Module 2: Plants
2nd Grade

About the Instructions:

This document is intended for use by classroom teachers, SciTrek leads, and SciTrek volunteers. The document has been composed with input from teachers, leads, volunteers, and SciTrek staff to provide suggestions to future teachers/leads/volunteers. The instructions are not intended to be used as a direct script, but were written to provide teachers/leads/volunteers with a guideline to present the information that has worked in the past. Teachers/leads/volunteers should feel free to deviate from the instructions to help students reach the learning objectives of the module. Places in which you can be creative and mold the program to meet your individual teaching style, or to meet the needs of students in the class are: during class discussions, managing the groups/class, generating alternative examples, and asking students leading questions. However, while running the module make sure to cover all the material each day within the scheduled 60 minutes. In addition, no changes should be made to the academic language surrounding observations or the Observation Activity.

Activity Schedule:

Day 2 must occur at least 4 days after Day 1.

Day 1: Observation Activity/Observations/Question/Materials Page (60 minutes)*
Day 2: Experimental Set-Up/Procedure/Results Table/Experiment (60 minutes)*
Day 3: Experiment/Graph/Results Summary (60 minutes)
Day 4: Poster Making (60 minutes)
Day 5: Poster Presentations (60 minutes)
Day 6: Draw a Scientist/Tie to Standards/Content Assessment (60 minutes)*

*This schedule assumes the teacher has given the Observation Assessments before SciTrek comes on Day 1 and Day 6 of the module and has done the Technique Activity before SciTrek comes on Day 2.

The exact module dates and times are posted on the SciTrek website (http://www.chem.ucsb.edu/scitrek/elementary) under the school/teacher. The times on the website include transportation time to and from the SciTrek office (Chem 1105). Thirty minutes are allotted for transportation before and after the module, therefore, if a module was running from 10:00-11:00 then the module times on the website would be from 9:30-11:30.

Student Groups:

Students are divided into four groups of ~five students each for the entire module. One volunteer is assigned to help each group. We find groups work best when they are mixed levels and mixed language abilities.

NGSS Performance Expectation Addressed:

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

Common Core Mathematics Standards Addressed:

2.MD-4 Measurement and Data (Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.)
2.MD-9 Measurement and Data (Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same
object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.)

2.MD.10 Measurement and Data (Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph.)

Learning Objectives:

1. Students will be able to list at least two variables that affect plant growth.
2. Students will be able to use a ruler to make repeated measurements of an object and compare them to determine the difference in measurements.
3. Students will be able to graph and interpret data.
4. Students will be able to generate at least three observations about a given system and identify statements that are not observations.
5. Students will be able to list at least one way that they behaved like scientists.

Classroom Teacher Responsibilities:

In order for SciTrek to be sustainable, the program needs to work with teachers on developing their abilities to run student-centered inquiry-based science lessons on their own in their classrooms. As teachers take over the role of SciTrek lead, SciTrek will expand to additional classrooms. Even when teachers lead the modules in their own classrooms, SciTrek will continue to provide volunteers and all of the materials needed to run the module. Below is a sample timeline for teachers to take over the role as the SciTrek lead.

* Groups are made up of ~five students.

1. Year 1
   a. Classroom teacher leads a group (Role: Group Lead; this role is referred to as a volunteer in these instructions)

2. Year 2
   a. Classroom teacher co-leads the modules with a SciTrek staff member (Role: Co-Lead)
      i. Classroom teacher will be responsible for leading entire class discussions (Ex: Observation Activity).
      ii. Classroom teacher will be responsible for time management.
      iii. Classroom teacher will be responsible for overseeing volunteers and helping any groups that are struggling.
      iv. Classroom teacher will be responsible for all above activities, the SciTrek co-lead will only step in for emergencies.
      v. The SciTrek co-lead will run the Tie to Standards Activity.

3. Year 3 and beyond
   a. Classroom teacher leads the modules (Role: Lead)
      i. Classroom teacher will be responsible for leading entire class discussions (Ex: Observation Activity).
      ii. Classroom teacher will be responsible for time management.
      iii. Classroom teacher will be responsible for overseeing volunteers and helping any groups that are struggling.
      iv. A SciTrek staff member will co-lead the Tie to Standards Activity with the classroom teacher for year 3.

SciTrek staff is counting on teacher involvement. Teachers should notify the SciTrek staff if they will not be present on any day(s) of the module. Additional steps can be taken to become a SciTrek lead faster than the proposed schedule above. Contact scitrekelementary@chem.ucsb.edu to learn more.
In addition, teachers are **required** to come to UCSB for the module orientation, ~one week prior to the start of the module. Contact scitrekelementary@chem.ucsb.edu for exact times and dates, or see our website at http://www.chem.ucsb.edu/scitrek/elementary under your class’ module times. At the orientation, teachers will go over module content, learn their responsibilities during the module, and meet the volunteers that will be helping in their classroom. If you are not able to come to the orientation at UCSB, you must complete an online orientation. Failure to complete an orientation for the module will result in loss of priority registration for next year.

**Prior to the Module (at least 1 week):**

1. Come to the SciTrek module orientation at UCSB.
2. Inform SciTrek staff if your class uses any method of subtraction other than what is shown below.

![Results Table]

**During the Module:**

*Note: We **highly recommend** that you complete the initial Observation Assessment prior to **Day 1** of the module, the Technique Activity prior to **Day 2** of the module, and the final Observation Assessment prior to **Day 6** of the module.*

If possible, have a document camera available to the lead every day of the module. If you do not have a document camera, please tell the SciTrek staff at orientation.

**Days 1-4:**

Have the students’ desks/tables moved into four groups and cleared off. This ensures that each student has a desk during SciTrek activities and that students can begin the module as soon as SciTrek arrives.

**Days 2-3:**

Have a spot in your classroom where 7 lights can be plugged in (at least 3 plugs, we will provide extension cords) and placed on top of ~5 Xerox boxes. These lamps need to be kept on until the next SciTrek meeting.
Days 5-6:
Have the students’ desks/tables cleared off. The desks/tables do not need to be moved into groups.

Scheduling Alternatives:

Some teachers have expressed interest in giving the students more time to work with the volunteers throughout the module. Below are options that will allow the students more time to work with the volunteers. If you plan to do any of the following options, please inform the SciTrek staff no later than your orientation date (~one week before your module, exact orientation times are found at: http://www.chem.ucsb.edu/scitrek/elementary). This will allow the SciTrek staff to provide you with all needed materials.

Day 1:
If you would like to have more time for your students to make observations and choose their changing variable, you can do one or both of the following activities before SciTrek arrives:
1) Observation Assessment (highly recommend)
2) Observation Activity

Day 2:
If you would like to have more time for your students to design their experiments, you can go over the Technique Activity before SciTrek arrives (highly recommend).

Day 5:
If you would like to have more time for your students to discuss their experiments during poster presentations, you may take more time for each presentation and finish the presentations after SciTrek leaves.

Day 6:
If you would like more time for the Tie to Standards Activity, you may give the Observation Assessment before SciTrek arrives (highly recommend).

Materials Used for this Module:

1. Wisconsin Fast Plants 200 seeds per pack (Amazon)
2. 9 oz Clear plastic cups (Smart and Final) with 0.5 inch hole drilled in the center of the bottom
3. 20 oz Clear plastic cups (Smart and Final)
4. 3 oz Cups any material (grocery store)
5. Multipurpose terry towel 14 in x 17 in (Home Depot) cut into 5 cm x 15 cm pieces
6. Kellogg’s Raised Bed and Potting Mix (Home Depot)
7. Vermiculite (Home Depot)
8. Aquarium rocks (Petco)
9. Water
10. Sugar solution (mixture with half Karo light corn syrup and half water)
11. Saturated salt solution (boil water and then add in as much salt as you can get to dissolve in the solution—about 36 g of salt for every 100 mL)
12. Fertilizer liquid (Boreal Science part number: 8202104)
13. Nalgene graduated cylinders 100 mL (Fisher part number: 08-572D)
14. Nalgene graduated cylinders 250 mL (Fisher part number: 3663-0250)
15. Disposable pipets (droppers) (Fisher part number: 13-711-7M)
16. Metric Ruler 30 cm/300 mm (Carolina Biological part number: 702613) Note: Cover cm part with masking tape so students measure in millimeters.
17. Individual Plant Light (Carolina Biological part number: 666900)
18. Light bulbs (60 W equivalent LED (800 lumen) light bulbs) (Philips part number: 046677455507) Make sure that you use LED light bulbs because the seeds will not grow as well if you use a different light bulb.

19. Extension Cord

20. Boxes for different amounts of light are hand-made by taking a Xerox box and cutting an 11.5 cm diameter hole in the top of the box (when the box is on its side) and taping on a 13 cm x 14 cm polarizing filter over the hole (Education Innovations part number: PF-12). The different amounts of light are then made by having the 800 lumen LED bulbs go through: one filter (level 4), two filters that are aligned (level 3), two filters that are 45° to each other (level 2), and two filters that are 75° to each other (level 1). All filters are taped to the top of the box so that they will not move. Another Xerox box is available with no holes to provide a dark environment (level 0). A picture of one of the boxes is shown below.

All printed materials used by SciTrek (student notebooks, materials pages, lead picture packet, poster parts, instructions, and nametags) can be made available for use and/or editing by emailing scitrekelementary@chem.ucsb.edu.

Module Notes:

~7 days prior to Day 1 of the module:
Plant the seeds for the original observation ~7 days before the first day of the module. Take 12, 9 oz (medium) cups with 0.5 in hole in the in the center and insert a 15 cm × 5 cm piece of towel through the hole, so that there is ~4 cm sticking into the medium cup and ~11 cm hanging out. Place the medium cups into 20 oz (larger) cups. Fill each medium cup with soil: 4 set-ups of each of the following (12 set-ups total): a) ~9 oz potting soil (this compacts to ~6 oz once water is added), b) ~6 oz vermiculite, and c) ~6 oz aquarium rocks. Put 2 seeds, no more than 0.5 cm below the soil, in each of the medium cups and pour 200 mL of water over them. Place the cups under constant light until the start of the module. On the day of the module, if both seeds have sprouted, remove one sprout so that there is only one plant per cup.

3 days prior to Day 2 of the module:
Use the same set-up as above to make cups with the requested number of plants in potting soil and vermiculite. We suggest planting ~10% more than the requested number of plants cups in case some seeds do not sprout. Put 2 seeds in each of the cups and pour ~120 mL of water over them. Place the plants under constant light. On the day of the module, remove the excess water in the large cup and, if both seeds have sprouted, remove one sprout so that there is only one plant per cup.
Types of Documents:

Student Notebook:
One given to every student and is filled out by the student. In these instructions, the examples are rectangular and filled out in black. The lead will use a student notebook to write in as an example for students. The notebook that the lead uses is referred to as the class notebook in these instructions.

Notepad:
One given to every group and is filled out by the volunteer. In these instructions, the examples are squarer and filled out in blue.

