Using the Scientific Method with FastPlants

Curriculum Guide for Implementation at JJK

Curriculum Notes

-Text written in blue is recommended teacher dialog.

-All documents referred to in material and text can be found here

-Two more lessons will be added at an alternative time to the beginning and end. These lessons will be developed to help incorporate a partnership with another classroom.

Lesson One

Lesson CODE:	**Topics:**	**Grade Level:**
TheScientificMethodWithFastPlants.FP/SM.ELM.1	- What is a scientist? - The scientific method - Planting seeds	K-3rd grade

Background/Previous Knowledge/Skill:

This is a beginner's lesson. Students do not need any previous knowledge to be successful. Some understanding of plants would be helpful such as plants grow from seeds, and plants need water and light.

Lesson Objectives:

1. Students can outline an experiment with FastPlants using the scientific method.
2. Students can identify the main steps to the scientific method.
3. Students can apply their knowledge about what plants need to grow by creating an experiment changing one of the plants needs into a variable.

Materials:

*quantity estimates for a class of 16

- 3 packets of FastPlants
- 2 Growing Trays
- 32 small pots
- Soil (Jolly Gardener recommended)
- Water Source
- Light Bank
- Draw a Scientist Worksheet (pre-survey)
- What I know About Plants Worksheet
- Scientific Method Worksheet

Standards:

NGSS: Students who demonstrate understanding can:

2-LS2-1. **Plan and conduct an investigation to determine if plants need sunlight and water to grow.** [*Assessment Boundary: Assessment is limited to testing one variable at a time.*]

Introduction: -Pre-assessment: Draw a Scientist -Scientist Introductions	Time Est.: 15 minutes
Direct Instruction: -Introduce the scientific method -Make Observations and create a question -Make a Hypothesis	Time Est.: 30 minutes
Activity: -Plant FastPlants	Time Est.: 15 minutes
Additional Resources:	

Introduction:

Draw a scientist:

1. Ask students to draw a picture of a scientist on the worksheet Draw a Scientist. Give the students access to colors. Do not prompt the students by showing them pictures or a scientist or describing the job of a scientist. Do not allow the scientist to enter the room during this activity.
2. Ask students to write their name on their picture and then collect the images.

Scientist Introductions:

1. Educators introduce themselves and their jobs. Simplify your job description (ex: I work with plants to see if I can make them grow bigger/stronger)
2. State the purpose of the visit "We are here to help you practice being a scientist. Over the next few weeks, we are going to run an experiment and learn something new from the results."
3. Emphasize to students that they too are scientists.

Direct Instruction:

Introduce the Scientific Method:

1. "We are going to practice being scientists by running an experiment using a set of steps that all scientists use when they want to answer a question." Start by asking students if they might know any of the steps of the scientific method or an experiment. Let students share all their ideas.
2. Show the following video about the scientific method: https://www.youtube.com/watch?v=KIFz_-KzURY

3. After the video, ask students what the five main steps of the scientific method are (1. Make an Observation, 2. Ask a question 3. Form a Hypothesis/Make a prediction 4. Make a Test/Experiment 5. Form a conclusion). As the students are listing the steps, write them on the board so that the list can be seen by the whole class and hand out the Scientific Method Worksheet.

Make Observations and create a question:

1. "Let's start at the beginning of the scientific method by making an observation.We are plant scientists so we are interested in knowing more about plants and how they grow."
2. Place students in small groups and give them a sheet of paper Called "What I Know about plants". Instruct students in their small groups to either write down a list or draw what they know about plants and seeds.
3. Ask the scientist to buddy up with a group of students. Instruct the scientists to ask students about what they are drawing/writing. In addition, the scientist can ask questions to help the students think deeper about plants such as:
    a. What do plants need to live? To grow?
    b. Are there different types of plants? Can you list some?
    c. Do plants have different parts?
4. Have students share some of their answers with the class and write some of their ideas on the Observation section of the Scientific Method Worksheet.
5. "Next step we are going to ask a question. We are going to plant a seed that turns into a plant called *Brassica rapa* or a fastplant. What are some questions we can explore about how a seed turns into a plant?"
6. Write students ideas on the board. If prompting is needed, ask students about what seeds need to grow and how might changing those things affect the growth? (potential dialog: You told me that plants need water to grow? How much water do you think a Fastplant seed needs to grow? What happens if we change the amount of water?)
7. Once a list is provided, the instructor should choose the question to pursue (or give the students the ability to vote on the question). It is recommended to choose a question about if seeds need light to grow or a question about amount of water to grow for easiest implementation. You could also split the class and do both questions. When the question has been developed, have them write it on the Scientific Method Worksheet.

