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. Some 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 Assessment/Observation Activity/Observations/Question/Materials Page (60 minutes)
Day 2: Technique/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: Observation Assessment/Tie to Standards/Content Assessment (60 minutes)

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 10-11 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 know how to use a ruler to measure an object.
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 ~5 students.
1. Module 1 & 2 (year 1)
   a. Classroom Teacher Leads a Group
2. Module 3 & 4 (year 2)
   a. Classroom Teacher Co-Leads the Class (an experienced SciTrek volunteer will be present to help out if needed)
      i. Classroom teacher will be responsible for leading entire class discussions (examples: observation activity, tie to standards, etc.).
      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.
3. Any Additional Modules (year 3 and beyond)
   a. Classroom Teacher Leads the Class
      i. Classroom teacher will be responsible for leading entire class discussions (examples: observation activity, tie to standards, etc.).
      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.

SciTrek staff will be 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 scitrekadmin@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 scitrekadmin@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 do 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.

During the Module:

If possible, have a document camera available to the SciTrek 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 (3 plugs) and placed on top of ~5 Xerox boxes. These lamps need to be kept on until the next SciTrek meeting.

Days 5 and 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](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
2) Observation activity
Note: We **highly recommend** that you complete the observation assessment prior to Day 1 of the module.

**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.
Note: We **highly recommend** that you complete the technique activity prior to Day 2 of the module.

**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.

**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 Raised Bed & 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. Gooseneck desk lamps (with adjustable heads) (Target part number: Room Essentials Gooseneck Desk Lamp)
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 750 lumen incandescent 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 seen 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 scitrekadmin@chem.ucsb.edu.

Module Notes:

~7 days prior to the module:
Plant the seeds for the original observation ~7 days before the first day of the module. Take 12 small cups (9 oz) with 0.5 inch 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 small cup and ~11 cm hanging out. Place the small cups into larger cups (20 oz). Fill each small cup with ~6 oz of soil (4 set-ups of each of the following, 12 set-ups total: a) potting soil, b) vermiculite, and c) aquarium rocks). Put 2 seeds, no more than 0.5 cm below the soil, in each of the small cups and pour 200 mL of water over them. Place the plants 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.

2 and 3 days prior to day 2 of the module:
Use the same set-up as above to make cups with potting soil or vermiculite as the soil type depending on the requested soil type for each group. The potting soil cups should be planted 3 days before the needed day and the vermiculite cups should be planted 2 days before the needed day. Make ~10% more cups than needed of each of the two soil types in case some seeds do not sprout. Put 2 seeds in each of the cups and pour 200 mL of water over them. Place the plants under light. Before taking the plants to the classroom remove the excess water in the large cup. If both seeds have sprouted remove one sprout so that there is only one plant per cup.
Day 1: Observation Assessment/Observation Activity/Observations/Question/Materials Page

Schedule:

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)
- (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
- Bucket with lid
- (4) Just made cups set-up with potting soil (labeled A)
- (4) Just made cups set-up with vermiculite (labeled B)
- (4) Just made cups set-up with rocks (labeled C)
- (4) 7 Days old cups set-up with potting soil (labeled 1)
- (4) 7 Days old cups set-up with vermiculite (labeled 2)
- (4) 7 Days old cups set-up with rocks (labeled 3)

Lead Box:
- (3) Blank nametags
- (3) Extra student notebooks
- Lead instructions
- Plants picture packet
- Lead lab coat
- (25) Observation assessments
- Time card
- (3) Materials pages (one for each possible variable)
- (2) Pencils
- (2) Wet erase markers
- (4) Markers (purple, green, blue, orange)
- Scotch tape
- Paper towels
- Water (at least 200 mL)
- (2) 100 mL Graduated cylinders
- 250 mL Graduated cylinder
- 20 oz Cup unmarked
- 9 oz Cup with hole in bottom
- (2) 3 oz Colored cups
- Cloth strip
- Vermiculite
- (25) Cotton balls
- Dropper
- (2) Polarizing filters
**Notebook Pages and Notepad Pages:** (Note: Notebook pages are rectangular and filled out in black and notepad pages are squarer and filled out in blue.)

**SCIENTIFIC PRACTICES**

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

Circles are your initial thought and boxes are the correct answer.

