

How Does Your Garden Grow? (6th Grade)

Conservation, Ecosystems, and Soil Health

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

Essential Question

Why should we care about soil health?

Summary

This lesson is a middle school adaptation of the high school lesson "How Does Your Garden Grow?" Students will explore principles of soil health, soil chemistry, nutrient cycles, and environmental impacts of soil quality and investigate optimal soil conditions for plant growth. 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 examine photographs of healthy and unhealthy soils and crops and discuss what may have caused the differences between the images.

Explore

Students collect soil samples from a variety of locations and evaluate the pH and nutrient level of each sample. Students also explore and discuss information about healthy soil and practices that support healthy soil.

Explain

Students complete a digital breakout room using information about soil chemistry and nutrient cycles, then collaborate to make connections between soil health, management practices, and nutrient cycles.

Extend

Students grow plants in a variety of healthy and unhealthy soils to investigate soil conditions and soil management practices.

Evaluate

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

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD403: Translate information into a table, graph, or diagram
EMI404: Identify similarities and differences between models

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

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Oklahoma Academic Standards (6th Grade)

6.ESS2.1 : Develop a model to describe the cycling of Earth's materials and the flow of energy that drives these processes within and among Earth's systems.
6.ESS2.1.1: All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems.This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produces chemical and physical changes in Earth's materials.

Attachments

- Lesson Slides—How Does Your Garden Grow (6th Grade).pptx
- Soil Conditions Experiment—How Does Your Garden Grow (6th Grade) - Spanish.docx
- Soil Conditions Experiment—How Does Your Garden Grow (6th Grade) - Spanish.pdf
- Soil Conditions Experiment—How Does Your Garden Grow (6th Grade).docx
- Soil Conditions Experiment—How Does Your Garden Grow (6th Grade).pdf
- Soil Hand Texture—How Does Your Garden Grow (6th Grade) - Spanish.docx
- Soil Hand Texture—How Does Your Garden Grow (6th Grade) - Spanish.pdf
- Soil Hand Texture—How Does Your Garden Grow (6th Grade).docx
- Soil Hand Texture—How Does Your Garden Grow (6th Grade).pdf
- Soil Investigation—How Does Your Garden Grow (6th Grade) - Spanish.docx
- Soil Investigation—How Does Your Garden Grow (6th Grade) - Spanish.pdf
- Soil Investigation—How Does Your Garden Grow (6th Grade).docx
- Soil Investigation—How Does Your Garden Grow (6th Grade).pdf
- Window Notes—How Does Your Garden Grow (6th Grade) - Spanish.docx
- Window Notes—How Does Your Garden Grow (6th Grade) - Spanish.pdf
- Window Notes—How Does Your Garden Grow (6th Grade).docx
- Window Notes—How Does Your Garden Grow (6th Grade).pdf

Materials

- Lesson Slides (attached)
- Soil Investigation handout (attached; one per student)
- Soil Hand Texture handout (attached; one per group)
- Window Notes handout (attached; one per student)
- Soil Conditions Experiment handout (attached; one per student)
- Soil samples (collected during the lesson)
- Gloves
- Paper towels or disinfectant wipes
- Mineral-free water (e.g., DI water)
- Soil test kit or chemical test strips
- Student devices with internet access
- Sticky notes in three different colors
- Posters
- Markers

15 minutes

Engage

Teacher's Note: Lesson Versions

There are three different versions of this lesson available. Each lesson has similar Engage, Explore, and Explain phases, but the Extend and Evaluate phases address different standards.

This version of the lesson addresses the Oklahoma Academic Standard 6.ESS2.1, an sixth-grade science standard. Follow the links below to access versions of this lesson appropriate for seventh grade, eighth grade, and high school grades.

- How Does Your Garden Grow? (7th Grade) addresses standard 7.LS2.3.
- How Does Your Garden Grow? (8th Grade) addresses standard 8.LS1.5
- How Does Your Garden Grow? is for high school grades 9–12.

Use the attached **Lesson Slides** to facilitate this lesson. Display **slide 2** and introduce the title of the lesson, then display **slides 3–4** and introduce the essential question and learning objectives.