Make a Hypothesis:

1. "Now that we have our question, we need to form a hypothesis or make a prediction. What is a hypothesis or a prediction" Allow students to turn and talk with the partner and then share their answers with the class.
2. In their small groups, ask students to look at their question and make a prediction/hypothesis. Give an example to the students both verbally and on the board. Possible example: If my question is Does drinking milk make people taller, my prediction/hypothesis might be If someone drinks milk everyday, then they will be really tall.

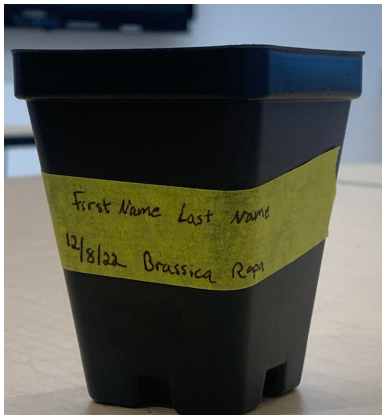
3. Have the scientist talk with the students while they are developing their hypotheses. Scientists should ask the students what made them think of their hypothesis and why they think it is true.
4. Have students share their hypotheses with the whole class and then write them on their Scientific Method Worksheet. It is okay for students to have different hypotheses.
5. "Finally it is time to test if our hypothesis or prediction is true. To do this we are going to design an experiment. How might we find out the answer to our question?"
6. Lead students through a discussion about the steps to their experiment. Explain that one set of plants will get one condition (such as light or water everyday) and another set of plants will get the other condition (such as dark or water every three days). Allow students to ask questions about the experiment or share ideas on what they would do.

Activity:

Plant FastPlants(*Brassica rapa)*

1. Set up: The experimental treatments are the environmental conditions (light versus dark; and well -watered versus not well watered). The teacher should prepare the classroom space for the planting activity by setting aside stations/areas for implementing the environmental conditions that will be kept completely dark and one that will receive light over several days. If students choose to change the environmental condition of the amount of water, dedicate two separate leveled classroom spaces that can hold pots planted with seeds and watered at different frequencies. Label each station with one of the respective treatment conditions (light, dark, well watered or non well- watered). In addition, it recommended to pre-fill the pots for the students with soil.
2. Give each student two pots and four seeds for planting. Have scientists help with seed distribution.
3. Demonstrate to the students how to plant. Show the students that they will poke two holes in each pot, about an inch deep. They will then put one seed inside each hole and cover it with soil. Ask the students to repeat the directions back to you throughout the demonstration to ensure understanding. Ask the scientist to monitor planting for accuracy

4. Once students have planted their seeds, now they need to water. Hand out spray bottles filled with tap water to each group and instruct the students to spray the top of each planted pot with water.
5. Have the students write their names on a piece of tape, and attach the tape to the side of their pots so they can identify which plants are theirs.
6. On a second piece of tape, have students write down the common name of their plant, and the date of planting and attach the second piece of tape to their pots



7. Have the students take their pots to the prepared classroom stations dedicated to the activity, each station should have clean labeled potting trays (Each student should place one pot at the station that will receive light and the second to the dark station or each student should place one pot at the station that will receive water everyday and the second pot at the station that will be watered every three days depending on what conditions the students as a class decided to investigate).
8. If the students are experimenting with the environmental condition of frequency of watering, discuss the watering schedule with the whole class. Indicate to the students that watering their plants will be a classroom responsibility that needs to be completed when they first arrive to the classroom in the morning. Students will water their plants in one tray everyday. In the other tray, the students will water the plants every three days. Watering the plants will include students using tap water in a spray bottle and spraying the plants with 10mL of tap water (the teacher should make sure students are given the correct amount of water or help them use the measurements on the side of the spray bottle to show how much water is being used. The teacher can also set up alternative watering cans for better accessibility). Excess water will drain in the tray below the pots.
9. If the students are experimenting with the environmental condition of light, discuss the light bank and darkness schedule with the whole class. Indicate to the students that the light bank should be turned on when they first enter the classroom for the day and turned off when they leave the classroom at the end of the school day. In addition, the plants in the dark condition should stay in the dark condition at all times (plants can be taken out of the dark for watering if necessary. Both the plants in the light condition and the dark condition should be watered every other day. The plants should be watered in the

morning when the students first arrive into the classroom. Watering the plants will include students using tap water in a spray bottle and spraying the plants with 10mL of tap water (the teacher should make sure students are given the correct amount of water or help them use the measurements on the side of the spray bottle to show how much water is being used. The teacher can also set up alternative watering cans for better accessibility). Excess water will drain in the tray below the pots.

