Seed Germination Experiments

Overview:
This lesson provides guidance on conducting your own seed germination experiments in the classroom. There are sections on materials, methods, choosing a research question, choosing experimental treatments, measuring seedlings, and analyzing your data. There is a link to a web-based data set with pictures of germinating seeds. Students can measure and analyze the data of the virtual experiment on-line within a few class periods. This analysis can provide a springboard for student’s ideas and research questions. They can also compare the results of the virtual web-based experiment to their own experiments.

Objectives:
1. Students will know the parts of a seed
2. Students will understand the requirements for seeds to germinate and grow
3. Students will be able to explain the growth patterns of seedlings
4. Students will recognize differences between plants in their germination and growth requirements

Materials:
Seed packets
Re-sealable plastic bags (sandwich or quart size)
Paper towels or napkins
Water and cups
Tape
Cardboard (optional)
Paper clips (optional)
Binder clips (optional)
Worksheets
String

Basic set-up methods:

Germination viewers were constructed as follows:

1. Cardboard holders were cut
2. Seeds were soaked overnight
3. Paper towels were placed inside re-sealable plastic bags
4. Approximately 30 milliliters of water were added using an empty film canister
5. Soaked or unsoaked seeds were placed inside the bags. More than one seed is used, because not all seeds will germinate, and by using more than one seed you can be sure at least one will germinate if the conditions are right
6. Bags were sealed and taped to the cardboard holders
7. A binder clip was attached to the holder and used as a hook to hang the viewer on a large piece of cardboard. Germination viewers can also be laid on a table, or taped to a window.
8. Seeds will germinate more quickly if they are first placed in a cup of water and allowed to sit and soak-up water
9. We placed some seed viewers in the dark, some in rooms with only artificial light, some had the light on 24 hours, some had the lights on for 10 hours, and other seed viewers were placed by the window, where they received natural light. Some seed
viewers were rotated. For these seedlings gravity changed direction every time they were rotated.

Activity 1:
We took pictures of our seed viewers everyday for 2 weeks. Your students can use these images to study the effects of our experimental treatments.

1. Discuss the structure and parts of the seed. Have students label a seed dissection diagram.

2. Discuss with students the concepts of:

   Experimental treatments – what was done to each seed viewer
   Control – the viewer you want to compare with an experimental viewer to answer a specific question.

   For example, if I want to know what effect darkness has on the development of a seedling, I have to choose two identical viewers. The only difference between them should be that one was in the dark and the other wasn’t. These two viewers should both have the same amount of water, the same kind of seeds and weren’t rotated. Any of these other factors would complicate the analysis of the results. If I want to know what effect does 24 hour light have, I should compare that treatment to a viewer that had the same type of light, but not for 24 hours. One complication to be aware of; light and heat often go hand in hand. In our experiment, the seeds in natural light were warmer that those in artificial light, when we compare these two treatments, we cannot be sure if the differences we see are because of the light or the heat.

3. Discuss with students which treatments are available on the online image library. Help them decide what questions they can ask, and which two treatments they should compare to answer those questions.

   Some possible questions are:
   - What is the difference between the germination of soaked seeds and unsoaked seeds?
   - What is the difference between the germination of seeds in the dark and seeds in the light?
   - What is the difference between the development of rotated and unrotated seeds?
   - Do unsoaked seeds grow differently in the dark and light?
   - What is the difference between the development of seeds in 24 hour light and those in 10 hours light?

4. Have students write their question, which treatments they will compare, and their predictions of what they might see.

5. Students should then observe and record changes in the two seed viewers using the worksheets.

6. Students should use the scale on the images and string or rulers to measure the different parts of the seedling. (If using rulers, they must remember to calculate and use conversion factors)

7. Measurements should be recorded and graphed
8. Have students present their methods, findings and the answer to their initial question to the class.

Activity 2:
Based on their results, students should have further questions. You can have them try their own experiments in the classroom using the same basic germination viewer.

Some experiments to try include:
- Effects of temperature (for each type of plant there is an optimum temperature where there is maximal germination, above and below that temperature not as many seeds germinate)
- Compare seeds of different sizes, they will have different responses to light and dark
- If gravity and light are coming from the same place (if the light source is coming from below), which will win, which way will the plant grow?
- If a seedling is continuously rotated (as on a turntable) will it know which way to grow? (This is similar to the problem of growing plants in space where there is no gravity)
- What happens to a seedling that has been grown in the dark when it is placed back in the light? What about one moved from the light to the dark? Chlorophyll is only produced in the light, how long does it take to be produced in noticeable quantities?

Evaluation:
Diagram labels (1)
Worksheet completion and report (2, 3 and 4)