Display **slide 5** and introduce the Photo Deconstruction activity to students. Explain to students that they will see four photographs on the next slide. Tell students to study the four photos and consider the following questions:

- What do you observe in each photo?
- What are some causes of the things you observed?
- What do the healthy plants have that the unhealthy plants do not have?

Tell students that as they study the photos they should attempt to answer all three questions in a single-sentence summary.

Show **slide 6** containing a series of photographs of soil and plants in different soil conditions. The images illustrate the following:

- Healthy, harvested wheat field
- Bare field
- Plants growing in healthy soil
- Plants growing in unhealthy soil

Invite students to share out any observations and guide a class discussion on the images.

Teacher's Note: Guiding the Discussion

Ideally, students should conclude that soil is a critical component in growing healthy plants. If they do not arrive at this conclusion, guide the conversation toward what the plants are growing in. Explain that while plants do not require soil to grow, in these cases soil is the source of many necessary plant nutrients.

After the discussion, display **slide 7**. Ask students to summarize what they think they know about all four images in a single sentence. Explain their sentences should capture the main information they gained from the discussion. Invite volunteers to share their summaries.

30 minutes

Explore

Teacher's Note: Investigation Preparation

Prior to the activities featured in this phase of the lesson, have students collect soil samples from various garden sites around campus. Lead students in collecting soil from multiple sites so there are multiple samples to compare. You may even encourage students to bring soil samples from home. This process will need to be done at least one day in advance, as the soil samples will need to sit in a solution overnight.

Part 1: Assessing Soil Chemistry

Display **slide 8** and draw students' attention to the soil samples. Inform students that they will be analyzing each soil sample using common soil chemistry tests. Explain to students that they will be testing the soil pH as well as the nitrogen level, phosphorus level, and potassium level.

Show **slide 9** and explain the process for preparing the soil samples.

Begin by having students create the soil solution. Instruct them to add 100 mg of soil and 200 mL of water to a beaker or other container. Ensure that they measure both the soil and water correctly.

Instruct students to stir the mixture using stirring sticks or rods. Ensure that students use a new or different stirring utensil for each soil sample.

Once each mixture has been prepared, allow them to sit overnight.

In the following class period, resume the lesson by displaying **slide 10**. Review portions of the lesson from the previous class period and stress to students that soil is important to plant health.

Pass out one copy of the attached **Soil Investigation** handout to each student. Additionally, provide each student with a **Soil Hand Texture** handout to assist them with the texture portion of the soil investigation. A copy of the Soil Investigation table can be seen below.

Soil Sample	Texture	pH	Nitrate (NO_3)	Nitrite (NO_2)	Phosphorous (P)	What are some possible issues you notice?

Explain the procedure for testing soil samples. This procedure may vary based on the types of soil test kits you purchased. Review the specific directions with students. Tell students that they should dip their test strips into the sample solution, allow 50–60 seconds for the test strip to change color, then compare the color of the test strip to the color chart. Tell them that each measurement should then be recorded in their Soil Investigation tables.

Additional Steps for Test Strips

If you are using test strips that require color comparison, like nitrogen test strips, you may need to filter the water sample before collecting data. Use a double or triple layer of coffee filters to filter the sample until it is clean enough to test. You may need to filter the water 2–3 times depending on how murky the water is.

Tell students that they should document their process and results as they test the samples. They may do this by taking photos using tablets or their phone camera, if your classroom allows student devices. Explain to students that they will incorporate these pictures into their final presentations.

Instruct students to begin testing their soil samples. As they test the samples, walk around the room and assist students with the testing process. Answer any questions they may have and guide them in making observations about their samples, if necessary.

After the testing process is complete, display **slide 11** and explain the clean-up process.

Teacher's Note: Clean-Up Procedures

Slide 11 provides basic clean-up procedures. You may choose to edit the slide to add any clean-up procedures specific to your classroom.

Part 2: Investigating Soil Health

Display **slide 12** and introduce the next part of the lesson to students. Explain that students will explore several online resources to learn more about soil properties and soil health.

