

Garden Lesson – with Variables (Scientific Investigation)

Topic: What Are Seeds? (Germination)

Learning Points:

- Seeds are plants' way of continuing their species.
- Without seeds plants can't survive and therefore humans can't survive,
- Seeds grow in a variety of different environments but must have the key ingredients to germinate (grow into seedlings). The key factors are: water, oxygen, favorable temperature, and usually light.
- Unspoken learning point is students/parents can sow seeds indoors or outdoors at a relatively low cost and time commitment.

Common Core Standards:

Science: K-LS1-1: Use observations to describe patterns of what plants and animals need to survive.

Science: 2-LS2-1: Plan and conduct an investigation to determine if plants need sunlight and water to grow.

Science: 3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

Science: 4-LS1-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Science: 5-LS1-1: Support an argument that plants get the materials they need for growth chiefly from air and water.

Speaking and Listening K-SL3 thru 3-SL3: Ask and answer questions.....for understanding.

Lesson Plan Design Options:

There are many ways to design this lesson plan depending on class size, academic level, time allotment, space limitations, financial limitations, and/or core curriculum goals. The lesson could be as simple as having each student or group of students plant a couple of seeds in planting cells by following standard indoor or outdoor planting procedures with no other variables (water, temperature, light, soil, fertilizer, etc.) being introduced into the activity (See Lesson 2 – Basic). In fact, the Basic lesson plan could be used for lower grade level students. This lesson plan is for those students who are ready for a scientific investigation activity. We want these students to learn first hand what happens when you vary the environment (key factors). There is one control group (Group D) which follows standard indoor sowing practices. The remaining seven groups alter one or more of the key factors. The students will determine the success of seeds germinating when one or two of the key factors is removed or altered.

In addition, there are five different seed types (we chose lettuce, Kale, Mustard, Endive, and Spinach, but could use others instead). These seedlings will be transplanted into the outdoor garden to support subsequent garden lessons and eventually will be harvested for the school and/or community. You could elect to use only one seed type instead of five. We chose these plants because they are cool weather plants and address school cafeteria needs.

Items Needed: (Based on the described Lesson Plan with 120 students in 3 groups of 40 students each)

-4 sets of plant germination kits (each kit has 8 ea. 6-cell planting containers, a water tray, and a clear plastic dome cover) - dark material to cover Tray 3. -1 heating mat for one of the germination trays.

-Seeds (72 seeds for each seed type (crop) or a total of 360 seeds combined for 5 different seed types)

-starter soil mix (8 qts bag) -native soil (about 1 gal) -Jiffy planting pellets (15)

-3 containers to hold extra soil mix, native soil and Peat Moss -Germination fertilizer granules (1 oz bag)

-1/4 teaspoon measuring spoon - one gallon container

-Water - At least 2 small watering cans (light sprinkle type) -120 popsicle sticks or plant labels

-Optional: Grow lamp with stand (2 feet wide is standard), one extra heating mat, soil moisture meter, soil temperature gage, timer for heating mat and/or grow light.

Preparation: See Attachment – Please note that almost all of the preparation can and should be accomplished prior to the day of the instruction and activity (most can be done several days before).

Begin Class Instruction and Activity

Questions: (10 minutes)

1. Who can name a fruit that has seeds in it? (watermelons, apples, grapes, cherries, plums, tomatoes)
2. Why do you think these fruits have seeds? (so more plants with the same fruit can grow)
3. Do most plants have seeds (not just fruits)? (yes)
4. What do you think would happen if plants did not have seeds? (plants would eventually become extinct)
5. What would happen to us if plants became extinct? (we would become extinct as well because we rely on plants).

Statement: Seeds are important for plants survival as well as our survival.

Questions: (5 minutes)

1. What do you think seeds need(key factors) in order to grow into seedlings (young plants)? (water, oxygen, correct temperature, and usually light) – Refer to Germination handout (pages 30-31) for background reading.
2. What do you think would happen if the seeds did not get enough water, oxygen, light or the proper soil temperature? (the seeds would either not germinate (grow into seedlings) or would be small, weak seedlings and plants)) – Refer to Germination handout (pages 30-31) for background reading.