10. Remind students that watering the plants that they planted is a classroom responsibility. The students should take care of their plants in between the times of the scientists visits.
11. Have the students clean up their planting areas.
12. End the lesson by students drawing how they set up their experiment on their Scientific Method Worksheet. Scientists can guide the students to help make sure they include the amount of water, seeds, two different pots, and any other important information.
13. Remind the students that we will be following up at the same time next week and that we will be checking on their plants.
14. End lesson.

Lesson 2

Lesson CODE:	Topics:	Grade Level:
CollectingDataWithaRuler.FP/SM/LS.ELM.2	- Measuring with a ruler - Data Collection	K-3rd grade

Background/Previous Knowledge/Skill:

Students will need to have planted FastPlants (*Brassica rapa)* and started an experiment adjusting the variables of light or water in order to complete this lesson. In addition, some experience with using a ruler for measurement would be beneficial. A pre-lesson about measurement is advised. If no pre-lesson can occur, make sure there are enough educators to help students practice in small groups or one on one.

Lesson Objectives:

1. Students can use a ruler to measure plant height and record their measurements in standard units.
2. Students can make observations about plant growth.

Materials:
*quantity estimates for a class of 16

- Three packets FastPlants
- 32 small pots
- 2 Growing Trays
- Soil (Jolly gardener recommended)
- Water Source
- 1 Light Bank
- 16 Ruler
- Scientific method worksheet
- Plant Measurement Worksheet
- Variety of seeds (at least 5 different kinds, type depends on availability), whole and cut in half
- 16 Hand lenses
- Parts of a Seed Worksheet

Standards:

NGSS: Students who demonstrate understanding can:

2-LS2-1. **Plan and conduct an investigation to determine if plants need sunlight and water to grow.** [*Assessment Boundary: Assessment is limited to testing one variable at a time.*]

Introduction:
-Tracking Plants Growth

Time Est.:

15 mins

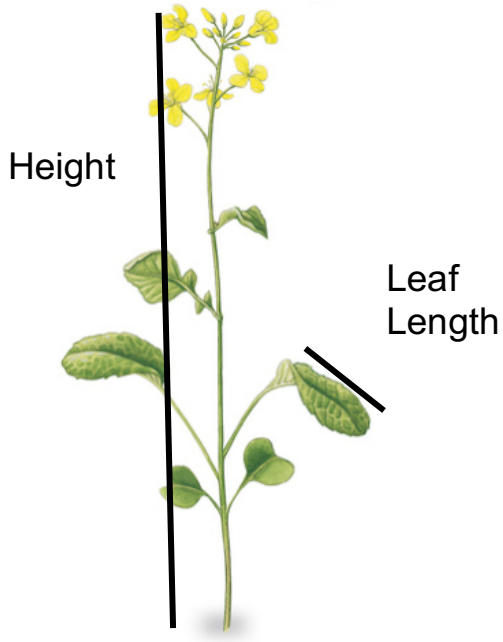
Direct Instruction: -Measuring Student's Plants	Time Est.: 15-45 mins *Measuring takes longer with less experience
Activity: -What Is a Seed? -Seed Exploration -Seed Knowledge Connects to Experiment	Time Est.: 30 mins
Additional Resources:	

Introduction:

Tracking Plants Growth:

1. Start the lesson with a re-introduction of the scientists, their jobs, and the purpose of their classroom visit.
2. Request the scientists to sit with the students at their tables(Have them sit with the same students as last session if possible)
3. Pass around the Scientific method worksheet from the last lesson and review the question, prediction/hypothesis, and test design. Have the students remind their scientists and the class about what experiment was chosen and why.
4. Ask students to gather around their different trays of seeds/plants. Have them point out observations of changes that occurred between planting the seeds to -date .
5. Ask the students "How can we tell how much bigger our plants are each day?" Students might suggest measuring how tall, wide, counting leaves, or seeing how healthy the plant looks.
6. Explain to the students that we will be collecting data or measuring how much our plant has grown in many different ways. "The next step in the Scientific Design process is to collect data in order to make a conclusion. What does the word data mean? (allow a few students to supply answers). Data is observations we can make about how the plant grows. We are going to collect a few types of data such as how tall the plant is in centimeters, how many leaves the plant has, and how healthy the plant looks. Later when we have collected all the data on your plants, we will be able to look at the numbers and understand how well the plant grew in the different conditions (be specific about the conditions whether it is changing the amount of light or water). First we need to practice before collecting data on our own plants."

