

**TEACHING KATE
TEACHING KIDS ABOUT THE ENVIRONMENT**

Environmental Effects on Plants

Grade Level: 9-12
(Biology 1, Biology II,
or Environmental Science)

Time required: 1 full day and 5 half days in
class; five minutes of class for at
least one month

SC Science Standards

This lesson plan was correlated with only the grade level specified unless otherwise noted.

- I. A. 1-2
- I. B. 1, 2, 8, 9, 10, 11, 12
- I. E. 1
- I. F. 2
- II. D. 4 b.
- II. D. 5. d
- II. E. a-b
- II. F. 2. d
- III. B. 1. a

Purpose

Students will research the effects of specific environmental variables on plant growth. Using their research results, they will then design an experiment to demonstrate these effects to other students. Students will prepare and deliver an oral presentation to their classmates that will discuss and explain their research and experimental results.

Skills

Designing experiments, organizing observations and data into graphs and tables, teaching concepts to classmates (oral communication).

Concepts

Effects of soil type, climate (ie. temperature, amount of rain, acid rain), nutrients (including fertilizers), and other organisms on the growth of plants.

Materials Needed

At least 9 plants per group (3 of 3 types) *	pots*
measuring devices (100 ml beakers)*	grow lights or windows*
clay soil	sandy soil
compost (optional)	fertilizer (one or more varieties)
potting soil*	acid (lemon juice)

Other materials will depend on how you allow students to design their experiments. Plan on having extra plants, especially for group four. This is just a starting point for materials, students could continue with their experiments using additional materials to determine other effects. Those materials which are starred are necessary for all groups.

Definition of Terms

<u>Acidic</u>	A substance with a pH below 7.
<u>Acid Rain</u>	Precipitation which has combined with sulfuric, carbonic, and/or nitric acids in the air; has a lower pH than normal.
<u>Basic</u>	A substance with a pH above 7. (Also referred to as Alkaline)
<u>Carrying Capacity</u>	The number of organisms of a species that a given location can support during the least favorable period of the year.
<u>Clay</u>	Soil particles which are less than 0.002 mm in size.
<u>Climate</u>	Prevailing weather conditions in a particular area
<u>Community</u>	All populations living in a given location and interacting with one another.
<u>Competition</u>	Contention between organisms for the same resources.
<u>Density-Dependent</u>	Factors that limit a population only when the population reaches a certain density.

<u>Density-Independent</u>	Factors which affect all populations in the same way, irrespective of population size.
<u>Fertilizer</u>	Chemicals which are added to soil to provide necessary nutrients to plants. These may vary in the amounts of each nutrient, but the main nutrients (nitrogen, phosphorous, and potassium) are always listed in the order: N-P-K.
<u>Loam</u>	A mixture of sand, silt and clay in specific proportions; considered the ideal soil texture for plant growth if all other conditions are favorable. (Use potting soil as a substitute)
<u>Nutrient</u>	A substance needed by an organism for metabolism, growth, repair, and maintenance of the physical structure.
<u>Osmosis</u>	Movement of water across a semi-permeable membrane from high to low concentration; method of water entrance into plant roots.
<u>Permeability</u>	The quality of the soil that enables water to move downward through the profile.
<u>pH</u>	The degree of acidity or alkalinity of a substance expressed as a value on a scale of 1 - 14, with 7 being neutral.
<u>Population</u>	All organisms of one species living in a given location.
<u>Porosity</u>	The proportional relationship between the amount of pore space between the soil particles and the amount of solid particles in a particular volume of soil.
<u>Sand</u>	Soil particles which are 2 mm to 0.05 mm in size.
<u>Silt</u>	Soil particles which are between 0.05 mm and 0.002 mm in size.

Before the Meeting

Decide if you want to do all four parts of this project and what questions the students should research as background information. Decide how many student work groups will be doing the exercise and plan for at least 9 plants for each group. You should get 3 different types of plants in order to see how certain characteristics affect some species and not others. Begin to prepare for this project at least one month before assigning it to the students. This will allow plants to grow

from seeds and establish themselves. If your class is small and you do not need so many plants, you could buy small plants rather than growing them from seeds. Gather the materials you wish to use. You may limit your students to these provided materials or tell them that they may bring other materials for their experiments. Gather books students may use for research or make sure that there are sufficient numbers of copies of different references in the library to answer the questions you assigned them. Arrange at least one month in advance for any outside speakers you plan on having come in to discuss these topics. The Department of Natural Resources has resource specialists who may be available as speakers to visit and discuss some of these topics with the class.