Picture Packet:
One per class that, if needed, the lead fills out. In these instructions, the examples are rectangular, labeled, and, if applicable, filled out in blue.

In these instructions, all other example documents are labeled.

Day 1: Observation Activity/Observations/Question/Materials Page

Note: We highly recommend that teachers complete the Observation Assessment prior to Day 1 of the module. The suggested times in the lesson plan below are assuming that the Observation Assessment was given prior to SciTrek arriving.

Schedule:

Times if teacher gave assessment prior to SciTrek:
Introduction (SciTrek Lead) – 2 minutes
Observation Activity (SciTrek Lead) – 12 minutes
Observation Discussion (SciTrek Lead) – 7 minutes
Observations (SciTrek Volunteers) – 17 minutes
Question Discussion (SciTrek Lead) – 3 minutes
Question (SciTrek Volunteers) – 11 minutes
Materials Page (SciTrek Volunteers) – 6 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Times if SciTrek must give assessment:
Introduction (SciTrek Lead) – 2 minutes
Observation Assessment (SciTrek Lead) – 5 minutes
Observation Activity (SciTrek Lead) – 12 minutes
Observation Discussion (SciTrek Lead) – 7 minutes
Observations (SciTrek Volunteers) – 16 minutes
Question Discussion (SciTrek Lead) – 3 minutes
Question (SciTrek Volunteers) – 9 minutes
Materials Page (SciTrek Volunteers) – 4 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Materials:

(4) Volunteer Boxes:
☐ Student nametags
☐ (7) Student notebooks
☐ Volunteer instructions
☐ Volunteer lab coat
☐ (3) Materials pages (one for each possible variable, 3 total)
☐ (2) Pencils
☐ (7) Mechanical pencils
☐ (2) Wet erase markers
☐ Scotch tape
☐ Paper towels

Other Supplies:
☐ (4) Large group notepads
☐ (4) Trays
☐ Lamp with 750 lumen LED bulb
☐ (4) Just made cups set-up with potting soil (labeled A)
☐ (4) Just made cups set-up with vermiculite (labeled B)
☐ (4) 7 Days old cups set-up with potting soil (labeled 1)
☐ (4) 7 Days old cups set-up with vermiculite (labeled 2)
Bucket with lid

Lead Box:
- (3) Blank nametags
- (3) Extra student notebooks
- Lead instructions
- Plants picture packet
- Lead lab coat
- Observation Assessment (if teacher did not take assessments then (25 assessments and (25) cotton balls)
- Time card

- (4) Just made cups set-up with rocks (labeled C)
- (4) 7 Days old cups set-up with rocks (labeled 3)
- (3) Materials pages (one for each possible variable, 3 total)
- (2) Pencils
- (2) Wet erase markers
- (4) Markers (orange, blue, green, purple)
- Scotch tape
- Paper towels
- Water (at least 200 mL)
- (3) 100 mL Graduated cylinders
- (2) 250 mL Graduated cylinder
- 20 oz Cup unmarked
- 9 oz Cup with hole in bottom
- (2) 3 oz Colored cups
- Cloth strip
- Vermiculite
- Dropper
- (2) Polarizing filters

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**Notebook Pages, Notepad Pages, and Picture Packet Page:**

<table>
<thead>
<tr>
<th>Observations</th>
<th>Not Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of things using:</td>
<td>incorrect observations</td>
</tr>
<tr>
<td>sight</td>
<td>opinions</td>
</tr>
<tr>
<td>touch</td>
<td>inferences</td>
</tr>
<tr>
<td>hearing</td>
<td></td>
</tr>
<tr>
<td>smell</td>
<td></td>
</tr>
<tr>
<td>taste</td>
<td></td>
</tr>
</tbody>
</table>

**Observation:** A description using your __5 senses__

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**Page 1, Picture Packet**
It is recommended that instead of using this picture packet page that the lead write this chart on the board so students can refer to it while completing the Observation Activity on page 2 of their notebook.

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**Student Page**
SCIENTIFIC PRACTICES
Observations
Observation: A description using your 5 senses

Circle OBSERVATION if the statement is an observation you can make about the object. Circle NOT AN OBSERVATION if the statement is not an observation you can make about the object.

1. The object is smaller than a jump rope. Observation: Not an Observation
2. The object is made out of metal. Observation: Not an Observation
3. The object is hotter than boiling water. Observation: Not an Observation
4. The object is simple. Observation: Not an Observation
5. The object has a pointed end. Observation: Not an Observation
6. The object can be twisted at one end. Observation: Not an Observation
7. The object has been used to write many words. Observation: Not an Observation

Circles are your initial thoughts and boxes are the correct answers.

Lead Page

CUP A:
- Potting Soil
- Water is dirty
- Soil is damp

CUP B:
- Vermiculite
- Water is clear
- Soil is damp
- Least amount of water in large cup
- Soil absorbed the most water

CUP C:
- Soil
- Water is clear
- Soil is dry
- Most amount of water in large cup
- Soil absorbed the least water

Other Observations:

CUPS 7 DAYS OLD

CUP 1:
- Potting soil
- Soil is wet
- Largest plant

CUP 2:
- Vermiculite
- Smallest plant
- Soil absorbed the most water

CUP 3:
- Rocks
- Rocks are dry
- No plant growth
- Soil absorbed the least water

Other Observations:
Preparation:

SciTrek Lead:
1. Get the Observation Assessments from the classroom teacher and put them in the lead box.
2. Make sure volunteers are writing their name and group color on the whiteboard.
3. Make sure volunteers are passing out nametags.
4. Make sure volunteers are setting up for the initial observation. Details of how to do this are on a picture in the volunteer boxes.
5. If the classroom has a document camera, ask the teacher to use it for the Observation Activity (page 1, picture packet and page 2, student notebook). If the classroom does not have a document camera, then tape the poster-size notebook page to the front board.
6. It is recommended that you copy page 1 of the picture packet onto the board. This way students can look at this observation chart while they are doing the Observation Activity.
7. Assemble the experimental set-up demonstration.
   a. Fill two 100 mL graduated cylinders with 100 mL of water each.
   b. Fill two 3 oz. cups completely full of vermiculite.
   c. Plug in the lamp.
   d. Set out materials above and large cup, medium cup with hole, and cloth strip where students can see.
8. Have two polarized filters and a 250 mL graduated cylinder available to show students during the observation discussion.

SciTrek Volunteers:
1. On the front whiteboard in the classroom, write your name and the color of the group (orange, blue, green, or purple) you will be working with.
2. Pass out student nametags.
3. Assemble the experimental set-up (shown in picture below) on a tray.
a. Get three plants (one of each: 1) potting soil, 2) vermiculite, 3) rocks) that are 7 days old and place on tray.

b. Get three plants (one of each: A) potting soil, B) vermiculite C) rocks) that were just made and place on tray.

4. Have notebooks and mechanical pencils available to pass out.

**Introduction:**

(2 minutes – Full Class – SciTrek Lead)

If they have not done so already, have volunteers write their name and group color on the front whiteboard, and then get student nametags out of their group box and walk around the room quietly setting each student’s nametag on their desk. After, they should assemble the experimental set-up.

For UCSB Lead:
“Hi, we are scientists from UCSB and we want to show you what we do as scientists. We will show you an experiment and then you can make observations and design your own experiment to help answer the class question. We want to show you that you can do science and have fun.”

For Teacher Lead:
“I have asked some scientists from UCSB to come and help us with a long-term science investigation. We will make observations, come up with a class question, and you will design your own experiment to help answer the class question.”

Allow the UCSB volunteers to introduce themselves and share their majors.

**Observation Assessment:**

(5 minutes – Full Class – Given By Classroom Teacher Prior to SciTrek)

“Before we start with the module, we will determine how your ideas on observations are developing.” Pass out the Observation Assessment and a cotton ball to each student and tell students to fill out their name, teacher’s name, and date at the top of the assessment. Remind the students that it is important that they fill out this assessment on their own.

Read the instructions to the students. Then read each of the statements and tell students to circle “observation” for statements that are observations or “not an observation” for statements that are incorrect observations or statements that cannot be observations. When students are finished, collect the assessments and the cotton balls and verify that the students’ names are on the papers.
**Observation Activity:**
*(12 minutes – Full Class – SciTrek Lead)*

Have volunteers pass out a notebook to each student.

Have students fill out their name, teacher’s name, group color (color of their name on their nametag: orange, blue, green, or purple), and their volunteer’s name (volunteers’ names should be written on the board next to the group color they will be working with) on the front cover of their notebooks. If a student does not have a nametag, only have them fill out their name and teacher’s name on the cover of their notebook. They will be placed in a group when the class divides into groups for observations and they can fill out their group color and volunteer at that point.

Tell the class that for this module we are going to work together to try to answer the question, “What variables affect plant growth?” The first thing we will do in this module is make observations of several plants.

If the chart from page 1 of the picture packet is not copied onto the board, then put page 1 of the picture packet under the document camera (shown below). Tell the students that scientists make many observations. Ask the class, “What is an observation? What are the types of things that you can record for an observation?” If they have trouble, show them an object and let them make observations. Help them realize that observations are descriptions of things using their five senses. As they come up with what they can use to make observations, record these on the chart. Then, write the definition of observation under the list and have the students tell you the definition a few times. Have students generate an observation about something in the classroom using each of their senses other than taste.

![Observations and Not Observations Chart](image)

Ask the class, “Are there statements that are not observations?” Students should be able to generate opinions, incorrect observations, and inferences. Record these under “not observations” on the chart. Remind students that inferences are something that you think might be true about an object/system.
based on past experiences and evidence you’ve collected. For instance, in the mini module when they thought the object in the candleholder was a “candle” before it was eaten. Have students give you examples of statements that are opinions (Ex: chocolate chip cookies taste better than ice cream), incorrect observations, and inferences (Ex: the white lab coats are bought from Target). If they are unable to generate these categories or cannot give you an example, give them an example statement in each category and then have them identify the type of statement.

Have the volunteers pass-out a mechanical pencil, found in their group box, to each student.

Tell students they are now going to do an activity where they look at a list of possible observations about the object they just received (mechanical pencil). They will then decide if each statement is an observation or not an observation about the object.

Have students turn to page 2 of their notebooks and place a blank notebook under the document camera and turn to page 2. Have students fill in the blank in the observation definition at the top of the page. Then have them repeat the definition to you a few times.

Read the directions aloud to the class. Read the first statement to students, then give them ~15 seconds to circle the answer. For each statement, have a student tell you what the correct answer is and why. Then, have the class vote using thumbs up/thumbs down if they agree/disagree with the student’s reasoning. If many students in the class disagree with the response of the original student, have another student explain why they disagree. If needed, let them have “mini conferences” with the students that are sitting in their area. After the class has come to a consensus, tell students they will now box the correct answer. Remind them not to erase their original answer because then they will be able to see which concepts/categories they are struggling with. Mark the correct answer on the class notebook for students to copy.