**Observations:**

- **Cup 1:**
  - Potting soil
  - Water is dirty
  - Soil is damp

- **Cup 2:**
  - Vermiculite
  - Water is clear
  - Soil is damp
  - Least amount of water in large cup
  - Soil absorbed the most water

- **Cup 3:**
  - Rocks
  - Water is clear
  - Soil is dry
  - Most amount of water in large cup
  - Soil absorbed the least water

- **Cup 4:**
  - Vermiculite
  - Smallest plant
  - Soil absorbed the most water

- **Cup 5:**
  - Rocks
  - Rocks are dry
  - No plant growth
  - Soil absorbed the least water

Other Observations:

**Observations:**

- **Experimental Set-Up:**
  - 2 small cups of soil in medium cup
  - Water poured through the soil
  - Cup put under light
  - Towel stuck through hole in medium cup

**Color:** Red
Set-Up:

SciTrek Lead:

Fill two 100 mL graduated cylinders with 100 mL of water each. Fill two 3 oz cups completely full of vermiculite. Plug in the lamp. Set out materials for experimental set-up demonstration (2) 3 oz cups of vermiculite, (2) 100 mL graduated cylinders with 100 mL of water, large cup, small cup with hole, ruler, and cloth strip).

Have two polarized filters and a 250 mL graduated cylinder available to show students during the observation discussion.

If the classroom has a document camera, ask the teacher to use it for the observation activity (page 2, student notebook). If the classroom does not have a document camera, then tape the example poster-size notebook page to the front board.

On the board, write the four group colors (orange, blue, green, and purple) and the name(s) of the volunteer(s) that will be working with each group.

SciTrek Volunteer:

Put your name, the teacher’s name, and your group color on the top of your group notepad.

As students are taking the observation assessment, walk around the room and quietly place the students’ nametags, which are in your group box, on each student’s desk.

Have SciTrek notebooks and mechanical pencils available to pass out after students complete their assessment.
Once you have passed out the nametags, assemble the experimental set-up (seen in picture below) on a tray. Use the following steps to help you with the set-up:

1. Get three plants (one of each: 1) potting soil, 2) vermiculite, 3) rocks) that are 7 days old and place on tray.
2. Get three plants (one of each: A) potting soil, B) vermiculite C) rocks) that were just made and place on tray.

**Introduction:**

(2 minutes – Full Class – SciTrek 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.”

If you are a teacher that is leading the class tell your students that they are going to start a long-term science investigation and you have asked some scientists from UCSB to come and help. Allow the UCSB volunteers to introduce themselves and share their majors.

**Observation Assessment:**

(5 minutes – Full Class – SciTrek Lead)

As the students are taking the assessment, the volunteers should get the student nametags out of their group boxes and walk around the room locating their students. Have the volunteers quietly lay each student’s nametag on their desk. If students do not have their name on their paper remind them to do so. After volunteers have handed out the nametags they should assemble the experimental set-up.

“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 top of the papers.
Observation Activity:
(12 minutes – Full Class – SciTrek Lead)

As soon as students complete the observation assessment, volunteers should pass out a SciTrek notebook to each student.

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

Put page 1 of the picture packet under the document camera (seen 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.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Not Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sight</td>
<td>Inferences</td>
</tr>
<tr>
<td>touch</td>
<td>Opinions</td>
</tr>
<tr>
<td>hearing</td>
<td>Incorrect Observations</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
Ask the class if there are statements that are not observations. Students should be able to come up with 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 based on past experiences. 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 (example: chocolate chip cookies taste better than ice cream), incorrect observations, and inferences (example: the white lab coats are bought from K-Mart). If they are unable to come up with 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. Afterwards, have students generate another example.

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 student to tell you whether it is an observation or not an observation about the object 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 the other students tell why they do not agree. 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 that they will now box the correct answer. Remind them not to erase the 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.

In addition, have students identify the sense that they used to classify the statement. If the statement is an observation, write down which sense students used and if the statement is not an observation, write down why it is not an observation in the example notebook. Students do not need to write these in their notebook.
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 – False 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.

What sense did you use to tell this?
Sight

**Number 3:** The object is hotter than boiling water.
*Not an Observation – False 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.

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

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 Class – SciTrek Lead)
Tell students we will now use the skills that we learned to make observations. Ask students if they remember the question the class will be investigating. (What variables affect plant growth?) If students do not remember, show them it is on the front of the notebook. Ask the students, what are some variables that might affect plant growth? Possible answers: light amount, water amount, soil type, etc. Make sure that in your discussion students come up with soil type as one of the variables. Tell the class that they will first explore how soil type affects plant growth.
Tell the students 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 the students if they remember what this soil is called (they worked with it in their first module that year). If the students don’t remember, tell them it is a special type of soil called vermiculite that they will be working with during the observations today. 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 a seed into the cup of vermiculite. Have a student tell you the amount of water in each of the graduated cylinders (100 mL each) and then 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 make observations 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 the class they will now get in their group and make observations. 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:**

(16 minutes – Groups – SciTrek Volunteers)

Once the students come over to your group, have them sit in boy/girl fashion. Students will not be using their notebook until they generate a question. Feel free to collect the notebooks and redistribute them when they generate their question. Make sure the table is set-up as described in the set-up section.

As a group, have the students generate observations about the experimental set-up that was just shown to them and record them on page 1 of the group notepad.