Background Information

No organism may grow completely isolated from all other parts of the ecosystem. In this project, plants and how they interact with the environment are being studied. Plants must have other organisms in the ecosystem to provide carbon dioxide for use in photosynthesis. Other factors also determine how well plants may survive. The type of soil may allow too much or too little water to surround the plant roots. The climate may alter the temperature, the length of the growing period, or the amount of water entering the soil. Plants must have nutrients in order to perform a variety of chemical reactions for survival, the amounts of these may affect plant growth. Size of a population and the amount of competition may affect how well a plant grows.

There are three types of soil particles: clay, silt, and sand. The relative amounts of these affect the type of plants able to grow in a habitat. Some plants may be able to live in an area with a high clay concentration, while others must have a high sand concentration. A mix of these types may be simulated with potting soil. Addition of compost to soil will enrich the soil and provide more nutrients for the plants. Sandy soils are more permeable than clayey soils and will not hold as much water, but rather will let it pass through more rapidly. This will affect the types of plants which flourish in each soil type.

The climate factors which this unit looks at are temperature, amount of precipitation, and acid rain. You could also include altitude and latitude (the biomes – tropical rain forest, tundra, etc.). Plants are specialized to live in certain temperature ranges. If the temperature moves too far from that range, then the plant may not survive. Some plants must have temperature changes to produce seeds or fruits. Some pines must have extreme temperatures (from fires) to release their seed. A variety of plants must have a frost before blossoming or producing fruits. Too little precipitation may deprive the plant of water and nutrients, while too much may deprive the plant of air and cause the roots to rot. Either of these situations may ultimately cause the plant to die, but the deleterious impact may be gradual and not immediately apparent. Acid rain changes the composition of the soil and may cause damage to certain plants, because plants are also specialized to live in certain pH ranges. There are four main physiographic regions in South Carolina. From west to east they are: Blue Ridge, Piedmont, Sand Hills, and Coastal Plain.

Nutrients are necessary for plant development. These are dissolved in water which the plant roots take up through osmosis. Additional nutrients may be added to soil through the use of fertilizers and compost. Not all fertilizers are the same. Most of the commonly available ones contain nitrogen, phosphorus and potassium. These elements are listed in that order as a ratio (15:30:15) on the fertilizer package or label. Some fertilizers may not contain any amount of one of these elements and their labeled ratio would so indicate: e.g.; 0:20:20 would indicate an absence of Nitrogen. Differing amounts or types of fertilizers may affect the health and growth of species of plants differently.

Interactions with other organisms may affect how well a plant grows. If too many plants of a population are present, carrying capacity will be reached and competition for light, water, and nutrients will ensue. The strongest and best suited to the environment will survive and the weaker will probably die. Some factors which affect plant growth do not depend on population size. These density independent factors may include weather phenomena (ie. thunderstorms, tornadoes). A limiting factor is the factor which prevents the population from growing larger. Examples may be: amount of water, amount of nutrients, amount of sunlight, soil structure and chemistry.

Suggested Lesson Plan

This project will take at least one month to complete. You may extend it indefinitely depending on how in-depth you wish to examine the topics. There will only be a few days in which the entire period (or a large portion of it) is consumed with these projects. Every class period, at least one student per group should record any changes in their plants.

Day 1: (45 minutes)

Explain the project.

- Have students research one of these four topics, design an experiment based on this research, and teach this information to the class.
- Split students into 4 groups (ideally, 3-5 students per group.)
- Assign one topic to each group.
- Give the students their list of questions to answer. Allow students to begin to research their topic and discuss ways to design their experiments.

Day 2: (one week later, whole period)

- Have students set up their experiments.

Days 3-6: (half period, over the next four class periods)

- Have each work group teach the class the information they researched. All students will have test questions based on all four groups' research reports. A portion of each group's grade will depend on how well the rest of the class did on the test questions from their presentation.

Continue the observations for as long as you wish; at least a month is necessary to see results.

Application

This project may be used to teach not only the individual components of the environment, but also how they interact with and affect other members of an ecosystem. Students will begin to understand that no organism can live without being influenced by outside occurrences. How often plants are watered or how much light they receive will affect how much growth occurs and the length of time the plant lives. Students also need to understand how competition will work to decrease (or maintain) the size of a population. While not every student will grow plants later in life, all will be exposed throughout their lives to populations of various organisms in which such factors are at work. Students will study their own and other groups' plants to see whose is doing the best and the worst. These comparisons may be used as the basis for class discussions on causative factors involved. It is important for students to recognize and understand that there are many factors which can affect populations.

Extension

Combine several of these factors to see how the reactions in the populations change. Discuss the rate of growth in the human population and have students study the effects this has on the world as a whole.

Resources Available

Biology. 1996. Addison-Wesley Publishing Co., Inc. New York, N.Y.