Statement: (1 minute)

- We are going to plant some seeds. They are lettuce, Kale, Mustard, Endive, and Spinach. (Refer to descriptions for each plant from The Vegetable Gardener's BIBLE)
- We will plant them indoors and eventually transplant them outdoors in our garden.
- Perhaps one day before school ends we will be able to eat some of these crops and share them with others.

Scientific Investigation Activity Explanation: (2 minutes)

We are going to conduct an experiment with these seeds.

- We will break up into groups of 5 students each. Groups named A through H. If you have a chart refer to it.
- Each student in each group will sow (plant) 2 seeds.
- Each group's seeds will be placed in a somewhat different environment. One group will water their seeds less than other groups. Some groups will use a different soil. One group will not allow seeds to get light. Another group(s) will use a heating mat to maintain warmer soil temperature. Over the next couple of weeks we will observe what seeds grow the best.

Activity Instructions: (12 minutes)

1. Time permitting, have students wash their hands before handling seeds.
2. Using the attached Experimental Design Graph page, give each group a planting container which will have 6 cells already filled with soil. You may choose to have already placed each student's label in their cell (see preparation for label instructions).
3. Place 2 seeds in front of each student and have them wait for further instruction (don't touch seeds).
4. Instruct students to select one of the cells as their own if you haven't already preselected it. There should be one extra cell for all groups. Do not plant seeds in these extra cells.
5. Have each student place both of their seeds into their one cell so that the seeds are somewhat separated but not near the edges of the cell. Be prepared to help students and give them extra seeds if needed.
6. Tell students not to press down on the seeds, just place them on the top of the soil.
7. Instruct students to take a small amount of extra soil and lightly sprinkle it over the seeds, just enough to cover them. Then lightly press down the newly added soil. Students can use the extra soil in the unused (6th) cell. Otherwise, use the extra soil designated for their group (native, starter mix, or Peat Moss).
8. Using a water can slightly moisten the soil on top, except Group G (no water).
9. If labels are not already placed in the students' cells instruct the students to stick their labels near one edge of their cell with their name facing outward.
10. Collect the planting containers and place them in the appropriate tray (see Experimental Design Graph) with students' names facing the front of the trays. Group A and G will need to be elevated in Tray 4 to be sure the bottoms of the planting containers are not touching any water in the tray.
11. After students turn in their planting containers and discuss their predictions (see Wrap Up) they will need to wash their hands.

Wrap up (Predictions):**Questions:** (5 minutes)

- Raise your hand if you think your group will have the healthiest seedlings. Ask students who raised their hands why they believe it. (Our group's seeds have all 4 key factors: water, oxygen, temperature, and light)
- Raise your hand if you think your group will have the weakest seedlings. Ask students who raised their hands why they believe it. (Our group's seeds are missing one or more of the 4 key factors) If a student says that the seeds without water will be the weakest or not germinate, this is an opportunity to restate the importance of water for seeds, plants, and humans.
- Note groups' predictions for future discussion (See Analysis and Discussion).

Follow Up Activities:

Below are the things you need to know and/or do during the days following the classroom activity.

- Water all the Groups' seed cells except for Group G. The soil must remain moist at all times but not excessively wet. The cells should be watered as needed during the morning hours and again around 5 pm each day. Use water can that lightly sprinkles the cells so not to disturb the seeds. You could use a moisture meter to ensure that the soil is moist in the middle of the cell. Be careful not to hit the seeds while checking the moisture level.
- Wipe off any condensation that develops on the inside of the clear plastic domes with paper towels or a cloth. Cover domes promptly.
- Once seedlings have sprouted two leaves, remove the domes and keep the seedlings in a location where they continue to get light. The exception would be Group F (no light group).
- If you are using a grow light keep the light about 3 to 4 inches above the plants. Adjust light as needed.
- In Tray 4 do not allow water above the height of the spacers since we do not want Groups A and G to get water from the Tray.
- Groups C and E should be given fertilized water only.
- If seedlings are bending over in one direction toward the light, turn the tray around so they can reverse direction.