For each statement that is an observation, have students identify the sense (touch, taste, smell, hear, or see) that they used to classify the statement. Write down which sense students used in the margins. For each statement that is not an observation, have students identify why the statement is not an observation (incorrect observation, opinion, or inference). Write down why the statement is not an observation in the margins. Students do not need to write these in the margins in their notebook. See the example below for the student and lead pages.
Below are the answers to 1-7 on page 2 in detail.

**Number 1:** The object is smaller than a jump rope.

*Observation – With Sight (Comparison)*

Is the statement an observation or not an observation?

Observation

What sense did you use to make this observation?

Sight

**Number 2:** The object is made out of metal.

*Not an Observation – Incorrect with Sight*

Is this statement an observation or not an observation?

Not an observation

Why is this statement not an observation?

The object is made of plastic not metal (Incorrect observation).

What sense did you use to tell this?

Sight
Number 3: The object is hotter than boiling water.
*Not an Observation – Incorrect with Touch (Comparison)*

Is this statement an observation or not an observation?
Not an observation

Why is this statement not an observation?
The object is cooler than boiling water, not hotter (Incorrect observation).

What sense did you use to tell this?
Touch

Number 4: The object is simple.
*Not an Observation – Opinion*

Is this statement an observation or not an observation?
Not an observation

Why is this statement not an observation?
This statement is an opinion. Some people might think that mechanical pencils are simple, but others might think they are complex.

Number 5: The object has a pointed end.
*Observation – With Sight*

Is this statement an observation or not an observation?
Observation

What sense did you use to make this observation?
Sight

Number 6: The object can be twisted at one end.
*Observation – With Sense (Need to Test)*

Is this statement an observation?
If you have twisted one end of the pencil, then the statement is an observation. If you have not tested it then the statement is not an observation, it is an inference.

**Note:** Make sure that all students twist the end of the object making this statement an observation. Tell students that some inferences can be turned into observations by testing them.

What sense did you use to make this an observation?
Touch and sight

Number 7: The object has been used to write many words.
*Not an Observation – Inference*

Is this statement an observation or not an observation?
Not an observation

Why is this statement not an observation?
This statement is an inference because there is no way to tell if the object has been used to write many words. Since pencils are used to write words, the pencil could have been used to write many words but it also could be new and unused, or only used to draw pictures.

Once students have completed the observation activity, see if they can give you one or two more observations about the object. While students are giving other observations, the volunteers should walk around and collect the mechanical pencils from students and put them back in their group boxes.
Observation Discussion:
(7 minutes – Full Cass – SciTrek Lead)

Tell students, “We will now use the skills that we learned to make observations.” Ask students, “Do you remember the question the class will be investigating?” They should respond, “What variables affect plant growth.” If students do not remember, show them where to find it on the front of their notebook. Tell the class that today they will explore how soil type affects plant growth.

Tell the students that in order to find out how the soil type affects plant growth, you planted seeds in three different soil types (potting soil, vermiculite, and rocks) 7 days ago, and you are now going to show students how you planted the seeds. Take out the large (20 oz) and medium (9 oz) cups. Feed the towel (5 cm X 15 cm) through the hole in the bottom of the medium cup, so that there is ~4 cm of towel sticking into the medium cup and ~11 cm of towel hanging out. Then, put the medium cup into the large cup. Get out the vermiculite and walk around the class showing it to the students. First, ask student, “Do you remember what this soil is called?” They worked with vermiculite in their first module so they might know the name. If the students don’t remember, tell them it is a special type of soil called vermiculite. Have them say the word vermiculite with you so that they remember the word. Pour two small (3 oz) cups of vermiculite into the medium cup. Place an imaginary seed into the cup of vermiculite (students should think the seed is real). Tell students that the seed that you have just planted is called a fast plant. Have a student tell you the amount of water in each of the graduated cylinders (100 mL each) and then slowly and in a circular fashion pour the 200 mL of water on the vermiculite. Place the cup system under the lamp and turn the light on.

Tell students that they will first share with their volunteer observations that they just made about the experimental set-up (what you just showed them), followed by the seeds that were just planted this morning (lettered cups), and then they will finish by making observations about the plants that are 7 days old (numbered cups). Tell students that it is important to only generate observations and not inferences/opinions. Tell the class they will now get in their groups. Tell each colored group where to go and to bring their notebook and a pencil.

If a student does not have a nametag, identify the group with the least number of students in it and write the student’s name on one of the extra nametags that are in the lead box using that color of marker.

Observations:
(17 minutes – Groups – SciTrek Volunteers)

Once the students come over to your group, have them sit in boy/girl fashion Verify the table is set up as described in the Set-Up Section. Students will not fill out observation in their notebooks.

As a group, have the students generate observations about the experimental set-up that was just shown to them. As students make observations, record them on page 1 of the group notepad. Make sure to record the following observations about the experimental set-up: cup sizes, water amount (200 ml), soil amount (2 cups), seed type (fast plant), and location (under full light). This should take you no longer than 5 minutes.

Once students have exhausted these observations, bring out the lettered cups that were just made. Have students generate observations about the contents of each cup and record these on page 2 of the group notepad. Students should observe the relative amount of water in the bottom of each cup. In the “other observations” section, record comparisons between the three cups or other general observations of the set-up. During this time discuss with your group which soil type absorbed the most water (vermiculite) and which soil type absorbed the least water (rocks). Ask students, “Are you surprised by these results?”
**Note:** Students have already completed a module on soil-water retention earlier in the year so they should be able to relate the previous module about how different soil types absorb different amounts of water to the current module. An example of the group notepad is shown below.

After your group has made observations about the lettered cups, have the students make observations of the cups that were planted seven days ago, which are labeled by numbers, and record these on page 3 of the group notepad. Repeat the process by recording the contents of each cup and then general observations under the “other observations” heading. Have the students compare the relative amounts of water in each of the cups and talk again about the amount of water that each soil type has absorbed.

If there is additional time, have students summarize what they saw and learned. Make sure that students know that for this experiment, the changing variable was soil type and they were learning how this variable affected plant growth.

An example filled out initial observations is shown below.
Question Discussion:
(3 minutes – Full Class – SciTrek Lead):

Have one student from each group share an observation with the rest of the class.

Review with the class how the plants changed over time. Ask students, “Does soil type affects plant growth and what evidence do you have to support this?” Possible student response: soil type affects plant growth because we observed the plants in the different soil types were different heights. Ask students, “If you wanted to grow the tallest plant, what type of soil should you use?” They should reply, “potting soil.” Ask students, “Do you think that plants in a garden would grow well if you replaced the soil in their garden with rocks, and why?” Possible student response: plants wouldn’t grow well if the garden soil was replaced by rock because rocks do not absorb water. Therefore, the plants would not get any water and they would die. Tell students, “We have now learned that soil type affects plant growth and in order to get plants to grow, we need a soil that absorbs water.”

Tell students that now they are going to pick a variable with their group to investigate. Make sure students understand that variables are parts of the experiment that can be changed. Tell student they can pick to explore if something about either liquid or light affects the amount of plant growth. If they are interested in exploring how light affects plant growth, they can change the light amount. To manipulate the light amount, they will be using boxes with polarizing filters. Get the two filters from the lead box. Face the light (that was on the plants) towards the class. Put the filters in front of the light and show students what happens when they are rotated. If they are interested in exploring how liquid affects plant growth, they can manipulate either the water amount or the nutrient amount. Tell students that the nutrients that they will be able to choose from include sugar, fertilizer, and salt. If they are interested in exploring how water amount affect plant growth, they will get to use the special 250 mL graduated cylinder, which is over double the size of the graduated cylinders that students will use in the other experiments. Show students the larger graduated cylinder. Tell students they will now vote in their groups about what changing variable they want to explore. This will let them determine the question for their experiment.
**Question:**
(11 minutes – Groups – SciTrek Volunteers)

Have students turn to page 3 of their notebooks. Then have them decide (by voting) if they are interested in investigating how liquid or light affects plant growth. If there is a tie, then the volunteer will make the deciding vote. Once they have decided on the factor they will investigate, have students circle what they chose in their notebooks. Then have them decide what their changing variable will be. If they decide to investigate a liquid factor, have them choose if their changing variable will be water amount or nutrient amount. If they decide to investigate a light factor, their changing variable will be the light amount. It is best if groups have different changing variables. The lead will help coordinate between groups to ensure there is a variety of changing variables. All experiments will measure the change in plant height.

Use their changing variable to generate the question that the group is going to investigate. Write the question in the group notepad, and have students copy it into their notebooks. An example filled out question is shown below.

**Materials Page:**
(6 minutes – Groups – SciTrek Volunteers)

If your group is changing the water amount, get a 250 mL graduated cylinder from the lead to aid your group in picking their water amounts.

If your group is changing nutrient amount, get a 100 mL graduated cylinder from the lead to aid your group in picking their nutrient amounts.

You can use the wet erase pen to mark amounts on the graduated cylinder.
Get the materials page (shown below) that corresponds to the changing variable that your group selected and tape it into the group notepad. Have students use the materials page to determine the values for their changing variable and controls. When selecting the values of the changing variable, ask students, “Do you think a wide or a narrow range of values would help you more effectively answer your question?” Make sure they understand that a wide range of values will make it easier for them to see a difference in their results. For each changing variable value, write the student’s name that will be in charge of the trial next to the value.

Make sure that students have picked liquid amounts that are within the limitations set on the materials page. Examples of all materials pages are shown below.

Students will not fill in the experimental set-up page in their notebook until the next session.

**Wrap-Up:**
*(2 minutes – Full Class – SciTrek Lead)*

Tell the students that they have taught you a lot about how the soil type affects plant height. You now know that potting soil produces the largest plant.

Tell the students that during the next session, they will get to design a procedure based on their question and then start their experiments to help us answer the class question: What variables affect plant growth?
Clean-Up:

1. Collect nametags and notebooks.
2. Put nametags in your group box and give the notebooks to the teacher to complete the Technique Activity before SciTrek returns.
3. Place plant back in tubs.
4. Place all other materials in your group box and bring materials back to UCSB.

Lead Note: Give the class notebook to the teacher to use for the Technique Activity.

Day 2: Experimental Set-up/Procedure/Results Table/Experiment

Note: We highly recommend that teachers complete the Technique Activity prior to Day 2 of the module. The suggested times in the lesson plan below are assuming that the Technique Activity was completed prior to SciTrek arriving.