Biology: Reviewing the Essentials. 1998. Medley, Dean. Amsco School Publications, Inc. New York, N.Y.

Boller, Larry; Kessler, George; Scharf, Richard. Ed. 634, Teaching About the Environment. June, 1998, Columbia, S.C.

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Environmental Effects on Plants Group Instruction Sheets

Group 1: Soils

Instructions:

1. Answer the following questions by next (day of week) (Month, date).
 - a. Describe the three types of soil particles.
 - b. How does the presence of organic material affect soil composition?
 - c. Why is soil necessary?
 - d. What are porosity and permeability?
 - e. What are examples of plants which will live best in sandy soil? clayey soil? mixed sand and clay?
 - f. What is loam?
 - g. Why can compressing the soil around a plant's roots kill it?
 - h. Why are plants able to live in water? (hydroponic cultivation)
2. Design your experiment by next (day of week) (Month, date).
3. Set up your experiment in the classroom during class on that day.
4. Observe your plants daily and record any changes.
5. Summarize all data into a lab report.
6. You will present your project information to your classmates on the day assigned. A part of your project grade will depend on how well the whole class does on the test questions developed from your section of information.

Group 2: Climate

Instructions:

1. Answer the following questions by next (day of week) (Month, date).
 - a. What is the climate?
 - b. How can this affect plant growth?
 - c. What are the geographic regions in South Carolina?
 - d. How do the types of plants in each region differ?
 - e. What are some factors which may affect the climate?
 - f. What are some causes of acid rain?
 - g. What effect does acid rain have on plants?

2. Design your experiment by next (day of week) (Month, date) .
3. Set up your experiment in the classroom during class on that day.
4. Observe your plants daily and record any changes.
5. Summarize all data into a lab report.
6. You will present your project information to your classmates on the day assigned. A part of your project grade will depend on how well the whole class does on the test questions developed from your section of information.

Environmental Effects on Plants

Group Instruction Sheets

Group 3: Nutrients

Instructions:

1. Answer the following questions by next (day of week) (Month, date) .
 - a. What are nutrients?
 - b. Why do plants need nutrients?
 - c. How do they get into the plant?
 - d. Why do some people put fertilizer on their plants?
 - e. How do different fertilizers affect plants?
 - f. What do the numbers 15:30:15 on a fertilizer bag stand for?
 - g. Why are these numbers important?
2. Design your experiment by next (day of week) (Month, date) .
3. Set up your experiment in the classroom during class on that day.
4. Observe your plants daily and record any changes.
5. Summarize all data into a lab report.
6. You will present your project information to your classmates on the day assigned. A part of your project grade will depend on how well the whole class does on the test questions developed from your section of information.

Group 4: Organisms

Instructions:

1. Answer the following questions by next (day of week) (Month, date) .
 - a. What is carrying capacity?
 - b. How does this affect a plant population?
 - c. What are some limiting factors in a plant population?
 - d. What happens to the plant population when the carrying capacity is reached?
 - e. How do density-dependent and density independent factors differ?
 - f. Give an example of each and describe how it affects the population.
 - g. What would happen to the plant population if no animals were present? Why?
 - h. What would happen to the plant population if the area became overpopulated with deer, rodents, or some other animal? Why?
2. Design your experiment by next (day of week) (Month, date) .

3. Set up your experiment in the classroom during class on that day.
4. Observe your plants daily and record any changes.
5. Summarize all data into a lab report.
6. You will present your project information to your classmates on the day assigned. A part of your project grade will depend on how well the whole class does on the test questions developed from your section of information.

**Environmental Effects on Plants
Project Components and Grade Scale**

WRITTEN LAB REPORT

1. Hypothesis (15 points)
2. Design of Experiment (40 points)
 - Control (5 points)
 - Variable (5 points)
 - Purpose (10 points)
 - Procedure (20 points)
3. Data Collection (35 points)
 - Tables (20 points)
 - Graphs (15 points)
4. Conclusions (30 points)
 - What happened? Why? Why is this important? Sources of Error

Total: 120 points

Presentation to Class

1. Background information from answers to questions on Group Instruction Sheets.
 - Must be turned in the day you make presentation. (30 points)
2. Lesson plan. (Who is doing what and when.) (10 points)
3. Presentation (25 points)
 - ALL group members participate (10 points)
 - Creativity in lesson (5 points)
 - Instructional Techniques (10 points)
4. Assessment (25 points)
 - Proposed Test Questions you turn in to teacher on day you make presentation (10 points)
 - 10 multiple choice, 5 short answer, and 1 essay.
 - Include answers!!!
 - Class achievement (15 points)
 - Derived from percent of your questions which your classmates answer correctly.

Total: 90 points

Total possible points: 210 points