Transition to **slide 13** and pass out the **Window Notes** handout to each student. Tell students that they will explore resources about soil health in a HIVE collection board. As they read each source, they will take Window Notes over soil health, but will leave the Nutrient Cycles portion of the handout empty. Direct students to access the *Explore Sources* HIVE and begin reading through the resources.

Part 3: Discussion

After students have read the sources, display **slide 14** and introduce the discussion portion of the lesson. On the class board or on a large sheet of paper, create an Anchor Chart for each quadrant of the Window Notes. Consider including diagrams or drawings of soil horizons as part of the chart.

Display **slide 15** and begin a class discussion on students' window notes. Use the following questions on the slide to guide the discussion:

- What is soil?
- How do we describe soil?
- How do we know if soil is healthy?
- What are the benefits of having healthy soil?
- What soil management practices or strategies would improve soil health?

25 minutes

Explain

Teacher's Note: Breakout Guide and Answers

Prior to this activity, visit the How Does Your Garden Grow? Breakout to familiarize yourself with the content and answers to the locks. The answers to the locks are provided below:

Number Lock answer: 18—This answer is found in the article linked in the first picture at the bottom of the page. The article is about nutrients essential for soil growth. The number refers to the number of essential nutrients.

4 Letter Lock answer: CNOP—This answer is found by taking the first letter of every nutrient cycle in the green box in the middle of the page.

Picture Lock answer: 6.5—This answer is found in the image linked to the third picture at the bottom of the page. When the image is revealed, students will see the number circled at the top.

Color Lock answer: GBORYWP—This answer is found in the activity linked to the second picture at the top of the page. Students will make a copy of the Google Sheets document and complete a vocabulary activity. When the activity is completed, it will reveal the answer.

Transition to **slide 16** and introduce students the breakout rooms activity. Display **slide 17** and direct students to the How Does Your Garden Grow? Breakout resource. Instruct students to form groups and collaborate to find the keys to the four digital locks at the bottom of the website. Explain that students should read all of the articles and images on the website and use information about how nutrients are cycled to find the keys to the digital locks. Instruct them to summarize the information they learn in the Nutrient Cycles quadrant of their Window Notes as they work. Explain that they may make additional notes or add more "windows" to their handout if necessary. Allow students time to complete the activity.

Display **slide 18**. Pass out three different-colored sticky notes to each student and introduce the Three Sticky Notes activity. Begin by having students summarize what they learned in the breakout activity using a single word. Display **slide 19** and have students summarize the breakout activity using a short phrase.

Instruct students to use the information they gained from the breakout activity to create a new Anchor Chart for the Nutrient Cycles window on their Window Notes handout.

Display **slide 20** and invite students to share out their words and phrases. As students share, add any new information to the three Anchor Charts created during the discussion from the Explore phase of the lesson.

Misconceptions, Vocabulary, and Notes

If the entire class is struggling with content details or information from the Explore activities, consider providing a brief lecture and instructing students to take notes. You may consider a lecture in which you fill in gaps in knowledge, address misconceptions, or assist students in developing definitions for content-specific vocabulary.

Display **slide 21** and direct students' attention to their third sticky notes. Assist them in synthesizing the many concepts from the activity, paying extra attention to the connections between the knowledge they gained from the activities during the Explore and Explain phases of the lesson. Guide students to make the following connections about soil and nutrient cycles:

- Nutrient cycles and soil health are related. For example, nutrient cycles support healthy soil, and unhealthy soil may disrupt nutrient cycles.
- Soil management practices support or supplement natural nutrient cycles.
- Soil management practices impact soil health.

After supporting students in making these connections, instruct them to summarize how nutrient cycles, soil health, and soil management practices relate to each other using one sentence.

30 minutes

Extend

Teacher's Note: Specific Instructions

Prior to this phase of the lesson, add class-specific guidelines and instructions for the investigations to **slide 23**.

During the investigation, have students grow plants in a variety of soil types to determine optimal soil conditions for specific types of plants, or the effectiveness of a specific soil health strategy for plant growth, or have them measure both factors.