Schedule:

Times if teacher did Technique Activity prior to SciTrek: Times if SciTrek must do Technique Activity:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Times if teacher did Technique Activity</th>
<th>Times if SciTrek must do Technique Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction (SciTrek Lead)</td>
<td>2 minutes</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Experimental Set-Up (SciTrek Volunteers)</td>
<td>10 minutes</td>
<td>7 minutes</td>
</tr>
<tr>
<td>Procedure (SciTrek Volunteers)</td>
<td>20 minutes</td>
<td>19 minutes</td>
</tr>
<tr>
<td>Results Table (SciTrek Volunteers)</td>
<td>5 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Experiment (SciTrek Volunteers)</td>
<td>21 minutes</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Wrap-Up (SciTrek Lead)</td>
<td>2 minutes</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Introduction (SciTrek Lead)</td>
<td>2 minutes</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Experimental Set-Up (SciTrek Volunteers)</td>
<td>7 minutes</td>
<td>7 minutes</td>
</tr>
<tr>
<td>Procedure (SciTrek Volunteers)</td>
<td>19 minutes</td>
<td>19 minutes</td>
</tr>
<tr>
<td>Results Table (SciTrek Volunteers)</td>
<td>5 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Experiment (SciTrek Volunteers)</td>
<td>15 minutes</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Wrap-Up (SciTrek Lead)</td>
<td>2 minutes</td>
<td>2 minutes</td>
</tr>
</tbody>
</table>

Materials:

(4) Volunteer Boxes:
- □ Student nametags
- □ Student notebooks
- □ Volunteer instructions
- □ Volunteer lab coat
- □ (2) Pencils
- □ (2) Wet erase markers
- □ (7) Rulers (mm) (only if classroom teacher did not do technique on own)
- □ Paper towels
- □ (3) Water (8 oz)
- □ (5) Droppers
- □ (5) 100 mL Graduated cylinders (if groups changing variable is liquid amount no graduated cylinder should be in group box, instead they will get 250 ml graduated cylinders in a separate box)
- □ (3) Nutrient (if needed)

Other Supplies:
- □ (4) Large group notepads
- □ Requested boxes to change light amount
- □ Bucket with lid
- □ Requested number of plants in potting soil labeled with group color and plant lettered
- □ Requested number of plants in vermiculite labeled with group color and plant lettered
- □ Lamps with 750 lumen LED bulb (1 lamp per light amount box plus one extra for full light)
- □ (5) 250 mL Graduated cylinders
- □ (2) Extension cords
- □ Requested number of boxes with (5) 250 mL graduated cylinders
Lead Box:

- ☐ (3) Blank nametags
- ☐ (3) Extra student notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat
- ☐ Time card
- ☐ (2) Pencils
- ☐ (2) Wet erase markers
- ☐ (4) Markers (orange, blue, green, purple)
- ☐ (4) Rulers
- ☐ Paper towels
- ☐ (3) Water (8 oz)
- ☐ (5) Droppers
- ☐ (2) 100 mL Graduated cylinders
- ☐ (2) 250 mL Graduated cylinders
- ☐ Salt solution (8 oz)
- ☐ Sugar solution (8 oz)
- ☐ Liquid Fertilizer (8 oz)

Notebook Pages and Notepad Pages:

![Diagram showing techniques with measurements](image)

First choose 1 circle the factor that you would like to experiment with. Then, within that row, circle what you would like your changing variable to be. Finally, circle the measurement you will make.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Changing Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid</td>
<td>Water Amount</td>
<td>Plant Height (mm)</td>
</tr>
<tr>
<td>Light</td>
<td>Light Amount</td>
<td>Plant Height (mm)</td>
</tr>
</tbody>
</table>

**QUESTION**

- If we change the light amount, what will happen to the amount of plant growth? (what you are measuring/dependent variable)

Fill out the materials page with your SciTrek volunteer before moving onto the experimental setup.

**EXPERIMENTAL SET-UP**

**Changing Variable:** light amount

**Controls:** Variables you will hold constant:

- Seed Type
- Fast Plants
- Nutrient Type
- Soil Type
- Potting Soil Amount
- Water
- Liquid Amount
- 100 mL
- Time
- 3 Days

Notebook Pages and Notepad Pages:
This is an example notebook for a group that chose nutrient amount as their changing variable.

This is an example notebook for a group that chose light amount as their changing variable.
Preparation:

SciTrek Lead:
1. Get the students’ notebooks from the teacher and give them to the volunteers to separate into the groups, attach nametags, and set out.
2. Get SciTrek’s second grade rulers and put them in the lead box.
3. Set up the light level boxes.
   a. Set up levels 0-4 boxes in ascending order with the lids left off
   b. Set-up a lamp for level 5 lighting. **Note:** This will not be in a box.
   c. Do not plug extension cords into other extension cords.
   d. Remind the classroom teacher that it is important that the lights are left on until the next session.

SciTrek Volunteers:
1. Get notebooks from the lead, separate them into groups, and attach nametags.
2. Set out notebooks/nametags.
3. Get your group’s plants and set them aside to use when students are ready to start their experiment.

**Note:** If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.
**Introduction:**
*(2 minutes – Full Class – SciTrek Lead)*

If needed, while you are doing the introduction have volunteers set out the notebooks/nametags where they would like students to sit. Tell students that a notebook will be put on their desk, which is not their notebook and they should not move it.

Ask students, “What did we do and learn during out last meeting?” Possible student response: we made observations about plants that were just planted and plants that were 7 days old. In addition, students should say that they came up with a question that they are going to design an experiment around.

Remind students that each group’s research is going to help answer the class question. Ask the class, “What is the class question we are investigating?” Students should reply, “What variable(s) affect plant growth?” Ask the class, “How will we tell if a variable affects plant growth?” Make sure by the end of the conversation students know that they will measure the plant in millimeters before they start their experiment and after their experiment is over and subtract the two numbers to determine how much the plant grew. If the classroom teacher did the Technique Activity with them already, remind them that they have already practiced measuring in millimeters using rulers.

If the teacher has not done Technique Activity do Technique Activity before continuing.

Tell students that now that they know how to use a ruler, they can measure the height of the plants today and then measure them again when SciTrek comes back. Ask students, “How can we determine how much the plants have grown?” Possible student response: you can take your first measurement and your last measurement and use a number line or subtraction to determine how much the plant grew. Tell students the next day SciTrek will be coming back and as a class, determine how much time (in days) this will be. They will need this value for one of their controls.

Tell students that the first thing that they will do in their groups is remind their volunteer what question they picked to investigate as well as the variable values that they picked. They will then use this information to generate an experimental set-up and a procedure. When designing a procedure, they will start by getting plants that are 3 days old from their volunteer. Once their procedure and results table are filled out, they can start their experiment.

**Technique:**
*(10 minutes – Full Class – Done By Classroom Teacher Prior to SciTrek)*

Make sure that each student has a ruler and has their notebook turned to page 4. Place the class notebook under the document camera and turn to page 4. Tell the class that rulers can be used to measure lengths, widths, or heights of objects. Ask students, “Does anyone know what units these rulers measure in?” They should reply “millimeters.” Tell students that when scientists make measurements, they use the metric system. Therefore, we are going to measure the length and width of objects in millimeters, like other scientists. Ask students, “What is the maximum measurement that they could make using this ruler?” They should reply, “300 mm.”

Tell students, “To measure the length or width of an object, first line up the zero mark on the end of the ruler with the end of the object that you are interested in measuring. Then follow the ruler to the other end of the object and read the measurement to the nearest whole number.” As a class, complete example 1 together.

Have the students complete 2 and 3 by themselves.
Once students have completed the measuring activity, have them share their results with the class. Once an answer is shared, have the rest of the class vote if they think the answer is correct/incorrect using thumbs up/thumbs down for agree/disagree. When a class consensus has been reached, write the correct number on the notebook under the document camera. Tell students that it is okay if their measurements differ by up to 3 mm.

**Experimental Set-Up:**
*(10 minutes – Groups – SciTrek Volunteers)*

Once students get to your group, have them sit in boy/girl fashion. Have them tell you what question they will be investigating as well as the values of the controls and changing variables they picked. If the group struggles, show them the group notepad to refresh their memory.

Turn to page 5 of the group notepad while students turn to page 3 in their notebooks. Ask your group, “What did we decide was going to be the changing variable?” Record this on the group notepad. After, have students copy the changing variable into their notebooks.

Ask your group, “What controls and values did we select?” Write the control on the left side of the slash and the value of the control on the right side of the slash (Ex: soil type / potting soil). In addition, have students copy these into their notebooks.

After going through the controls laid out on the materials page, there will be one blank left in the experimental set-up. Ask students, “What other information will they need to include to complete their experiment?” If students struggle, ask them, “When will we measure the plants?” Students should reply, “Today and when SciTrek comes back.” Ask them, “What control would this be? They should reply, “Time.” Tell them the number of days before SciTrek comes back.

An example filled in experimental set-up is shown below.
**Procedure:**

*(20 minutes – Groups – SciTrek Volunteers)*

Tell students they will now generate a procedure for their experiment. Ask students, “What is a procedure?” Lead them to understand that it is a set of steps to conduct an experiment. Tell them that we will draw one picture for each procedural step. Ask students, “What is the first step in conducting our experiment?” Lead them to understand it is getting the 3 day old plants and measuring them. Within the picture, write the soil type, the plant type (fast plants), and the word “measure.” Ask students, “What is the next step?” Lead students to understand that it is pouring liquid over the soil. Within the picture, write the liquid amount(s), nutrient amount(s) (if needed), and nutrient type. Ask students, “What is the next step?” Lead students to understand that it is putting the plants under the correct light amount. Within the picture, write the light amount(s). Ask students, “What is the next step?” Lead student to understand that it is waiting until the next session. Within the picture, draw a calendar indicating the correct amount of days until the next session. Ask students, “What is the next step?” Lead students to understand that it is measuring the plant height. Within the picture write the word “measure.” Ask students, “What is the last step?” Lead students to understand that it is using a number line to determine the amount of plant growth. Make sure to list all values of your changing variable for the step that includes your changing variable. Make sure all students in your group have drawn and labeled a procedure step before moving onto the next step. An example filled out procedure is shown in the Experimental Set-Up Section.

**Note:** If your group is changing nutrient amount you will add the desired amount of nutrient to the graduated cylinder and then use water to continue filling up the graduated cylinder to the correct liquid amount. The procedure below shows how you can draw this for step 2.
Results Table:  
(5 minutes – Groups – SciTrek Volunteers)

Fill out the variables section of the results table while students fill out the same section in their notebooks. When writing the values, make sure that for controls, they only write the value of the control in the trial A box and then draw an arrow through the remaining trials’ boxes; for the changing variable, they write the value in each trial’s box. An example filled out results table is shown below.
Experiment:
(21 minutes – Groups – SciTrek Volunteers)

Get the appropriate plants for your group’s experiment. These plants should already be labeled with your group’s color and trial letters. Give each student one of the plants and a ruler. This will be the plant that the student is responsible for during the rest of the experiment. Tell students to be careful with their plant because if they break it, they will not get another plant. Help students measure the initial plant height in millimeters and record this measurement in their notebooks. In addition, record all of the initial plant heights on the group notepad. Students can then measure the appropriate amount of liquid using a graduated cylinder. A wet erase pen (the pen that is used on the notepads) can be used to mark on the graduated cylinder to remind students how much liquid they need. Make sure that students pour the water slowly and not directly on top of the plant.

