

Activity Template

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Subject Area(s) measurement, chemistry, data analysis & probability, earth & space

Associated Unit

Yellow highlight = required component

Associated Lesson

Activity Title Acid Rain

Header

<p>Image 1 ADA Description: ___? Caption: ___? Image file name: ___? Source/Rights: Copyright © ___?</p>

Grade Level _5_ (_4_-_6_)

Activity Dependency Invisible Ink

Time Required 2 weeks

Group Size 2-4

Expendable Cost per Group US\$ _4_

Summary

In groups, students plan and implement their own experiment on how different pH levels of soil affect bean plants. They form their own hypothesis, collect data, analysis their results and form conclusions. As a class they compare results, generate some statistics and form an overall conclusion. They learn how pH levels of soil are connected to acid rain and environmental engineering.

Engineering Connection

Environmental engineers use their science and engineering knowledge to help improve the environment. Acid rain is a worldwide environmental problem that has been addressed by environmental engineers. It can change the pH of water and soil and have negative effects on plants and aquatic animals. The problem becomes worse and more widespread as the population and industry grows. Environmental engineers conduct studies to evaluate the significance of environmental hazards, advise on treatment and containment and can help develop regulations to improve or prevent conditions.

Engineering Category

(1) relates science concept to engineering

Keywords pH, acid rain, plants, weather, environment, acid, base

Educational Standards

- Texas science (2008): 2A-G, 4A
- State math:

Pre-Requisite Knowledge

Learning Objectives

After this activity, students should be able to:

- Plan and implement simple experimental investigations testing one variable.
- Formulate testable hypotheses, collect data through observation and measurement.
- Analyze data, form and communicate conclusions, construct simple tables and graphs
- Understand the connection between acid rain, pH, and environmental engineering

Materials List

To share with the entire class:

- potting soil
- plastic cups
- sun lamp
- 250mL beakers
- 1-14 scale litmus paper
- spray bottle (4, one for each different solution)
- rulers
- packets of bean seeds (amount depends on size of class)
- wooden dowels
- string or twine
- some possible acidic liquids: bottle of soda, lemon juice, orange juice, vinegar

Introduction / Motivation

Acid rain is an environmental problem that is being addressed by environmental engineers. The acid rain can affect the pH levels of the soil and have a negative impact on the plants. Each group of students is going to design an experiment, form a hypothesis, implement the experiment, collect data, analysis results and form a conclusion on these possible effects that different soil pH levels have on bean plants. (Write on board: design an experiment, form a hypothesis, implement experiment, collect data, analysis results, form a conclusion.) Does anyone know what a hypothesis is? (Answer: see definition below) What are some ways you can collect data? (Answer: take measurements, write down observations) How can you analysis results? (Answer: graph the data, calculate statistics: mean, median, etc.) When you form a conclusion what information do you use? (Answer: the collected data and your analysis) (Write on board: the list of materials the students will have access to when conducting their experiments) These are the

materials you will get to use when conducting your experiments. Does anyone know what litmus paper is? (Answer: pH indicator) The litmus paper that we have changes color depending on the pH of the substance you are testing. You can compare the color of the litmus paper to this color chart(hold up chart,comes with the litmus paper) and match the color to the a number, 1 through 14, that corresponds to the pH scale. (Demonstrate this once by using one of the acidic liquids to show the class how it works.) Are there any questions on how to use the litmus paper?

In most experiments, the effect of a certain outcome is tested. Let's say the effect is the fading of red shirts after you wash them many times with different detergents. What would you compare the fading shirts to? (Answer: new shirt) This is called an experimental control. Does anyone know why is it important to have an experimental control? (Answer: It can serve as a comparison for the results of an experiment) You need an experimental control, where you don't change any parameters, and compare the outcome of that experiment to one where you did change one parameter. Every group will need to decide what their experimental control will be when you are designing your experiment. You will design your experiment today and you will have two weeks to complete your experiment.

Vocabulary / Definitions

Word	Definition
pH scale	Measures how acidic or basic a substance is; ranges from 0 to 14
pH indicator	Shows through a color change if a substance is an acid or base.
acid	Substance described by a pH less than 7.
hypothesis	A tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation.
experimental control	A specific value or values that can serve as a comparison for the results of an experiment
Engineer	A person who applies science and mathematics to create for the benefit of society.
Environmental engineering	The application of science and engineering principles to improve the environment.