7. Back at their desks, have students practice measuring with rulers a picture of a full grown FastPlant. Instruct students to measure using the centimeter side of the ruler. If possible, project the image at the front of the classroom and demonstrate how to measure the plant. Ensure that students are measuring from the base of the plant to the top of the flower. In addition, measure the length of the leaf from the start of the stem to the end of the leaf using the International System (SI) or metric system units.



8. While students are measuring on their worksheet, scientists should walk around the classroom to make sure they are practicing the skills correctly. Allow students to estimate to the nearest cm when necessary.

Direct Instruction:

Measuring Student's Plants:

1. Once students have mastered measuring on paper, pass out the plants to the students. Each student should measure their plants from each environmental condition and record their findings on the Plant Measurement Worksheet.
2. While students are measuring their plants, instructors and scientists should walk around the classroom and help those who need it.
3. When all the students have completed their data collection, ask the class if there are any observations they think are important or any patterns they found. Allow students to express their ideas.
4. Remind students that their plants will be measured again at the next meeting for their growth progression over two weeks.

Activity:

What is a seed?:

1. "When we started growing our plants, we first planted a seed. What is a seed?" Allow several students to answer the question and conduct a class discussion. Write a definition using student ideas on the board.
2. From the formed definition ask two more questions: "What do you think is inside of a seed? How does seed grow into a plant? (what does a seed need to grow?)" Again allow for several students to answer with their ideas.
3. Hand out the worksheet on "parts of a seed". Instruct students that they are going to label and color the seed together with the teacher .
4. First label and color the seed coat. Provide students with the location and purpose of the seed coat.
5. Next label and color the embryo. Provide students with the location and purpose of the embryo.
6. Finally label and color the cotyledon. Provide students with the location and purpose of the cotyledon (you can also allow students to label this "food store".)
7. Once the worksheet has all the labels and is colored, ask students again, "what do seeds need to grow into plants"?

Seed Exploration:

1. Divide students into small groups. In each group, give the students magnifying glasses and a variety of different types of seeds (provide two of each seed, one whole and one cut in half).
2. Instruct student groups to identify the different parts of the seed. Instructors walk around the room to hear the students thoughts and ask them about their observations of the seeds.

Seed Knowledge Connects to Experiment:

1. Ask students "Based on what you learned about seeds and how your plants looked today, what do you predict your plants will look like next time we meet?" Have them talk about their predictions to the classmate next to them first.
2. Allow students to share their predictions to the whole class. Ask them why they think their predication will happen. Have students vote on if they agree or disagree with the shared prediction. For example "Raise your hand if you agree with Brandon that the plants which get more sunlight are going to be even bigger next week."
3. Wrap up the lesson by letting students know that next week the experiment will be finished and their predictions checked.

Lesson Three

Lesson CODE: DevelopingaConclusion.FP/SM/LS.ELM.3	Topics: - Measuring with a ruler - Data Collection and interpretation - Graphing	Grade Level: K-3rd grade

Background/Previous Knowledge/Skill:

Lesson Objectives:

1. Students can use a ruler to measure plant height.
2. Students can make observations about plant growth and develop a conclusion statement.
3. Students can use their data to make a graph.

Materials: *quantity estimates for a class of 16 - Three packets of FastPlants - 2 Growing Trays - 32 small pots - Soil (Jolly gardener recommended) - Water Source - 1 Light Bank - 16 Rulers - Scientific method worksheet - Final Plant Data worksheet - FastPlant Graphing worksheet - Draw a Scientist Worksheet	Standards: NGSS: Students who demonstrate understanding can: **2-LS2-1.** **Plan and conduct an investigation to determine if plants need sunlight and water to grow.** [*Assessment Boundary: Assessment is limited to testing one variable at a time.*]

Introduction: -Final Measurements -Class Data	Time Est.: 15-30 mins *Depends on student experience

Direct Instruction: -Graphing	Time Est.: 15-30 mins *Depends on student experience
Activity: -Writing a Conclusion -I am a Scientist	Time Est.: 30 mins
Additional Resources:	

Introduction:

Final Measurements:

1. Start the lesson with a re-introduction of the educators, their jobs, and the purpose.
2. Inform students that they will be collecting final measurements of their plants progress.
3. Hand out the students' plants, one plant from each environmental treatment .
4. Assign scientists to students that they worked with from the week before to assist with the measuring plants. Students should record their measurements on the Final Plant Data worksheet.
5. While students are taking measurements, instructors should walk around the classroom to make sure measurements are being done correctly.
6. When students are finished taking measurements, have them return to their seats.