For groups changing nutrient amount, have students add the appropriate amount of nutrient to the graduated cylinder using a dropper, and then use water to fill the graduated cylinder to the appropriate total liquid amount. (Ex: if you would like a total liquid amount of 100 mL and Trial A had 30 mL of nutrient, you would add 30 mL of nutrient to the graduated cylinder, and then add water up to the 100 mL mark.) You can use the wet erase pen to draw the first line on the graduated cylinder for the nutrient amount. Once the students have added the correct amount of nutrient, draw a second line on the graduated cylinder indicating the amount of water they need to pour in to get to the total liquid amount.

After the height of the plant has been measured/recorded and the plants have the appropriate amount of liquid, have students put their plants under the correct lighting source.

Make sure that students copy all initial plant heights into their notebooks.
Wrap-Up:
(2 minutes – Full Class – SciTrek Lead)

Tell students that during the next session, they will get to measure how tall their plants have grown and determine the change in plant height.

Clean-Up:
1. Collect notebooks with attached nametags.
2. Leave plants, boxes, and lights in the classroom; make sure that all lights are left on.
3. Place all other materials into your group box and bring materials back to UCSB.

Day 3: Experiment/Graph/Results Summary

Schedule:

Introduction (SciTrek Lead) – 2 minutes
Experiment (SciTrek Volunteers) – 30 minutes
Graph (SciTrek Volunteers) – 10 minutes
Results Summary (SciTrek Volunteers) – 16 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Materials:

(4) Volunteer Boxes:
- □ Student nametags
- □ Student notebooks
- □ Volunteer instructions
- □ Volunteer lab coat
- □ (8) Partial graph pieces
- □ (2) Pencil
- □ (2) Wet erase markers
- □ Scotch tape
- □ Paper towels
- □ (5) Rulers (mm)

Other Supplies:
- □ (4) Large group notepads
- □ (3) Tubs to take plants back to UCSB

Lead Box:
- □ (3) Extra student notebooks
- □ Lead instructions
- □ Plants picture packet
- □ Lead lab coat
- □ Time card
- □ (8) Partial graph pieces
- □ (2) Pencils
- □ (2) Wet erase markers
- □ Scotch tape
- □ Paper towels
- □ (4) Rulers (mm)
Notebook Pages and Notepad Pages:

<table>
<thead>
<tr>
<th>RESULTS Table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variables</strong></td>
</tr>
<tr>
<td>Seed Type:</td>
</tr>
<tr>
<td>Soil Type:</td>
</tr>
<tr>
<td>Liquid Amount:</td>
</tr>
<tr>
<td>Light Amount:</td>
</tr>
<tr>
<td>Nutrient Type:</td>
</tr>
<tr>
<td>Nutrient Amount:</td>
</tr>
<tr>
<td>Times:</td>
</tr>
<tr>
<td>Initial Measurements:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Change in Plant Height:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Final Measurements/Observations:</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The independent variable is the changing variable and the dependent variables are the final measurements/observations.

Graph and Summary:

My experiment shows that plants in the dark will grow taller than plants in the light, because the plants in light level 1 (one day) grew 31 mm and the plant in the light level 5 (full light) grew 10 mm.
Preparation:
SciTrek Lead:
1. Make sure volunteers setting out notebooks.
2. Remove the plants from the boxes and give them to the appropriate volunteer.
3. Turn off the lights and put lamps in boxes and stack boxes to be returned to SciTrek. (This can be done after the module.)

SciTrek Volunteers:
1. Set out student notebooks/nametags.
2. Get your groups’ plants and have them ready to give to students.

Note: If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

Introduction:
(2 minutes – Full Class – SciTrek Lead)

If needed, while you are doing the introduction have volunteers set out the notebooks/nametags where they would like students to sit. Tell students that a notebook will be put on their desk, which is not their notebook and they should not move it.

Ask the class, “What have we been working on the last two meetings and what have we learned?”
Possible student response: we have been exploring plant growth and they found that soil type affects the plant height; soils that absorb more water allow plants to grow taller. They should also state they designed and started to carry out an experiment to test another variable that might affect plant growth. Have each group tell you the variable that they are investigating.
Tell the class that today they are going to observe their plant’s growth by measuring the plant heights. Ask students, “How will you determine how much your plant has grown since the start of their experiments?” Possible student response: we can measure the plant and then use a number line to find the difference between the initial height of the plant and the final height of the plant. After they are finished with their experiment and recording their results, they will then use the data to make a graph to see how their changing variable has affected plant growth.

**Experiment:**
*(30 minutes – Groups – SciTrek Volunteers)*

Pass out the plants to each student, making sure that each student gets the plant that they were working with before. Have each student measure the height of the plant in millimeters and tell you their measurement, then record these on page 6 of the group notepad under final plant height. Then have students copy the measurements onto page 6 of their notebook (see example group notepad below).

Ask students, “How will we figure out how much the plant has grown over the last couple of days?” Possible student response: we can use a number line to find the difference between the initial and final heights of the plant. As a group, do the math for each of the trials in the group notepad, making sure to use the appropriate subtraction method as dictated by the teacher. If more room is needed to do the math, use the backside of a notepad page. Students only need to record the change in plant height in their notebooks, not the math process to determine the change.

**Note:** Large amounts of salt or sugar will cause the plant to shrink/die. If this happens, you will still find the difference in plant height between the two measurements. Make sure that you record it as a positive number, but put a star or asterisk next to it (Ex: 5 mm☆ or 5 mm*).

Encourage students to make observations about their plant other than plant height, such as the relative amount of liquid in each cup, color of leaves/stem, number/size of leaves, etc. These can be recorded in the results table under “Other Observations.”
**Graph:**
*(10 minutes – Groups – SciTrek Volunteers)*

Pass one partial graph piece to each student and have them fill out the piece for the plant they oversaw. There is an extra partial graph piece in the group box that you should use as an example. On the bottom line, have students write the value of their changing variable (Ex: level 5), not the trial letter or the changing variable (Ex: A or light amount). This way when the pieces are rearranged, they will be able to see the values for each of the trials to help them identify any patterns. Have students draw a line across the column showing the appropriate change in plant height, as well as write in the numerical value of the change in plant height on top of the line and then quickly shade below the line. If the plant shrunk, have them graph the positive number and put a star next to the written in measurement. Once each student has completed their graph piece, have students help you arrange the partial graph pieces so that they are in increasing order as done in the example below. If your group had plants that shrunk, arrange these before the plants that grew. This will make your graph look like a parabola (u-shaped). In the example experiment discussed, the trials were graphed in the following order: E, A, D, B, C. Tape the partial graphs to the group notepad so that they look like a complete graph (see example group notepad below). When taping the graph pieces to the group notepad, make sure that each graph piece overlaps with the one next to it so that you can only see the y-axis for the first graph piece.
Note: When plants shrink, often the values of the changing variable for the plants that died are not in order (see graph to left). This is because plants can only shrink as much as they initially grew. For instance, at the start of the experiment if a plant started at 3 mm and 50 mL of sugar was poured over the plant, it would likely die and shrivel to the level of the potting soil. This would correspond to a change in height of 3 mm (starting height – final height). Say that for another trial, the initial plant height was 5 mm and then 25 mL of sugar was poured over the plant and it died. The change in height would be 5 mm. This does not mean that plants shrink more with 25 mL of sugar than with 50 mL of sugar. It just means that the sugar killed both plants.

After the pieces of the graph are taped into the group notepad, ask students, “What is our changing variable?” Record this answer for the x-axis title and have students copy this into their notebooks.
Results Summary:
(16 minutes – Groups – SciTrek Volunteers)

Have students use their graph to look for a pattern in their data. Challenge students to think about how their changing variable did or did not affect plant growth.

When writing their results summary (page 7, student notebook), make sure students start the statement with a claim (a statement that can be tested) about the trend or pattern in their data. If the values of their changing variable have an order (Ex: level 5 → level 4 → level 2), then that variable affected plant growth. If, on the other hand, there was no order for their changing variable values (Ex: level 4 → level 2 → level 5) and the difference between the plant heights for each trial is small, then that variable did not affect plant growth. If possible, try to have students generate a claim that allows them to make a prediction about something that they have not tested. An appropriate claim could be: the more salt poured over a plant, the shorter the plant. This is an appropriate claim because it allows the students to make a prediction about what would happen if new values of their changing variable were introduced.

After generating a claim about their experiment, write the word “because” and follow it with supporting data. Their supporting data should include at least two pieces of data, typically the minimum and maximum change in plant height. Make sure students are using their changing variable values (not trial letters) and specific measurements to support their claim. The supporting data for the previously mentioned claim would be: because when 0 mL of salt was added, the plant grew 26 mm taller and when 50 mL of salt was added, the plant shrank 3 mm).

Results summaries are still valid, and important, if they show that the changing variable tested did not affect plant growth. Even if their results summary is contrary to what you think, have students make a claim based solely on their data. Help students copy this statement into their notebook.

Once students have filled out their results summary, have them fill in the sentence frame (page 8, student notebook): “I acted like a scientist when...” Each student’s response should be unique and specific. They should NOT write, “when I did an experiment,” because this is general and applies to all of the students in the class. If students are having trouble with this sentence frame, ask them what they did during each SciTrek session.

Wrap-Up:
(2 minutes – Full Class – SciTrek Lead)

Tell students that during the next session, they will make a poster, which they will use to present their findings to the class. These posters will help us learn about what variables affect plant growth.

Clean-Up:

1. Collect notebooks with attached nametags.
2. Place all materials into your group box and bring materials back to UCSB.
3. Take all plants, lights, and light boxes back to UCSB.

Day 4: Poster Making

Schedule:

Introduction (SciTrek Lead) – 2 minutes
Experimental Discussion (SciTrek Volunteers) – 17 minutes
Poster Making (SciTrek Volunteers) – 36 minutes
Wrap-Up (SciTrek Lead) – 5 minutes

Materials:

(4) Volunteer Boxes:
- ☐ Student nametags
- ☐ Student notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ Poster diagram
- ☐ Appropriate sticker for how to present graph (changing light or water/nutrient amount)

☐ (2) Pencils
☐ (2) Paperclips
☐ (2) Wet erase markers
☐ Highlighter
☐ Scissors
☐ (2) Glues

☐ Poster parts pack (Scientists’ names, question, experimental set-up, procedure, results table, results graph, results summary, (6) “I acted like a scientist when,” (6) picture spaces)

Other Supplies:
- ☐ (4) Large group notepads
- ☐ Poster paper tube

Lead Box:
- ☐ (3) Extra student notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat
- ☐ Poster diagram
- ☐ Time card

- ☐ (2) Sticker sets for how to present graph (changing light and water/nutrient amount)
- ☐ (2) Pencils
- ☐ (5) Paperclips
- ☐ (2) Wet erase markers
- ☐ (2) Highlighters
- ☐ Scissors
- ☐ (2) Glues
- ☐ Scotch tape
- ☐ (1 each color) Poster part packet

Preparation:

SciTrek Lead:
1. Make sure volunteers setting out notebooks.
2. Ask the classroom teacher for a place to leave the student posters in the classroom.