Procedure



Image 1, [left justified]

Figure 1

ADA Description: _bean plant setup

Caption: Figure 1: _none_

Image file name: __beanplant.jpg

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Background

Before the Activity

- Order litmus paper
- Decide on a few acidic liquids you want to use that have different pH levels (soda, lemon juice, orange juice, vinegar)
- Gather remaining materials

With the Students

Split the class into groups of 2-4 students

Students in Groups

- 1) Test the pH of the liquids provided and record your results in a table.
- 2) Also test the pH of the tap water you will use. Remember only pure water is neutral or has a pH of 0.
- 3) Design your experiment to test the effects of different soil pH levels on bean plants.
 - a) What will be your baseline?
 - b) How will you get different soil pH levels?
 - c) What type of measurements or observations will you be taking?
 - d) How frequently will you take measurements?
 - e) What units will you use?
 - f) What materials have you decided to use?

g) Write out steps for your experimental procedure? (rough draft)

With the Students

Have each group explain the design of their experiment to the class. Check to make sure it makes sense and have a discussion if there are some problems or if they need to add anything else.

Example Experiment:

- 1) Plant 4 bean seeds in separate plastic cups with the same amount of soil. (Might want to plant more than one seed per cup in case one of the seeds isn't good.)
- 2) Label the four cups: water only (baseline), orange juice, lemon juice, vinegar.
- 3) Water each plant once a day with 50mL of liquid. The baseline plant will only be given water and the other plants will be watered with a solution of 25mL of water and 25mL of either orange juice, lemon juice, or vinegar.
- 4) Spray each plant three times with the same solution it was watered with.
- 5) Measure each plant, in cm, everyday for two weeks and record the data in a table.
- 6) Record each day any other observations such as: plant color, overall appearance or if leaves are falling off.

Students in Groups

- 4) Edit procedure if needed.
- 5) Write a hypothesis for your experiment and include the reasoning behind it.
- 6) Set up and conduct your experiment.
- 7) If the bean plants get too tall then use the wooden dowels and twine to help support them.
- 8) When the experiment is finished and all your data has been collected, turn your table of data into a graph or series of graphs.

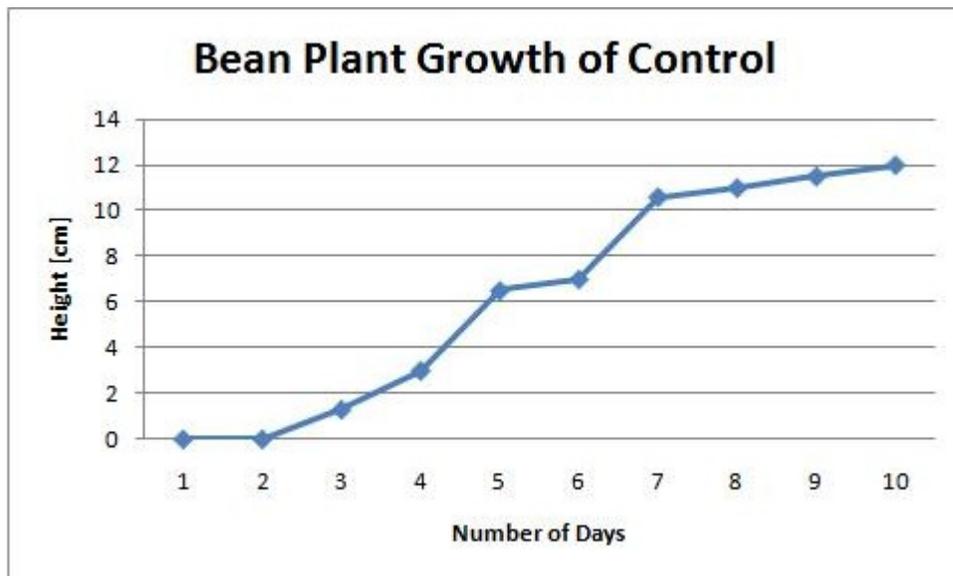


Image 2, [centered]

Figure 1

ADA Description: _Example Graph_

Caption: Figure 1: _Example Graph_

Image file name: beangraph.jpg

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- 9) Analyze your results and reach a conclusion.
10) Was your hypothesis correct? Explain.

With the Students

Have each group present their results, conclusions, and problems that they might have had. As a class compare the results, generate some statistics with all the data and come up with an overall conclusion.

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Attachments

Safety Issues

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Troubleshooting Tips

Investigating Questions

Assessment

Based on the results, conclusions, and problems have each student write out improvements or changes they might make to their experiment if they could do it again. Have them think of other environmental problems that environmental engineers might be involved in.

Pre-Activity Assessment

Title: ___?

Activity Embedded Assessment

Title: ___?

Post-Activity Assessment

Title: ___?

Activity Extensions

Activity Scaling

- For lower grades, ___?
- For upper grades, ___?

Additional Multimedia Support

References

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http://en.wikipedia.org/wiki/Environmental_engineering

Other

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