design depending on your preference. It is, however, critical that there be at least two different conditions to compare.

Show **slide 22.** Give students the **Soil Conditions Experiment** handout. Have students generate a question about what soil conditions (e.g., pH, N) will provide optimal resources for a particular plant to grow. Alternatively or in addition, suggest that students consider how a soil management strategy impacts plant growth.

Slide **23** provides a place for you to add instructions for the investigations and research associated with this activity.

Soil Management

There are a variety of easy strategies to use to change soil conditions. Examples include adding hydrogen peroxide (O), fertilizer with different nutrient ratios (NPK), and vinegar or baking soda (pH) to soil.

Either give students a little time to research methods based on what health factor they choose to target, or provide them with the relevant practice.

Three relevant sources are linked below, but many gardening websites have suggestions for specific deficiencies.

https://www.hometalk.com/2398055/soil-nutrient-deficiencies

https://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/using-hydrogen-peroxide-in-garden.htm

https://www.almanac.com/plant-ph

Show **slide 24.**

Setup:

Have students prepare their materials:

1. Punch holes in the bottom of plastic cups for drainage, fill each one with a specific soil type, and plant a few seeds in each cup.
2. Develop a watering and sunlight schedule based on the recommendations that come on the seed packet.
3. Come up with a plan for data collection and evaluation. (*Example guiding questions are on* **slide 25.**)
4. Determine a method for taking pictures the same way multiple times (e.g., height of camera, distance from plant, orientation).

Evaluate

Teacher's Note

Give students the opportunity to choose their research topic from the two following choices:

1. What soil conditions are best for plant growth?
    - Explain how soil health, nutrient cycles, and plant needs interact to impact growth.
    - Emphasize how the best soil ended up with/developed the right resources to meet the plant's needs (e.g., healthy soil has lots of bacteria which decompose plants and animals to add nitrogen to the soil for plants to use).
2. How do soil management practices affect plant growth?

- Explain how soil health, nutrient cycles, and plant needs work together to affect plant growth.
- Explain how your management practice and nutrient cycles work together to make soil healthier.

Show **slide 25.**

Have students present the results of their investigations and explain the relationship between soil health and the growth of their plants.

Explain to them that their presentations provide an explanation for how soil health, nutrient cycles, and plant needs interact to impact growth.

Have students emphasize how the best soil ended up with/developed the right resources to meet the plant's needs (e.g., healthy soil has lots of bacteria which decompose plants and animals to add nitrogen to the soil for plants to use).

If students tried to improve soil health, have them emphasize how their management method fits into/fixes/supports nutrient cycles to make the soil healthier (e.g., adding peroxide puts more oxygen into the soil which helps make it compact so it drains water better).

Show **slide 26**. Review presentation parameters for students who researched what soil conditions are best for plant growth.

Show **slide 27**. Review presentation parameters for students who researched how soil management practices affect plant growth.

Show **slide 28** to review content for presentations.

Teacher's Note

Slide 28 provides a space for you to add material- and classroom-specific instructions for presentations. The actual format of student presentations is at your discretion, but should include explanations of how the data showed which soil was better and visuals showing differences in plant growth.

If technology is available, a stop-motion or time-lapse video showing plants at different points in their growth is an excellent source of evidence to support students' explanations. Examples of ways to create these videos are can be found at the links below.

Stop Motion Studio: https://play.google.com/store/apps/details?id=com.cateater.stopmotionstudio

Stop Motion Studio (apple) https://apps.apple.com/us/app/stop-motion-studio/id441651297

Stop Motion Animator: https://chrome.google.com/webstore/detail/stop-motion-animator/dhgmfcabdnkbdhelnooodefedbilcpho

Ditch That Textbook: 11 Tips for creating stop motion in Google slides https://ditchthattextbook.com/11-tips-for-creating-stop-motion-in-google-slides/

Resources

- Arias, R. (n.d.). Unsplash. Mushroom. [Photograph]. https://unsplash.com/photos/ihpiRgog1vs
- Cateater. (2020). Stop Motion Studio (Google Play) [Application]. https://play.google.com/store/apps/details?id=com.cateater.stopmotionstudio
- Cateater. (2019). Stop Motion Studio (Apple Store) [Application]. https://apps.apple.com/us/app/stop-motion-studio/id441651297
- Farmer's Almanac. (n.d.). *Soil preparation: How do you prepare garden soil for planting?* The old farmer's almanac. https://www.almanac.com/preparing-soil-planting
- Felise, J. (n.d.). Unsplash. Wolf. [Photograph]. https://unsplash.com/photos/mblYxasm0nk
- Grant, Amy. (2021, April 4). *Garden uses for hydrogen peroxide: Will hydrogen peroxide hurt plants*. Gardening know how. https://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/using-hydrogen-peroxide-in-garden.htm
- How Does Your Garden Grow: Breakout. (n.d.). [Tech tool]. https://sites.google.com/ou.edu/gardengrowbreakout/home
- Ingham, E. (n.d.). *Soil biology and the landscape*. USDA natural resources conservation service. https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053868
- K20 Center. (n.d.). Anchor chart. Strategy. https://learn.k20center.ou.edu/strategy/58
- K20 Center. (n.d.). Cognitive comics. Strategy. https://learn.k20center.ou.edu/strategy/fe96d3de46cfdc1f385aab7e7500a422
- K20 Center. (n.d.). Concept card mapping. Strategy. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f505c351
- K20 Center (n.d.). Metaphorical thinking. Strategy. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5068fc
- K20 Center. (n.d.). Photo or picture deconstruction. Strategy. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5065b32
- K20 Center. (n.d.). Three sticky notes. Strategy. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f506d92f
- K20 Center. (n.d.). Window notes. Strategy. https://learn.k20center.ou.edu/strategy/fc74060730ea745c8c4f356aa2015ac0
- Miller, M. (2018, March 29). *11 tips for stop-motion animation with Google Slides*. [Blog]. https://ditchthattextbook.com/11-class-activities-with-sensors-you-didnt-know-your-phone-had/
- Monks, B. (n.d.) Flow chart. Soil hand texture. K20 Center. https://docs.google.com/document/d/1N7lJwsQJvEjkpReFXRgENvLYT34h-IHf/
- Shaffery, H. (n.d.). Crop and soil photographs.
- Soil Science Society of America. (2014, November 21). International year of soils [Video file]. https://www.youtube.com/watch?v=vDL6F6GkAzI&list=PLZVYohuIygMqtilTezSHbzveYUj3WLjdm
- Szager. (2017). Stop Motion Animator (Chrome) [Application]. https://chrome.google.com/webstore/detail/stop-motion-animator/dhgmfcabdnkbdhelnooodefedbilcpho
- Tessaro, A. (n.d.). Unsplash. Wildflowers. [Photograph]. https://unsplash.com/photos/8Qeelw9kL4s
- Toney, S. (n.d.). *Soil nutrient deficiencies.* DIY project. https://www.hometalk.com/rapid/2398055/soil-nutrient-deficiencies