SciTrek Volunteers:
1. Set out notebooks/nametags.

Note: If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

Introduction:
(2 minutes – Full Class – SciTrek Lead)

If needed, while you are doing the introduction have volunteers set out the notebooks/nametags where they would like students to sit. Tell students that a notebook will be put on their desk, which is not their notebook and they should not move it.

Ask the class, “What is the class question that we have been investigating?” Students should reply, “What variables affect plant growth?” Inform students that today they will be making posters to present their findings to the class. This presentation will be their chance to tell the class what their group has
discovered about the class question. Tell students they should write as neatly as possible on the poster parts so that the other class members can read their poster.

Tell the groups if they have not filled in the results summary or “I acted like a scientist when,” they should finish these before starting on their poster.

In addition, tell students that before they start their poster, they should explain their experiment to their volunteer along with what their results mean. They should try to do this without looking at their notebooks.

**Experimental Discussion:**

(17 minutes – Groups – SciTrek Volunteers)

If students have not finished their results summary or “I acted like a scientist when,” then have them complete these before discussing their experiment or starting their poster.

Have your students explain their experiment as well as their findings to you without looking at their notebooks. Ask each student in the group a question about the experiment. Questions can be about what the students did as well as what they learned. Also try to ask students to make predictions using their data about changing variable values that they did not test.

**Poster Making:**

(36 minutes – Groups – SciTrek Volunteers)

Pass out the writing portions (general poster parts and “I acted like a scientist when”) and have students write their names on them and complete them. In addition, have each student write their name on the scientists’ names poster part. Use the following guidelines when assigning poster parts:

<table>
<thead>
<tr>
<th>Number of Students in Group</th>
<th>Poster Division</th>
<th>Poster Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Each student gets an “I acted like a scientist when” and picture space.</td>
<td>Student that finishes 1st completes the results table (not presented)</td>
</tr>
<tr>
<td>1. Question and Experimental Set-Up</td>
<td>2. Procedure</td>
<td>3. Results Graph*</td>
</tr>
<tr>
<td>4. Results Summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1. Question</td>
<td>Student that finishes 1st completes the results table (not presented)</td>
</tr>
<tr>
<td>2. Experimental Set-Up</td>
<td>3. Procedure</td>
<td></td>
</tr>
<tr>
<td>4. Results Graph*</td>
<td>5. Results Summary</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1. Question</td>
<td></td>
</tr>
<tr>
<td>2. Experimental Set-Up</td>
<td>3. Procedure (Presents 1st half of procedure)</td>
<td></td>
</tr>
<tr>
<td>4. Results Table (Presents 2nd half of procedure)</td>
<td>5. Results Graph*</td>
<td></td>
</tr>
<tr>
<td>6. Results Summary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Give the results graph to the student that is most confident in presenting.

Once students have finished the writing section(s), have them draw a picture of their experiment or how they acted like a scientist.

In the students’ notebooks, highlight and number the section(s) that they will present. The parts should be numbered as follows: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results.
graph, and 6) results summary (see example below). Students will NOT present the results table or “I acted like a scientist when” parts from their poster. If a student is presenting multiple sections, use the paperclips in your group box to clip together the sections that they are reading so that when presenting, it will be easy to flip back and forth between pages.

![Image of experiment setup and results graph]

**Ex: Highlighted/Numbered Notebook Pages**

Place one of the following sentence frame stickers on the notebook page of the student that is presenting the results graph (page 7, student notebook).

**Changing Light Amount:**

The plant under light level _____ grew ____ mm.

**Changing Water/Nutrient Amount:**

The plant with _____ mL of water/nutrient grew ____ mm.

Then practice reading the five sentences with that student. For the graph above, the first sentence would be: The plant under light level 5 grew 13 mm. Leave the “changing variable value” and “measurement” blanks empty. An example of a sentence for a group that changed nutrient amount would be: The plant...
with 50 mL of salt water grew 0 mm. Make sure you fill in the second blank in the second sentence frame (Ex: salt water) for the student but leave the “changing variable value” and “measurement” blanks empty.

Ask the student, who is presenting the procedure to tell you in their own words what they did in each step and then you (the volunteer) write their words on each picture to form complete sentences. In the procedure below on the left, the boxed words were added to the student’s notebook. Therefore, the student would read:

Step 1: Get fast plants that are 3 days old in potting soil and measure.
Step 2: Pour 100 mL of water and no nutrients over plant.
Step 3: Put plants under level A) 4, B) 1, C) 0, D) 2, and E) 5 light.
Step 4: Wait 3 days.
Step 5: Measure how tall plant is.
Step 4: Use number line to find change in plant height.

In the procedure below on the right, the boxed words were added to the student’s notebook. Therefore, the student would read:

Step 1: Get fast plants that are 3 days old in potting soil and measure.
Step 2: Get sugar A) 25 mL, B) 50 mL, C) 40 mL, D) 15 mL, and E) 5 mL of sugar then add water up to 100 mL and pour over plant.
Step 3: Put plants under level A) 4, B) 1, C) 0, D) 2, and E) 5 light.
Step 4: Wait 3 days.
Step 5: Measure how tall plant is.
Step 4: Use number line to find change in plant height.

Students should not copy the boxed words onto the poster part.

As soon as students have completed some of their pieces, start gluing them onto the large poster paper, in landscape orientation, exactly as they are arranged in the example below. Do not allow students to glue the poster parts on the poster. Do not wait until students have completed all the pieces to start gluing them onto the poster.
Once the poster is complete, have students start practicing for the presentation. Make sure that students read from their notebooks instead of off the poster.

Ask your group a few questions about their poster. Have them use their findings to predict what would happen to plant growth for other changing variable values that they did not perform but are related to their experiment. For instance, if the group’s results summary was, “My experiment shows plants in the dark will grow taller than plants in the light, because the plant in light level 0 (dark, no light) grew 39 mm and the plants in light level 5 (full light) grew 13 mm,” ask the group, “If you tested level 6 light, how much would the plant grow?” They should be able to predict that it would be ~10 mm.

If there is additional time, tell students that the other students will ask them questions during their poster presentations. Tell them that they should think about what questions they will be asked and then think of the answers to those questions so that they will be prepared during their presentation.

**Wrap-Up:**
*(5 minutes – Full Class – SciTrek Lead)*

Ask students the following questions:
- How did you act like a scientist during this project?
- What did you do that scientists do?

After having a discussion about how they acted like scientists and talking about how everyone does things that scientists do in their everyday lives, tell students that they will present their findings during the next session and that you are looking forward to hearing about all of their experiments.

**Clean-Up:**

1. Collect notebooks with attached nametags.
2. Leave posters in the classroom.
3. Place all other materials into your group box and bring materials back to UCSB.
Day 5: Poster Presentations

Schedule:

- Introduction (SciTrek Lead) – 2 minutes
- Practice Posters (SciTrek Volunteers) – 15 minutes
- Poster Presentations (SciTrek Volunteers/SciTrek Lead) – 41 minutes
- Wrap-Up (SciTrek Lead) – 2 minutes

Materials:

- (4) Volunteer Boxes:
  - ☐ Student nametags
  - ☐ Student notebooks
  - ☐ Volunteer instructions
  - ☐ Volunteer lab coat
  - ☐ (2) Pencils
  - ☐ (2) Paperclips
  - ☐ Highligher

- Lead Box:
  - ☐ (3) Extra student notebooks
  - ☐ Lead instructions
  - ☐ Plants picture packet
  - ☐ Lead lab coat
  - ☐ Time card
  - ☐ (2) Pencils
  - ☐ (2) Wet erase markers
  - ☐ (4) Pencils
  - ☐ (2) Highlighters
  - ☐ Scotch tape

*Student posters should already be in the classroom.

Picture Packet Page:

![Picture Packet Page]

Page 2, Picture Packet
**Preparation:**

**SciTrek Lead:**
1. Make sure volunteers are setting out notebooks.
2. Assign volunteers a new group to work with. This will allow students to explain what they found and practice their poster with a new person.
3. If the classroom has a document camera, ask the teacher to use it for the Notes on Presentations (page 2, picture packet). If the classroom does not have a document camera, then write the class question on the board, “What variables affect plant growth?” Leave enough room to record student findings under the question.
4. Organize posters so experiments featuring the same changing variable are presented back to back and posters are presented from easiest to understand to hardest to understand (suggested order: nutrient amount (salt water, sugar water, fertilizer), water amount, light amount).

**SciTrek Volunteers:**
1. Today you will initially work with a new group of students. When your original group presents their poster, go up with them.
2. Set out notebooks/nametags.

**Note:** If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

**Introduction:**
*(2 minutes – Full Class – SciTrek Lead)*

Tell students that today they will present their posters to the class. Inform students that this is a common practice in science. Scientists go to conferences where they present posters about the experiments they conducted. At these presentations, other scientists give them feedback on their experiments, which allows them to return to the lab with new ideas for future experiments.

Tell students that today they will work with a new volunteer. They will have 15 minutes to discuss their experiment/results and practice presenting their poster with their group. While discussing their experiment/results, students should not look at their notebooks or poster. Remind students to read from their notebooks when presenting. Tell students that after practicing, they will return to their normal classroom seats.

**Practice Posters:**
*(15 minutes – Groups – SciTrek Volunteers)*

Have volunteers rotate groups.

If the posters are not already in order, the lead should organize the posters so the experiments featuring the same changing variable are presented back to back.

Have students explain what they did and what they learned from their experiment, without looking at their notebooks, if possible. Ask students questions to make sure that they understand what they did during their experiment. Make sure that you also have them use their results to predict what would happen for other systems that they did not test. Remind them to think about patterns or trends that they saw for their own results and apply these trends to make predictions about plant growth. For instance, if
the group’s changing variable was water amount, ask them, “What would the height of the plant be if 250 mL (this would be an amount of water that they did not test) of water was poured over the plant?” Possible student response: the plants would not grow any taller if you used 250 mL of water. Try to make sure that each student in your group answers one question.

Once the group has an understanding of their experiment, have them practice their poster presentation, making sure they are reading the poster parts in the correct order (scientists’ names, question, experimental set-up, procedure, results graph, and results summary). Make sure each student’s part is highlighted in their notebook. If students are reading from multiple pages, use a paperclip to clip these pages together to make it easier for them to flip back and forth. Remind students to read from their notebook rather than from their poster.

If there is additional time, tell the group that the other students will ask them questions during their poster presentations. Tell them that they should think about what questions they will be asked and then think of the answers to those questions so that they will be prepared during their presentation.

Do not let poster practice go over 15 minutes.