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 multiple weeks during the growth cycles of the plants.

Student investigations can be informal comparisons or controlled, designed experiments depending on your preference. However, it is critical that investigations incorporate two different conditions for comparison.

Display **slide 22** and give each student one copy of the attached **Soil Conditions Experiment** handout. Have students generate a question about which soil conditions (e.g., pH, N) will provide optimal resources for a particular plant to grow, and have them record this question in the box at the top of their handouts. You may also suggest that students consider how a soil management strategy affects plant growth in addition to, or instead of, soil conditions.

Display slide 23 and introduce your class-specific instructions for the investigations and research associated with the activity.

Show **slide 24** and provide students with the materials for the soil experiments. Have students complete the following set-up steps on the slide:

1. Punch holes in the bottom of the plastic cups for water to drain out.
2. Fill each cup with soil.
3. Plant seeds in each cup.
4. Create a schedule for watering and lighting.

Show **slide 25** and have students create a plan for data collection and evaluation. Guide students to determine a method for taking consistent pictures of the plants throughout the experiment. Discuss factors like the height of the camera, distance from the plant, and camera orientation.

25 minutes

Evaluate

Teacher's Note: Student Research Topics

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

1. Which soil conditions are best for plant growth?
    - Explain how soil health, nutrient cycles, and plant needs interact to impact plant growth.
    - Emphasize how the best soil had or gained the right resources to meet the plant's needs.
        - For example: Healthy soil has lots of bacteria to decompose plants and animals, which adds 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 chosen soil management practice and nutrient cycles work together to make soil healthier.

Display **slide 26**. Explain to students that they must present the results of their investigations. Tell them that their presentations must explain the relationship between soil health and the growth of their plants. Explain that their presentations must provide an explanation for how soil health, nutrient cycles, and plant needs interact to impact plant growth.

If students' investigations focused on improving soil conditions, have them emphasize how the best soil had or 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' investigations focused on improving soil management, have them emphasize how their management method connects to, fixes, or supports nutrient cycles to make the soil healthier (e.g., adding peroxide puts more oxygen into the soil which helps it compact so it water drains better).

Teacher's Note: Additional Instructions

Slide 27 provides a space for you to add material-specific and classroom-specific instructions for students' presentations. The final format of the presentations is at your discretion. However, presentations should include explanations of how the data demonstrates which soil was better visuals showing differences in plant growth.

Show slide 27. Review presentation parameters for student presentations on soil management practices and plant growth.

Resources

- Food and Agriculture Organization of the United Nations. (2015). *Our soils under threat* [Infographic]. http://www.fao.org/resources/infographics/infographics-details/en/c/326257/
- Food and Agriculture Organization of the United Nations. (2015). *Soil is a non-renewable resource* [Infographic]. https://openknowledge.fao.org/server/api/core/bitstreams/c43bacdd-2fb6-46d2-b9d0-6731c566be91/content
- Food and Agriculture Organization of the United Nations. (2015). *Soils help to combat and adapt to climate change* [Infographic]. https://openknowledge.fao.org/items/5230354d-be82-46fd-89b5-4d07f1493d8f
- K20 Center. (n.d.). Anchor charts. Strategies. https://learn.k20center.ou.edu/strategy/58
- K20 Center. (n.d.). *Explore sources: how does your garden grow?.* HIVE. https://hive.k20center.ou.edu/boards/19
- K20 Center. (n.d.). *How does your garden grow breakout*. https://sites.google.com/ou.edu/gardengrowbreakout/home
- K20 Center. (n.d.). Photo or picture deconstruction. Strategy. https://learn.k20center.ou.edu/strategy/140
- K20 Center. (n.d.). Three sticky notes. Strategies. https://learn.k20center.ou.edu/strategy/153
- K20 Center. (n.d.). Window notes. Strategy. https://learn.k20center.ou.edu/strategy/189
- Thien, S. J. (1979). A flow diagram for teaching texture by feel analysis. *Journal of Agronomic Education, 8*(1), 54–55.