How Does Your Garden Grow?

Chemistry & Soil Health

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Grade Level	9th – 12th Grade	**Time Frame**	4-5 class period(s)
Subject	Science	**Duration**	300 minutes
Course	Environmental Science		

Essential Question

Overarching: How do soil health and farming practices connect to environmental impact? Topical: How do farming practices impact soil health?

Summary

Students will explore soil chemistry, vegetable growth needs, environmental impact, and soil health through project based learning by creating a school garden proposal. Acknowledgement: Funding provided by USDA to Project No. 2012-02355 through the National Institute for Food and Agriculture's Agriculture and Food Research Initiative, Regional Approaches for Adaptation to and Mitigation of Climate Variability and Change.

Snapshot

Engage

Students will view pictures of crops growing in unhealthy soil and answer the question, "What's wrong with this picture?" Students will then discuss their connection to agriculture and how this connection has its foundation in soil health. Students will view USDA Video: Healthy Soil, Healthy Farmers.

Explore

Students will use a USDA School Garden Checklist as a guide to conduct group research about preparing a school garden project proposal. This proposal will be presented to the class and administration

Explain

Students will create and present a garden proposal that includes ways to improve vegetable production through recommended farming practices based on soil test results. Students will provide peer feedback on their presentations.

Extend

Students will test soil samples from possible garden sites and compare them to soil samples from other sites. Students will analyze each sample for common soil chemistry tests, which indicate soil with healthy balances of nutrients such as Nitrogen, Phosphorus, and Potassium.

Evaluate

Students will produce group School Garden Proposals to be presented to the administration and/or local community members and use a rubric to evaluate their project. As an option students may submit their

proposals to a School Garden Proposal Review Committee consisting of community member or the local County Extension office.

Standards

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

IOD202: Identify basic features of a table, graph, or diagram (e.g., units of measurement)
IOD203: Find basic information in text that describes a simple data presentation
IOD302: Understand basic scientific terminology
IOD304: Determine how the values of variables change as the value of another variable changes in a simple data presentation
IOD403: Translate information into a table, graph, or diagram
IOD404: Perform a simple interpolation or simple extrapolation using data in a table or graph
IOD502: Compare or combine data from a complex data presentation
SIN201: Find basic information in text that describes a simple experiment
SIN202: Understand the tools and functions of tools used in a simple experiment
SIN301: Understand the methods used in a simple experiment
SIN502: Predict the results of an additional trial or measurement in an experiment
SIN503: Determine the experimental conditions that would produce specified results
EMI301: Identify implications in a model
EMI401: Determine which simple hypothesis, prediction, or conclusion is, or is not, consistent with a data presentation, model, or piece of information in text
EMI502: Determine whether presented information, or new information, supports or contradicts a simple hypothesis or conclusion, and why
EMI504: Determine which models are supported or weakened by new information
EMI505: Determine which experimental results or models support or contradict a hypothesis, prediction, or conclusion

Next Generation Science Standards (Grades 9, 10, 11, 12)

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.

Oklahoma Academic Standards (Environmental Science)

EN.ESS2.6 : Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
EN.ESS2.7 : Engage in argument from evidence for how the simultaneous co-evolution of Earth's systems and life on Earth led to periods of stability and change over geologic time.

Attachments

- LM-School-Garden-Checklist-0.pdf
- SoilChemPresentationRubric-1 - Spanish.docx
- SoilChemPresentationRubric-1 - Spanish.pdf
- SoilChemPresentationRubric-1.docx
- SoilChemPresentationRubric-1.pdf
- SoilChemStudentInfoPlanning - Spanish.docx
- SoilChemStudentInfoPlanning - Spanish.pdf
- SoilChemStudentInfoPlanning.docx
- SoilChemStudentInfoPlanning.pdf
- USDALessonSoilChemistry - Spanish.docx
- USDALessonSoilChemistry - Spanish.pdf
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Materials

- Soil test kits (These may be purchased at any big box hardware store)
- Internet connected devices (at least one per group of three)
- Stirring rods or sticks
- Paper towels
- Plastic cups
- Water source: approximately two gallons of DISTILLED water needed for soil tests
- Soil Samples: Four soil samples from different locations
- Simple vegetable seeds, such as peas – several per group

Engage

Show the students a series of pictures of poor soil health conditions (e.g. yard with yellow patches, compacted soil, poor drainage, erosion, etc.).