**Poster Presentations:**
(41 minutes – Full Class – SciTrek Volunteers/SciTrek Lead)

Have students return to their original class seats. Ask the class, “What is the question we have been working on solving?” Students should reply, “What variables affect plant growth?” Ask the class, “Why are we interested in answering this question?” Possible student response: if we can determine the variables that affect plant growth, we could grow taller and healthier plants. Tell students that during the presentations you are going to take notes. Turn to page 2 in the picture packet. Tell them that they need to record everything the group writes on their poster. In addition, you will record the values of the changing variable and the measurements when the group presents their graph.

After each presentation, students will be given the opportunity to ask scientific questions to the presenting group to help them determine if/how the variable investigated affected plant growth. Tell them these questions are important because they will have to summarize for you what they learned from the group, so you can record it on the group notes. Therefore, their questions should focus on helping them be able to summarize the group’s findings.

Volunteers should make sure that students are quiet and respectful when other groups are presenting. When your group is presenting, go to the front of the room with them; prompt students if they do not know who talks next and remind them to read from their notebooks.

During the student question time, the lead and/or volunteers should ask at least one question. Examples of possible questions are: “How do you know...?” or “Is there anything else you can do to get more information about your question?” or “Can you predict what the change in plant height would be if you used (untested changing variable value)?” Each group should answer approximately five questions (one question per student).

When students are done asking questions, have them summarize what the group found. This is challenging for 2nd graders, therefore, you need to break it down into the following four question 1) What was the group’s changing variable? 2) (point to the notes where you recorded the values of the changing variable) What pattern do you see in the (insert changing variable)? 3) (point to the notes where you recorded the change in plant height) What pattern do you see in the change in plant height? 4) Can someone put what we learned into a sentence? If they are still having trouble give them the sentence
frame “As the (insert changing variable) (insert pattern) the change in plant height (insert what happens)”

Ex: As the light amount get lower the change in plant height get taller. Once they have generated a summary, record this on the notes page.

An example filled out Notes on Presentation is shown below.

---

After all poster presentations have been given, ask the class, “What did we learn about plant growth?” Have them summarize the class findings. The highlights from many experiments are shown below. Do not expect students to know highlights from experiments that were not run.

- The greater the salt amount, the shorter the plant, and in some cases, the plant can shrink.
- The greater the sugar amount, the shorter the plant, and in some cases, the plant can shrink.
- The larger the fertilizer amount, the more leaves on the plant. Many times, plants with more fertilizer are shorter.
- The water amount, does not affect the height of the plant, unless there is no water in the large cup, and then the plant will die.
- The greater the light amount (higher light level), the shorter the plant (for plants under ~10 days old).
- The greater the light amount, the greener and more leaves the plant has.

When summarizing experiments, use student-collected data and not what they should have found from the list above. Ask students, “What values of variables would you need to get plants to grow the tallest in ~7 days?”

- Soil Type: Potting Soil
- Nutrient amount: could use fertilizer but does not have large effect
- Water Amount: Any
- Light Amount: Dark
Ask students, “What values of variables would you need to get plants to grow the healthiest (greenest and most leaves) in ~7 days?”

- Soil Type: Potting Soil
- Nutrient Amount: could use fertilizer but does not have large effect
- Water Amount: Any
- Light Amount: Full

If no one in the class did experiments on one of the variables above, then they will not know how that variable affects plant growth and do not expect them to tell you which value to use. Tell students they have taught you a lot about plant growth.

**Wrap-Up:**

(2 minutes – Full Class – SciTrek Lead)

Tell the students that the volunteers that have been working with them are undergraduate and graduate students that volunteer their time so that they can do experiments. Have the students say thank you to the volunteers. This is the last day with their volunteers, therefore, they should say goodbye to them. Tell students that you will be back one more time.

Tell students to remove the paper part of their nametag from the plastic holder and that they can keep the paper nametag, but they need to give the plastic holder back to their volunteer.

**Clean-Up:**

1. Collect plastic nametag holders and allow students to keep the paper part of the nametag.
2. Collect notebook.
3. Leave poster in the classroom.
4. Place all other materials into your group box and bring materials back to UCSB
5. If you will not be attending the Tie to Standards day, remove all materials from your lab coat pockets, remove your nametag, unroll your lab coat sleeves, and put your lab coat into the dirty clothes bag at UCSB.

**Day 6: Draw a Scientist/Tie to Standards/Content Assessment**

**Note:** We highly recommend that teachers complete the Observation Assessment prior to this Day 6 of the module. The suggested times in the lesson plan below are assuming that the Observation Assessment was given prior to SciTrek arriving.

**Schedule:**

**Times if teacher gave assessment prior to SciTrek:**
- Draw a Scientist (SciTrek Lead) – 5 minutes
- Tie to Standards (SciTrek Lead) – 45 minutes
- Content Assessment (SciTrek Lead) – 10 minutes

**Times if SciTrek must give assessment:**
- Observation Assessment (SciTrek Lead) – 10 minutes
- Draw a Scientist (SciTrek Lead) – 5 minutes
- Tie to Standards (SciTrek Lead) – 40 minutes
- Content Assessment (SciTrek Lead) – 10 minutes
Materials:

Lead Box:
- ☐ (3) Extra student notebooks
- ☐ Student notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat

- ☐ Observation Assessment (if teacher did not take assessments then (25) assessments and (25) black beads)
- ☐ (25) Draw a Scientist
- ☐ (25) Content Assessments

Other Materials:
- ☐ 7 Day old plant grown in gravel
- ☐ 7 Day old plant grown in potting soil
- ☐ 7 Day old plant grown in 100 mL of water
- ☐ 7 Day old plant grown in 200 mL of water
- ☐ 7 Day old plant grown in no salt
- ☐ 7 Day old plant grown in 50 mL of salt

Other Materials:
- ☐ 7 Day old plant grown in gravel
- ☐ 7 Day old plant grown in potting soil
- ☐ 7 Day old plant grown in 100 mL of water
- ☐ 7 Day old plant grown in 200 mL of water
- ☐ 7 Day old plant grown in no salt
- ☐ 7 Day old plant grown in 50 mL of salt

Notebook Pages:

1. I acted like a scientist when I measured the height of the __________ plant in __________

TIE TO STANDARDS

1. Is plant growth predictable?

You would like to grow the tallest plant, circle the values below that would allow you to do this. If the variable does not affect how tall the plant will grow then circle either.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Either</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Type</td>
<td>Gravel</td>
<td>Planting Soil</td>
<td>Either</td>
</tr>
<tr>
<td>Water Amount (in Bottom Cup)</td>
<td>100 mL</td>
<td>200 mL</td>
<td>Either</td>
</tr>
<tr>
<td>Nutrients (Salt) Amount</td>
<td>None</td>
<td>50 mL</td>
<td>Either</td>
</tr>
</tbody>
</table>

2. Do plants grow in the light? Plot the data for the plants with water and with no water in the light.

- Light / No Water
- Light / Water

3. What did plants in the light need to grow? __________
Preparation:

SciTrek Lead:

1. Get the Observation Assessments from the classroom teacher and put them in the lead box.
2. If the teacher is not leading the Tie to Standards Activity, do the following:
a. Ask the teacher if they completed the SciTrek final survey. If not, give them the QR code from the lead box and ask them to go to the website (at a later time) and fill out the evaluation of the program.

b. Give the teacher an extra student notebook and have them fill it out with their students to follow along.

c. Collect the teacher’s lab coat and put it in the lead box.

3. If you are a teacher and did not complete the SciTrek final survey, take the QR code from the lead box and fill out the evaluation of the program at a later time.

4. Pass out notebooks to students or get the classroom teacher to pass the out.

5. If the classroom has a document camera, ask the teacher to use it for the Tie to Standards Activity (pages 8-12, student notebook and pages 3-10, picture packet). If the classroom does not have a document camera, then tape the poster-size notebook pages to the front board.

6. Have the 6 plants ready to show students.

7. Put your lab coat in the lead box at the end of the day.

Observation Assessment:
(5 minutes – Full Class – Given By Classroom Teacher Prior to SciTrek)

“Before we start our activity today, we will determine how your ideas on observations are developing. One of the ways that we get program funding is by demonstrating program effectiveness. Therefore, we need you to do your best on the assessment.” Pass out the Observation Assessment and a black bead to each student. Tell students to fill out their name, teacher’s name, and date on the top of the assessment. Remind the students that it is important that they fill out this assessment on their own.

Read the instructions to the students. Then read each of the statements and tell the students to circle “observation” for statements that are observations or “not an observation” for statements that are incorrect observations or statements that cannot be observations.

When students are finished, have them turn over their paper. Read the three Attitudes Towards Science questions to students and have them answer them. When they are finished, collect the assessments and black beads and verify that the student’s names are on the top of the papers.

Draw a Scientist:
(5 minutes – Full Class – SciTrek Lead)

Pass out the draw a scientist paper. Tell students to fill out their name, teacher’s name, and date on the top of the assessment. Give students exactly 4 minutes to draw a picture of a scientist. Once they are done, ask them to write on the bottom line who they drew a picture of. If it was no one specific, they can leave the line blank. Then collect the papers from students, verifying that their names are on the top of the papers.

Tie to Standards:
(45 minutes – Full Class – SciTrek Lead)

Plant Growth Predictability (5 minutes)

Tell the class that you enjoyed their poster presentations the last time you were there. Today we are going to revisit all of the variables that they have been investigating and determine how they affect plant growth. Have students turn to page 8 of their notebooks. Place the class notebook on the document camera and turn to page 8.
Ask the class, “What is a prediction?” They should realize that a prediction is the best guess we are able to make about a system. Ask them, “Do you think the growth of plants is predictable?” They should reply, “Yes.” Tell the students that you started an experiment 7 days ago and you brought in the plants from your experiment for the class to observe. Tell the students that they will predict which of two plants grew taller under different growing conditions. Go over each of the predictions with the students. Have one student share which plant they think will be taller and why. Then have the class vote, using thumbs up/thumbs down if they agree/disagree with the student. If many students are in disagreement, ask one of the disagreeing students what they think and why. After, show the students the two plants and have them circle the plant that grew taller in their notebooks as you record the answer in the class notebook. An example can be seen below.

Tell students since they made such good predictions you now know that plant growth is predictable and that the amount of water (in the bottom of the cup) does not affect how tall the plant grows, but soil type, and nutrient amount both affect how tall a plant will grow. Tell students that knowing these things will help them determine optimal growing conditions for plants in the garden.

Tell students that they are now going to make predictions about plant growth over time for plants that were grown in the light. Inform them that you are going to record their predictions on graphs for them to reference later. After they make predictions, you will show them actual data that was collected so that they can compare their predictions with the actual data. Do not have students copy the prediction graphs into their own notebooks.