Optional Investigation:

If you want to monitor the temperature and/or moisture level of the seedlings you should obtain the following items and measure, record, and perhaps graph your results.

- Using a soil thermometer measure the soil temperature in each group and record it. Do this daily or at least weekly and chart results. Consider measuring temperature in early morning (coldest period) and in afternoon to determine the range of the soil temperatures. Compare this with the suggested published range (see Preparation) for each crop.
- Using a moisture meter measure soil moisture in each group and record it. Do this daily or at least weekly and chart results. The moisture meter will indicate whether more water needs to be added. If so, follow the guidelines stated under Follow Up Activities. Record and perhaps graph your findings.

Analysis and Discussion:

Approximately two weeks after sowing seeds the groups should discuss their observations. This could be incorporated into the following gardening lesson plan as a transitional activity or done at any other convenient time.

- Bring groups together and remind them of their earlier predictions.
- What actually happened?
 - Seek observations from each group
 - Refer to any recorded information and/or graphs if completed (watering, temperature, etc.)
- Discuss possible reasons some seeds performed better than others
- Revisit the 4 key factors (water, oxygen, temperature, and light). Also did the different soils make a difference? Soil will be discussed in a different lesson.
- State that these key factors will continue to be important as the seedlings grow into mature plants.
- State that these seedlings will need more space for their roots to grow, so we will need to transplant them into larger containers or into the garden.

Transplanting seedlings:

Germination for the above described seeds should occur within one to two weeks. We would usually leave the seedlings in their existing planting cells for an additional two to three weeks (total of 4 to 5 weeks). At this point the seedlings should be transplanted into larger pots and kept inside if the weather is not conducive to planting outdoors. If the weather is conducive to planting outdoors the seedlings will need to undergo a two week "hardening off" process before planting them into the outside garden.

Hardening off is the process of gradually introducing the seedlings to the outdoor weather. This is accomplished in stages as follows: During the first week of hardening off, set seedlings outdoors during the warmer part of the day for a few hours in a sunny, protected area (no heavy wind, rain or excessive cold or heat). During the second week of hardening off leave the seedlings outdoors (day and night) in a sunny, protected area as long as the weather isn't excessively cold (freezing), hot, or excessively windy or rainy.

Be sure to check on the seedlings on a regular basis during the hardening off period to make sure they are not showing signs of stress (wilting, yellowing). If so, bring them indoors until conditions improve. By the end of the two weeks of hardening off the seedlings should have adapted well enough to the outdoors to be planted in the garden beds.

Preparation:

- The activity design is based on having 3 classes each with 40 students divided into 8 groups of 5 students.
- Determine whether any students have a “nut” allergy since the starter soil mix may contain some amount of nut product.
- Create a Chart showing the periods, groups, seed types and student names in case labels get removed from seed cells. Use the attached “List of Students” form to identify your groups.
- For lowest grades you could simply remove the scientific investigation design and have those students sow seeds and water according to standard practice. (see Lesson 2 – Basic, also article entitled: “Starting Seeds Indoors”).
- If using the Scientific Investigation design, students will be assigned to a group of 5 students who will follow specific directions. During the activity students will add seeds to pre-prepared planting cells. They will sprinkle a small amount of soil over the top of the seeds and then lightly sprinkle water over the cell soil, except for Group G (no water).
- Planting containers should be pre-made for each group (see Groups and Trays below – Also Experimental Design Graph) to save time.
 - Native dirt containers should be compacted well (Groups B and C) – want soil to be dense – less oxygen
 - Starter Mix containers (Groups D thru H) and Jiffy pellet containers (Group A) should be lightly compacted to allow greater oxygen at roots.
- Separate the planting containers from the trays. One container will be given to each group and then returned to the appropriate tray at the end of the activity.
- Pre-water all Groups’ cells except for Group G (No water group). This should be done at least two hours before the activity. The Jiffy pellets (Group A) will expand once water has been added. You could do this the afternoon or evening before if needed.
- After Jiffy pellets have expanded gently pull back the netting from the top of pellets – do not remove netting.
- Turn on heating mat for Groups B and D (Tray 1) at least 2 hours before activity. If you have a second heating mat, place it under Groups C and E (Tray 2). The mat(s) should warm to about 80 degrees. Keep mat(s) dry and on a flat surface. Keep it away from combustibles and liquids.
- Consider using a timer to maintain the correct soil temperature, which should be in the range of 60 to 70 degrees throughout the day and night.
- Have a water can available for each group except Group G (no water group). It is important that water is lightly sprinkled on top soil so that seeds are not displaced.
- In a 1 gallon container of water, add ¼ teaspoon of granular fertilizer –mix well. Label it “Fertilizer”. What the students in Group C and E don’t use during the activity will be used for daily watering of groups C and E cells.
- Use regular water for Groups A, B, D, F and H. You will use the excess water for daily watering of Groups A, B, D, F and H cells.
- Place spacers underneath Group A and G cells in Tray 4. This will elevate cells so that they don’t come in contact with water.
- Prepare extra soil (about a cup) for each group as follows:
 - Group A (Peat Moss)
 - Group B, C (native soil)
 - Group D – H (starter mix soil)
- Sort seeds in groups of 2 for each student. If using more than one type of seed (different crops) be certain all seed types are represented in all groups (have a different seed type for each student in a group).
- Create labels (or popsicle sticks) for each student that identifies their Group and seed type (if more than one used) on one side and student’s name and period on the other side. You can choose to place labels into cells before handing planting containers to the students.
- Given the suggested soil temperatures during germination (see next page), it appears that all seeds would germinate with soil temperatures between 60 degrees and about 70 degrees. Room temperatures are not necessarily the same as soil temperatures, so best to check soil temperatures using a soil thermometer.
- If using a grow light with a standard 2 feet wide stand, place Tray(s) 1 and 2 under grow light. If you don’t have a grow light, place Trays 1, 2, and 4 near a window that gets as much sun as possible.
- Using a timer with a grow light works best so that it automatically turns on and off each day, including weekends.

Groups:

- Group A: plant seeds using the Jiffy Green House pellets made of Peat Moss.
- Group B: plant seeds using native soil and no added fertilizer.
- Group C: plant seeds using native soil and added fertilizer.
- Group D: plant seeds using seed starter mix and no added fertilizer
- Group E: plant seeds using seed starter mix and added fertilizer
- Group F: plant seeds using seed starter mix and no light
- Group G: plant seeds using seed starter mix and no water
- Group H: plant seeds using seed starter mix with no heating mat

Trays:

- Tray 1: No Fertilizer - Groups B, D (has clear plastic dome) Optional grow light.
- Tray 2: Added Fertilizer - Groups C, E (has clear plastic dome) Optional grow light.
- Tray 3: No Light - Group F (Use a cover that blocks out light)
- Tray 4: No Heating Mat - Group H (has clear plastic dome) Optional grow light.
- Tray 4: Raised Planting Containers - Group A, G (elevate them above water with spacers)
 - Water Jiffy pellets with regular water if they get dry (turn light brown)
 - Do not water Group G

Suggested Germination soil temperatures and likely time frames for germination:

- Lettuce – 40 – 68 degrees (7-14 days to germinate)
- Kale – 40 – 70 degrees (5-10 days to germinate)
- Mustard – 65 – 70 degrees (4-6 days to germinate)
- Endive – 60 – 65 degrees (5 – 7 days to germinate)
- Spinach – 50 – 75 degrees (7 - 14 days to germinate)