Teacher's Note

It may be useful to describe what the cover crop for the picture is. You also may need to describe what healthy crop growth may look like.

Ask them: What's wrong with this picture? What do you think is the cause? You may lead a discussion or use a strategy such as Commit and Toss.

Next, ask the students the question: Does what we eat have an effect on the environment? How? What evidence do you have or how do you know this?

Facilitate a student discussion to elicit student prior knowledge regarding agriculture and farming and how they relate to the environment. Once students have a general understanding of where their food comes from and that the beginning of most food production depends on soil to grow the food we eat or to feed the livestock that we eventually eat.

Teacher's Note

You can draw a diagram showing the flow of energy and food beginning with soil to the student's plate.

Then ask the question: What is soil?

Teacher's Note

Soil is complex, yet it can be generalized to be composed of 4 components: Sedimentary material, organic material, water, and air. Soil also varies by region as different types and sizes (sand, silt, & clay) of sediments will be present and organic material will vary depending on region. Soil will develop specific layers called horizons over time. The development of soil horizons is a good indicator of soil health.

Student responses will vary; however the instructor should help guide students to understand the 4 components of soil and any other characteristics of soil.

Show the USDA Video: Healthy Soil, Healthy Farmers https://www.youtube.com/watch?v=-qPu0xING8wOR the Natural Resources Conservation Service (NRCS) Building Soil Health https://www.youtube.com/watch?v=QaOpyycbDcM.

Lead a discussion or ask students to think, pair, share about what the term "soil health" means, being sure they answer the following questions:

- What criteria factor into soil health?
- What are the benefits of having healthy soil?
- What soil management practices or strategies would improve soil health?

Explore

Inform students that they will be planning a school garden and that one component of planning a garden is assessing the health of the soil.

Divide the class into collaborative working groups of 5 or 6. Assign each student a role corresponding to the six components (i.e. evaluate your available space, find resources and make partnerships, soil health, design challenge, plant palette, build and use your garden) found on the USDA School Garden Checklist (http://www.letsmove.gov/sites/letsmove.gov/files/pdfs/LM%20School%20Garden%20Checklist_0.pdf). Explain that each student will be responsible for leading the group in their assigned aspect of the garden-planning project.

Pose the question to the groups: if we are going to plan a garden, what things might we need to consider? Have the students discuss with an elbow partner to create a list. Give the students enough time to discuss this thoroughly. Have the students share out with the class and compile a class list on the board.

Pass out a copy of the Student Information: The USDA School Garden Checklist, Garden Planning handout, and the School Garden Presentation Rubric to each student.

Go over the USDA School Garden Checklist pointing out what each role in the garden planning will entail. Go over the Garden Planning handout directions along with the presentation rubric with the class so they understand the project and your expectations.

Teacher's Note

Students individual roles are explained in more detail on the Garden Planning handout as well as project expectations and Garden Proposal Presentation requirements are explained on the Presentation rubric. Relevant data tables (e.g. soil chemistry) will be provided in these handouts as well.

Explain to the groups the time they will have to plan their school garden. Since this is a group project, allow some class time and Internet access to research and plan. (Additional resources can be located at http://www.fns.usda.gov/farmtoschool/census/resources).

Explain

Have groups present a rough draft of their plans. As each group presents, ask the others to make one suggestion for improvement and ask one question for peer feedback. This feedback will be used to refine their final presentations.

