

Teacher Guide: Growing Plants



Learning Objectives

Students will:

- Determine what a seed needs to grow into a healthy plant.
- Explore the effects of light intensity, water levels, and soil additives on plant growth.
- Design a controlled experiment to investigate a question.
- Collect data from multiple trials.
- Analyze data using tables and graphs.



Vocabulary

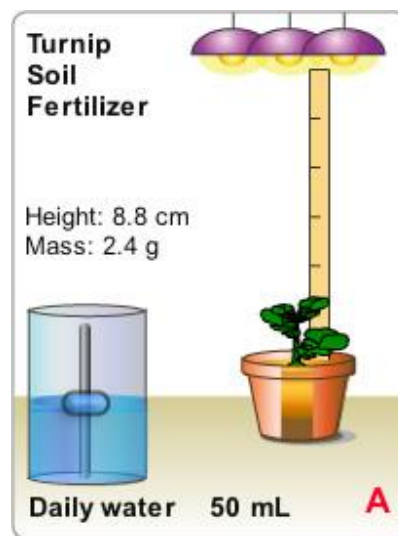
compost, fertilizer, mass, seed, soil, variable



Lesson Overview

The *Growing Plants Gizmo*™ simulates plant growth. Students can manipulate four variables: seed type (bean, tomato, or turnip), soil additives (compost and fertilizer), amount of water, and amount of light. Students can use the Gizmo to try to grow the biggest plants they can, or to investigate the effect of each variable individually.

In this process, students will gain experience in designing fair experiments and following an investigative process that includes asking questions, designing experiments, collecting and analyzing data, and drawing conclusions.



The Student Exploration sheet contains three activities:

- Activity A – Students explore whether plants need water to grow into a healthy plant.
- Activity B – Students examine how the amount of light affects plant growth.
- Activity C – Students create their own question and then design an experiment to answer it.



Suggested Lesson Sequence

1. **Prior to using the Gizmo** (🕒 10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and to demonstrate its basic operations, such as how to set up experiments, view data, and take Gizmo snapshots.
2. **Gizmo activities** (🕒 10 – 15 minutes per activity)
 Assign students to computers. Students can work individually or in small groups. Have students work through the activities in the Student Exploration, using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

3. Discussion questions

(🧠 15 – 30 minutes)

As students are working or just after they are done, discuss the following questions:

- What is the best way to measure a plant: height or mass? (Some plants may be tall but have very small leaves and little overall mass. Are these plants the healthiest plants?)
- Why do plants in dim light grow taller than plants in full light?
- What does it mean for an experiment to be fair or controlled? If you are testing the effect of one variable, such as water, what should you do with the remaining variables?
- Are results for the same experiment always exactly the same? Why or why not? How much data do you need before your results can be trusted?

4. Follow-up activity: Grow your own plants

(🧠 3 – 6 weeks)

After students have used the Gizmo, they are ready to grow their own plants. You will need soil, seeds, and containers such as disposable cups. You and your students can decide what plants to grow and which variables to investigate.



Scientific Background

The plant growth model used in the Gizmo was calibrated by experiments conducted by staff members of ExploreLearning and their families. The model was designed to be as realistic as possible:

- Plants in the Gizmo require light and water to gain mass. In the process of photosynthesis, plants use the energy of light to convert carbon dioxide and water to simple sugars. These sugars are linked into more complex molecules to form leaves, stems, and roots. Without adequate light and water, plants will not be able to gain mass.



Testing the effect of water levels on tomatoes

- Plants grown in dim light may grow taller than plants grown in ample light, although they will gain less mass and have smaller leaves. Plants that are overshadowed by other plants will have a better chance to reach sunlight if they grow tall quickly.
- Fertilizers can greatly accelerate plant growth because they provide large amounts of nutrients to the plant. (Too much fertilizer can have an adverse effect, but this is not modeled in the Gizmo.) Compost has a less dramatic effect, but also promotes plant growth by providing smaller amounts of nutrients and improving the structure of the soil.
- Over-watering can cause as much harm as under-watering. Plant roots need oxygen, and will rot if they are constantly saturated with water. Each plant in the Gizmo has an ideal amount of water for healthy growth.
- Individual plants will respond slightly differently to the same growing conditions. Occasionally a seed won't germinate at all, even in "good" conditions!

As your students study the needs of plants, keep in mind the need to design and carry out **controlled experiments**, or fair tests. The key to a controlled experiment is that every variable but the one that is tested is kept constant. For example, if students are investigating the effects of soil on tomatoes, each pot should have the same type of seed, the same amount of water, and the same amount of light. Only the soil should be different in each pot.

Note: The Student Exploration only describes a few of the many experiments that can be done with this Gizmo. Feel free to do as many experiments as you like!



Environmental Connection

As demand for food has increased with human populations in the last century, farmers have come to rely on chemical fertilizers to improve crop yields. Fertilizers provide essential nutrients to plants, including nitrogen (N), phosphorus (P), and potassium (K). But the large-scale use of fertilizers has serious environmental consequences:

- Extracting nitrogen requires burning natural gas, contributing to the greenhouse gases that cause global warming.
- Agricultural runoff pollutes streams, rivers, and oceans. An excess of nutrients in the water encourages the rapid growth of aquatic plants and algae. When these plants die and decompose, dissolved oxygen is depleted and animals can no longer survive.

Natural alternatives, such as manure and compost, can be used instead of chemical fertilizers for small-scale farming. Compost is an especially attractive option because it recycles resources that would otherwise be thrown away. Starting a class composting bin would be an excellent school project for interested students.



Selected Web Resources

General plant information: <http://www.exploratorium.org/gardening/>

Elementary plant activities: <http://www.proteacher.com/110013.shtml>

Plant nutrition: <http://www.agr.state.nc.us/cyber/kidswrld/plant/index.htm>

Agricultural history: <http://www.crystalinks.com/agriculturehistory.html>

Composting: <http://aggie-horticulture.tamu.edu/kindergarden/kidscompost/cover.html>