**Plants in the Light Prediction (10 minutes)**

Ask students, “What do you think a graph would look like for a plant that was in the light and had no water?” Allow a couple of students to share their answers. Have the rest of the class use thumbs up/thumbs down to show if they agree/disagree. Once the class has reached a consensus use their ideas to make a graph (page 3, picture packet) and place that graph under the document camera. Typically, students predict that a plant in the light with no water will grow a small amount given enough time. An example of this graph can be seen below on the left.
Now ask students, “What do you think a graph would look like for a plant that was in the light and had water?” Allow a couple of students to share their answers. Have the rest of the class use thumbs up/thumbs down to show if they agree/disagree. Once the class has reached a consensus, use their ideas to make a bar graph (page 4, picture packet) and place that graph under the document camera. Typically, students predict that a plant in the light with water would continuously grow taller throughout a given amount of time. An example of this graph can be seen above on the right.

**Effect of Light and Water on Plant Growth (10 minutes)**

Have the students turn to page 9 in their notebook. Tell students that they are now going to look at data that you collected over the course of 15 days (page 5, picture packet) to see if their predictions were correct (there is a half sheet of paper behind page 5 of the picture packet that can be used to cover the data to allow you to reveal the points one by one). Tell students that you used the same experimental set-up as they used for their own experiments. Have students look at the data in the table for “light/no water” and ask them, “How tall was the plant was on day 0?” Students should reply, “0 mm.” Show them where 0 mm is on the graph and draw a line and write the numerical value on top of the line. Repeat this process for the other three points. Then have students explain what happened and what this means for plant growth. Students should notice that no plant growth took place for the seed that was in the light with no water. Therefore, plants need light and/or water to grow.

Place the class prediction graph (page 3, picture packet) over the class notebook to have students compare their prediction to the actual results picture below on right. Tell students not to focus on the numbers but to look at the overall trends.
Tell the students that we are now going to plot the data for “light/water” (page 5, picture packet). Again, reveal the points one by one. Ask students, “How tall the plant was on day 0?” Students should reply, “0 mm.” Draw a line at 0 mm and write the numerical value on top of the line. Ask students, “How tall was the plant was on day 5?” Students should reply, “23 mm.” Put your finger at zero and tell the students to tell you to stop once you reach the appropriate level for day 5. Once you have reached the level draw a line, write the numerical value over the line, and quickly shade below. Tell the students when they are shading, they should try to beat how fast you shaded in the area. Repeat the process for the other two data points. Example student work is seen above on the left. After the data has been plotted, ask students, “What happened to the seed in the light with water?” Students should notice that with light and water the plant continued to get taller until day 15. Place the class prediction graph (page 4, picture packet) over the class notebook to have students compare their prediction to the actual results.

Ask students, “What did plants in the light need to grow?” Students should see that plants in the light needed water to grow. Record “water” for question number 3.

Now tell students that they are going to make predictions about plant growth over time for plants that were grown in the dark. Inform them that you are going to record their predictions on example graphs for them to reference later. After they make predictions you will show them the actual data that was collected so that they can compare their predictions with the actual data. Do not have students copy the prediction graphs into their own notebooks.

Plants in the Dark Predictions (6 minutes)

Ask students, “What do you think a graph would look like for a plant that was in the dark and had no water?” Allow a couple of students to share their answers. Have the rest of the class use thumbs up/thumbs down to show if they agree/disagree. Once the class has reached a consensus, use their ideas to make a graph (page 6, picture packet) and place that graph under the document camera. Typically,
students predict that a plant that was in the dark with no water would not grow over a given amount of time. An example of this graph can be seen below on the left.

![Class Prediction Graph](Page 6, Picture Packet)

Ask students, “What do you think a graph would look like for a plant that was in the dark and had water?” Allow a couple of students to share their answers. Make sure that the students state whether the plant in the dark with water would be taller or shorter than the plant in the light with water. Have the rest of the class use thumbs up/thumbs down to show if they agree/disagree. Once the class has reached a consensus, use their ideas to make a graph (page 7, picture packet) and place that graph under the document camera. Typically, students predict that a plant in the dark with water will grow but be smaller than the plant in the light with water. An example of this graph can be seen above on the right.

After you have completed the predictions tell the class that they are now going to graph the data that you collected to see if their predictions are correct (page 8, picture packet) (there is a half sheet of paper behind page 5 of the picture packet that can be used to cover parts of the data).

**Effect of Darkness and Water on Plant Growth (7 minutes)**

Have the students turn to page 10 in their notebook. Tell the students that we are now going to plot the data for “dark/no water.” Have students graph the data for “dark/no water” on their own. If needed, volunteers can walk around and help students. While students are plotting the data, remove the notebook from the document camera and plot the data on the class notebook. After ~3 minutes put the class notebook under the document camera and have students check their graph. Example student work is shown below. After the data has been plotted, ask students, “What happened to the seed in the dark without water?” Students should notice that there is no plant growth in the dark with no water. Ask students, “How does this data compare to plants in the light with no water?” They should see that the data is the same. Place the class prediction graph (page 6, picture packet) over the class notebook to have students compare their prediction to the actual results.
Tell the students that we are now going to plot the data for “dark/water” (page 8, picture packet). For this graph show the points one by one. As you reveal each point, give students about 30 seconds to try and graph the point on their own. If needed, volunteers can walk around and help students. While students are plotting the data, remove the notebook from the document camera and plot the data on the class notebook. Repeat this process for each of the points. Example student work is seen above. After the data has been plotted ask students, “What happened to the seed in the dark with water?” Students should notice that in the dark with water the plant continued to get taller until day 15. Ask students, “How does this data compares to plants in the light with water?” Students should see that the plant in the light did not grow as tall or as fast as the plant in the dark. Place the class prediction graph (page 7, picture packet) over the class notebook to have students compare their prediction to the actual results.

Ask students, “What did plants in the dark need to grow?” Students should see that plants in the dark needed water to grow from the results and from their graphs. Record “water” for question number 5.

Ask students, “Why do you think plants in the dark with water grow faster than plants in the light with water?” Have a couple students share their responses with the class. Make sure by the end of the conversation students understand that the plants in the dark might be growing at a faster rate to try to reach the light. Then ask students, “What do you think the plants in the dark and the light look like over the course of the 15 days?” Have student share their answers.

Matching Plant Growth Pictures (4 minutes)

Have students turn to page 11 in their notebook. Tell students, “I took pictures of the plants in the light with water (question 6) and pictures of the plants in the dark with water (question 7) during the 15 day experiment. Unfortunately got the pictures mixed up and I need your help you get them back in the correct order.” Put page 9 of the picture packet under the document camera, which shows colored pictures of the plants. Tell students that the plants need to be matched to the correct day. Have one student share what they think is the correct order. Then have the class vote, using thumbs up/thumbs
down if they agree/disagree with the student. If many students are in disagreement, ask one of the students that is in disagreement what they think and why. Once a class consensus has been reached, record the correct number of days under each picture.

Repeat the process for the plants that were in the dark, question 7, by using the colored pictures of the plants in the dark (page 10, picture packet). See example above on the right.

Ask students, “How did the appearance of the plants differ when they were in the light and in the dark?” Possible student response: the plants that were in the dark were taller but that they were also less green, skinny, and had very small leaves and the plants that were in the light had green leaves that were very large.

Ideal Conditions for Plant Growth (3 minutes)

Have the students turn to page 12 in their notebook.

Ask students, “Do you think that water or light is more important for plant growth and why?” Possible student response: water because plants were not able to sprout without water, but they were able to sprout without light. If needed, turn back to the graphs on pages 9 and 10 of the notebook. Circle water for the answer to question 8.

Ask students, “Which do you predict to be taller at day 10, a plant in the light with water, or a plant in the dark with water?” Students can look back at the data that they graphed if they need help answering this question. Students should realize that at day 10 a plant in the dark would grow taller because this plant is using all of its energy to find light. Circle the correct answer for question 9.

Now ask students, “What plant would you predict to be healthier (greenest and more leaves) at day 10, a plant in the light with water or a plant in the dark with water?” Students should realize that a plant in the
light with water would be healthier (greener and more leaves) than a plant with water in the dark. Circle the correct answer for question 10.

10. Which would you predict to be healthier (greener and more leaves) at day 10, a plant in the light with water or a plant in the dark with water?

- Dark
- Light

Ask students, “What conditions are needed in order for plants to live the longest and healthiest life?” Students should now realize from previous discussions and from the data that in order for a plant to live the healthiest and longest life they would need to be in the light and have water. Record these conditions for question 11.

11. What conditions are needed in order for plants to live the longest life?

- Light
- Water

Variables (time permitting)

Do this section with the class only if there is time remaining. Make sure to leave 10 minutes for the Content Assessment.

Ask students, “What is the definition of a variable?” They may be able to tell you that a variable is something we can change about an experiment to learn more about a system. Write the definition (something you can change) as the answer to number 12. Ask students, “What were some examples of the variables that you changed in your experiments?” (water amount, nutrient amount, light amount).

12. What is a variable? Something that can be changed in an experiment.

Now that all students know the definition of a variable, ask them, “What are other variables that might affect plant growth?” Tell them to think of variables that they might have seen out in their own gardens. A few examples of these are shown below along with an example of student work. Record two of these in the class notebook.

- Temperature
- Soil type
- Container type
- Plant type
- Soil amount

13. What other variables might affect plant growth? (List at least 2)

1. Soil amount
2. Temperature

Tell students that this module has taught you that plant growth is predictable and that plants need water and light to grow and be healthy. In addition, they have given you a few ideas for other experiments that you may be able to try out another time. Tell students that before you leave, you would like to see how their science content knowledge has changed.
**Content Assessment:**
(10 minutes – Full Class – SciTrek Lead)

Tell students to close their notebooks and place them in the corner of their desk. Pass out the Content Assessment and a ruler to each student. Tell students to write their name, teacher’s name, and date on the top of their paper. During the assessment, remind students to work by themselves. Read each of the content questions to the students and have them select/fill out the correct answer. As soon as students have completed question 1, collect the rulers. When students are finished, collect the assessments and verify that they have written their name on the assessment.

Tell students that they can keep their notebooks and that you have enjoyed working and learning with them, and you hope they continue to see themselves as scientists and explore the world around them.

**Clean-Up:**

1. Leave notebooks with students.
2. Place all other materials in the lead box and bring materials back to UCSB.
3. Remove all materials from your lab coat pockets, remove your nametag, unroll your lab coat sleeves, and put your lab coat into the dirty clothes bag at UCSB.

**Extra Practice Solutions:**

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**EXTRA PRACTICE**

**Observations:**

Observation: A description using your senses.

Circle **Observation** if the statement is an observation you can make about the picture. Circle **Not an Observation** if the statement is not an observation you can make about the picture.

1. The boy is smiling. **Observation**
2. The boy is wearing a black shirt. **Observation**
3. The measuring cup is larger than the oil bottle. **Observation**
4. Cooking is exciting. **Observation**
5. There are equal number of measuring cups and bottles. **Observation**
6. The boy’s hair is black. **Observation**
7. The boy is making something to eat. **Observation**