After students have given peer feedback, provide students with a brief overview of nutrient cycles (http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-5685/E-1003.pdf, http://www.envirothon.org/pdf/CG/nutrient_cycles.pdf, http://biology.about.com/od/ecology/ss/nutrient-cycle.htm, http://www.soil-net.com/dev/page.cfm?pageid=secondary_cycles_nutrient&loginas=anon_secondary) related to agriculture. Have students incorporate this information into their presentations.

Extend

Have students collect soil samples from possible garden sites around campus.

Teacher's Note

You may have students collect soil from multiple sites to use as a comparison. Students may even bring soil sample from home to test.

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.

Preparing the Soil Samples:

1. All of tests require a soil solution which is best to prepare at least a day before to get better results due to the nutrients leaching into the water.
2. Have the students create a soil solution by adding 100 mL of soil and 200 mL of water to a beaker or other container.
3. Now have the students use the stirring rod or sticks to blend the mixture.
4. Ensure that students clean the stirring rod thoroughly or use a different stirring utensil for each soil sample.

Testing the Soil Samples:

1. Now that the students have a garden plan have them test the soil types to determine the level of the nutrients present and if any soil modification will need to be done based on the chosen crops and their nutrient requirements. Hand out the Student Information: Soil Testing & Presentation handout.
2. Provide each group with a soil test data sheet OR have each group create their own data table (See Sample Soil 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.

Soil Sample	pH	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Is this soil deficient? How?	How could you improve the soil?

Sample Soil Test Data Table

Optional Extensions:

Teacher's Note

Initial setup is one class but analysis may be extended over weeks during growth cycle of plants.

Test Your Results:

- Guide students to grow their own vegetables in the sample soils and predict the results using their soil test data as evidence.
- Choosing one simple vegetable type like peas, have each group grow one plant in each of the soil sample types.
- Have students plant in individual plastic cups that have holes punched in the bottom for water drainage.
- Have the students come up with the planting, watering, and sunlight schedule based on the recommendations that come on the seed packet.
- Also have the students come up with a plan for evaluation. How are they going to determine which soil is the best?
- Have each group write up and submit for your approval their group's watering schedule, light, plan of evaluation and predication.

Evaluate

Option 1. Present your plan to the administration

Now that your students have presented their proposals they can create a singular proposal based on the information they researched and presented.

Have them prepare the proposal for a formal presentation to the school administration to receive feedback and possible approval to pursue and implement the school garden project.

This extension will only be successful if you have a designated committee that is passionate about the project.

The first step is to create a class committee, that is, a group of students that spearheads the collaboration as well as the members of the group who presents the proposal to the administration. Have student volunteer for committee member positions which can include a leader (and possibly co-leader), and then specialists in research, community outreach, and presentation production and design. You and the committee members must be willing to meet outside of class-time, either before or after school. During your meetings, facilitate the process of the proposal creation as well as outreach to the administration and the community. In addition to the information already researched, include additional research over other successful school garden projects. You can start with:

- http://schoolgardenproject.org/
- http://www.fao.org/docrep/009/a0218e/A0218E02.htm
- http://edibleschoolyard.org/

Option 2. Written proposal

Have students prepare and turn in their school garden proposal. Have various community members and/or your local county extension office serve as a School Garden Proposal Review Committee to "review" each proposal.

Teacher's Note

This is similar to a blind grant review process. The instructor will have to contact community members ahead of time to find volunteers to form the review committee. You will need to provide the review committee with evaluation rubrics to score each proposal. Review committee evaluation rubrics will vary and can utilize components of the student planning sheet and/or the presentation rubric.

After the committee has reviewed each proposal return the proposals to the students to allow them to read the feedback provided by the committee. You can utilize the committee scores as one part of the project grade.

Resources

- Soil Health for Educators:http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/assessment/?cid=nrcs142p2_053870
- Everything you want to know about soil tests including building your own:http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=nrcs142p2_053873
- Soil Biology resource:http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=nrcs142p2_053873
- Natural Resources Conservation Service (NRCS) YouTube channelhttps://www.youtube.com/user/nrcsnssc