5E STEM Farm Soil and Water Practices Unit

(5 days)

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: High School

Materials

- Water samples: 1 L whole field simulation and 1 L variable spray (See teacher notes)
- Containers for demo
- Food coloring
- Containers for water samples
- Soil kit 1 Soil Kit 2 Soil Kit
- Water kit
- Containers to hold soil
- White sand
- Soil
- Fertilizer
- Spray bottle
- Pencil/pen
- Teacher notes
- Lab Activity
- Lab Notebook Rubric.docx
- Farming Meets Innovation.mp4

STANDARDS

Next Generation Science Standards

- **HS-ESS3-4:** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Mathematics Standards | Common Core State Standards

- **HS.N-Q.A.1** Reason Quantitatively And Use Units To Solve Problems: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas;
- **HS.S-ID.C.9** Distinguish between correlation and causation.
- **HS.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

English Language Arts Standards | Common Core State

- **CCSS.ELA-LITERACY.RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- **CCSS.ELA-LITERACY.RST.11-12.3** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
- **CCSS.ELA-LITERACY.RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- **CCSS.ELA-LITERACY.RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

LESSON OBJECTIVE(S)

- Students will be able to define agricultural runoff and describe its impact on water quality
- Students will be able to understand and explain the differences between variable spray and traditional whole spray fields.
- Students will be able to conduct experiments or simulations to observe the impact of different spraying techniques on water quality.
- Students will be able to develop problem-solving skills by designing a hypothetical agricultural system that minimizes water pollution.
- Students will be able to understand the importance of sustainable agricultural practices and their role in protecting water quality.

CAREER CONNECTION(S)

Mentor Background: Dr. Jesse Roberts: Dr. Roberts is a research chemical engineer within the Environmental Laboratory at the U.S. Army Engineering Research and Development Center (ERDC) in Vicksburg, MS. They provide solutions for tomorrow's environmental challenges by finding new ways to clean water and remediate environmental contaminants. His role focuses on developing and characterizing new materials for synthetic biology and environmental applications. Specifically, Dr. Roberts works with graphene nanomaterials to remove harmful cyanotoxins from water sources that pose a significant risk to human health. Dr. Roberts has a PhD in chemical engineering from the University of Arkansas where he focused on biomaterial development for tissue engineering and biosensing applications. His team serves to make the world better by developing and utilizing materials to provide sustainable water infrastructure through clean and safe water.

STEM Careers:

- Environmental Engineer
- Agricultural Scientist
- Environmental Scientist
- Water Resource Engineer
- Soil Scientist
- Biologist
- Ecologist
- Environmental Policy Analyst

ENGAGEMENT

Brief Description: Introduce students to the impact of agricultural practices on water quality and engage their curiosity and interest in the topic.

Procedures:

- Pose the question to the class: "How do you think different agricultural practices affect the quality of water in nearby rivers and lakes?". Give 2 minutes to discuss.
- Play a brief video highlighting the effects of agricultural runoff on water quality and aquatic ecosystems Fertilizer Runoff and Drinking Water.
- After the video, have a short discussion with the students:
    - What did you notice about the water quality in areas with different spraying practices?
    - Why do you think these differences occur?
    - How do you think technology can help reduce negative impacts on water quality?
- Ask students to predict how variable spraying technology might improve water quality compared to traditional methods. Have them write down their hypotheses and what specific indicators (e.g., pH, turbidity, nutrient levels) they think will show improvements.

EXPLORATION

Brief Description: Provide opportunities for students to explore and investigate the impact of agricultural practices on water quality through hands-on activities and demonstrations.

Procedures:

- Conduct a demonstration comparing runoff from traditional whole spray fields and variable spraying scenarios.
- Use clear containers filled with water, sand, and food coloring to simulate runoff.
    - Put sand and food coloring into one container and a smaller amount in the second container
    - Stir the containers and allow students to observe and compare the differences in water clarity, sedimentation, and nutrient levels.
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- Present a case study of a local or well-documented water body affected by agricultural runoff. Discuss for ~3 minutes about the specific challenges and environmental impacts observed in the case study area.
- Lab activity - two parts Lab Activity
    - The students will complete a lab testing soil and water from simulated fields that the teacher will set up using the Teacher notes

EXPLANATION

Brief Description: Students will present and discuss their findings from the lab on whole- field versus variable spray fertilizer application methods. The goal is to deepen their understanding of the effects of these practices on soil nutrient levels and water quality.

Procedures:

1. Digital Gallery Walk: Each group will create a digital gallery walk using a shared Google Slide presentation. Each group will be assigned their own slide where they will summarize their lab results.
2. Slide Content: On their assigned slide, each group should include:
    - A brief summary of the experiment
    - The results for the control, whole spray, and variable spray conditions
    - Data tables from their experiments
    - Graphs or charts illustrating their results
3. Peer Review: Once all groups have completed their slides, students will participate in a digital gallery walk. They will view each group's slide and use the sticky note function in Google Slides to leave comments, questions, and feedback. Encourage students to provide constructive feedback and ask questions that promote deeper thinking.
4. Class Discussion: After the digital gallery walk, facilitate a class discussion where each group presents their findings to the class. Allow time for groups to respond to the comments and questions they received during the gallery walk.

5. Key Concepts Review: During the discussion, highlight key concepts such as:
    - The impact of different fertilizer application methods on soil and water quality
    - The importance of sustainable agricultural practices
    - How soil and water testing can inform better farming decisions
6. Conclusion: Summarize the main findings and discuss any discrepancies or unexpected results. Emphasize the real-world implications of their findings and how they relate to agricultural practices and environmental sustainability.

ELABORATE

Brief Description: Students will apply what they have learned by conducting the experiment again, but this time they will collect their own soil and water samples. This hands-on activity will deepen their understanding and reinforce their skills in soil and water testing.

Procedures:

- Review the initial experiment results and discuss improvements or changes that could be made in the new experiment.
- Divide students into groups and assign each group a specific area from which to collect their soil and water samples.
- Lab Activity

EVALUATION

Brief Description: Students will demonstrate their understanding of the experiment and their ability to communicate scientific findings through a formal lab write-up. This activity will help assess their comprehension of the scientific process, data analysis, and the implications of their results.

Procedures:

1. Lab Notebook Rubric: Provide students with detailed guidelines on how to structure their lab report.
2. Assessment Criteria: Explain the criteria by which the lab reports will be evaluated.

REFERENCES

- Miracle-Gro instructions
- Fertilizer Runoff and Drinking Water