Class Data:

1. Allow students to help write the data on a classroom white board or you can have them report it to you to write on the classroom board by trays and conditions..
2. Inform the students that they need to find out what the data from the measurements is showing us by looking for patterns and outliers (big differences). This is called “analyzing data”.
3. Ask students what patterns they see. Have them talk in small groups first and then report their answers to the class. When the students talk about the patterns they see, use colored markers to highlight the patterns that they point out .
4. Instructors may need to ask follow up questions to help students point out patterns and make connections between the different applied conditions and the data.

Direct Instruction:

Graphing:

1. Hand out the FastPlants Graphing worksheet.
2. Instruct students to look at the example graph displayed on the worksheet. Ask students "Why do you think scientists make graphs?" Allow several students to answer. Some answers might include having a picture, to show the end numbers better, or so other people understand. Scientists can add their thoughts on why they use graphs to help show importance.
3. Depending on the student background, the instructor might need to explain how to read and construct a graph. Using the example graph, point out to the students that the numbers on the side (y-axis) are how tall the plants grew. The numbers on the bottom (x-axis) represent each of their four plants. The different color bars show which plant received which treatment. Finally, how high each bar goes up shows the height of each plant. In small groups with their scientist pair, have the students practice reading the example graph.
4. Once students are able to show that they can read a graph, allow students to make a graph of their own using the template provided. Students will use their height data which is highlighted on their Final Plant Data worksheet. Have the scientist work with their students to help them draw graphs correctly.
5. When students have finished making their graphs, use student examples at the front of the room. With each student example, ask the class how tall each of the plants were based off of the graph ("How tall is Jane's Plant #1?") and is there a difference between the plants with different conditions ("Do you see a difference between the plants height that got water everyday and the plants height that got water every three days?").
6. Go through at least four student examples so that students can have practice finding patterns and reading graphs.

Activity:

Writing a Conclusion:

1. Tell the students "Now that we have found patterns in the data that we collected by measuring our fast plants, we need to write a conclusion. A conclusion is our final thoughts on the experiment and should answer our question and say if our hypothesis was correct or not. We are going to write our conclusions together."
2. First, have students look at their Scientific Method worksheet at the questions and hypotheses they made. With the classmate next to them,, have the students discuss if they now have an answer to their question. Once they have discussed, have students share their answers to the whole class.
3. Write the sentence starter on the board: I have learned____ Fill in the remainder of the sentence with what students developed as an answer to their question. (ex: I have learned that plants need light to grow or I have learned that seeds need water to grow into plants). Have students copy the sentence onto their Scientific Method worksheet.
4. Next, have students discuss with their shoulder partner if their hypothesis was correct. Let the students know that it is okay if their hypothesis was wrong because they still

learned something (adding in a personal experience about when a scientist hypothesis was wrong will help show students that it is normal).

5. Have students share whether their hypothesis was correct with the class and how they know. Make sure students have an explanation as to how they have figured out if their hypothesis was correct. Instructors might need to direct students back to the data to help make the connection.
6. Using the sentence starter: My hypothesis was_____ because_____. Write the students' answers on the board and have them copy the sentence onto their scientific method worksheet.
7. If time allows, students can add to their conclusions with sentence starters: Other observations I made are_____ or Something I still have a question about is_____
8. Congratulate the students on finishing the experiment and writing a great conclusion. Instructors can connect this to the job of a scientist by letting students know that all their work on the Scientific Method worksheet is the process scientists go through and then would publish for other people to read.

I am a Scientist:

1. “Now that you have practiced being a scientist for three weeks and have gone through the whole scientific design process, do you think you have gained new skills to be a scientist? I am going to give you back a button that you can wear. It says I am a Scientist! After all the work we have done together, I think you can proudly call yourself a Scientist. Congratulations.”
2. Hand out buttons to each student.
3. Inform the students that there is one last task that they need to do before you go. Hand out the Draw a Scientist blank worksheet.
4. Tell students that you would like them to draw a scientist. Let them know that they can use colors. Have scientists remove themselves from this activity in order to prevent bias.
5. Collect images at the end as part of the post-activity analysis.
6. Thank the students for their hard work as scientists, end the lesson, and say goodbye.