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 if they are 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 seen 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 the 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 group notepad is seen below; feel free to deviate from the example. Students do not need to record their observations into their notebooks.

**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 the students if soil type affects plant growth and what evidence they have to support this. The students should reply that soil type affects plant growth because they observed the plants in the different soil types to be different heights. Ask students if they wanted to grow the tallest plant, what type of soil they would use. Students should tell you that they
would want to use potting soil to get the tallest plant. Ask students if they think that plants would grow well if they replaced the soil in their garden with rocks and why they think this. They should say that plants wouldn’t grow well if their garden soil was replaced by rock because rocks do not absorb water. Therefore, their plants would not get any water and they would die. Tell students that 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 they will now get to pick another variable that might affect plant growth to investigate within their group. The variables that they will get to pick from are some of the variables that they suggested before. They can either pick to explore if liquid or light affects 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. Tell students that if they decided to manipulate water amount 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. Shows students the larger graduated cylinder. Tell students they will now vote in their groups about what they want to investigate and determine their group question.

**Question:**
*(9 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 which 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. Encourage your group to have factors/changing variables that are not being explored by other groups. All experiments will measure the change in plant height.

As a group, discuss why/how they think their changing variable will affect plant growth.

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 of the group notepad/student notebook is seen below.
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.

Feel free to use the wet erase pen to mark amounts on the graduated cylinders.

Get the materials page (seen 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 if they think a wide or a narrow range of values would help them more effectively answer their question. For changing variable values write the student’s name that will be in charge of each trial next to each 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 seen below.

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

**Materials Page:**

*(4 minutes – Groups – SciTrek Volunteers)*

<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 are you measuring (dependent variable)?*

<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>

*First choose/circle the factor that you would like to experiment with. Then within that row, circle what you would like to be your changing variable. Finally, circle the measurement you will make.*
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 the next time we meet they will get to design a procedure based on their question and then start their experiments. Tell the students that all of the class experiments will help us be able to answer the question: What variables affect plant growth?

**Clean-Up:**

Before you leave, have students attach their nametags to their notebooks and place them in the group box. Bring all materials back to UCSB. In addition, put your lab coat into your group box.

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

**Schedule:**

- Introduction (SciTrek Lead) – 2 minutes
- Technique (SciTrek Lead) – 10 minutes
- Experimental Set-Up (SciTrek Volunteers) – 7 minutes
- Procedure (SciTrek Volunteers) – 19 minutes
- Results Table (SciTrek Volunteers) – 5 minutes
- Experiment (SciTrek Volunteers) – 15 minutes
- Wrap-Up (SciTrek Lead) – 2 minutes
Materials:

(4) Volunteer Boxes:
☐ Student nametags
☐ Student notebooks
☐ Volunteer instructions
☐ Volunteer lab coat
☐ (2) Pencils
☐ (2) Wet erase markers
☐ (7) Rulers (mm)
☐ Paper towels
☐ (3) Water (8 oz bottles)
☐ (5) Droppers
☐ (5) 100 mL Graduated cylinders (if groups changing variable is water amount use (5) 250 mL graduated cylinders)
☐ 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 number
☐ Requested number of plants in vermiculite labeled with group color and plant number
☐ Lamps with 750 lumen LED bulb (1 lamp per light amount box plus one extra for full light)
☐ (2) Extension cords

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

(2) Pencils
☐ (2) Wet erase markers
☐ (7) Rulers (mm)
☐ Paper towels
☐ (3) Water (8 oz bottles)
☐ (5) Droppers
☐ (5) 100 mL Graduated cylinders (if groups changing variable is water amount use (5) 250 mL graduated cylinders)
☐ 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 number
☐ Requested number of plants in vermiculite labeled with group color and plant number
☐ Lamps with 750 lumen LED bulb (1 lamp per light amount box plus one extra for full light)
☐ (2) Extension cords

Lead Box:
☐ (3) Blank nametags
☐ (3) Extra student notebooks
☐ Lead instructions
☐ Plants picture packet
☐ Lead lab coat
☐ Time card
☐ (2) Pencils
☐ Sharpie
☐ (2) Wet erase markers
☐ (4) Markers (purple, green, blue, orange)
☐ (3) Water (8 oz bottles)
☐ (5) Droppers
☐ Masking tape
☐ (2) 100 mL Graduated cylinders
☐ (2) 250 mL Graduated cylinders
☐ Salt solution (full 8 oz bottle)
☐ Sugar solution (full 8 oz bottle)
☐ Liquid Fertilizer (full 8 oz bottle)
☐ Paper towels
☐ (4) rulers
Notebook Pages and Notepad Pages:

**TECHNIQUE**

Rulers are used to measure lengths of different items.

*How to measure an item using a ruler:*  
1. Line up the zero mark on the ruler with one end of the item.  
2. Follow the item down the ruler.  
3. Record the measurement to the nearest whole number on the ruler at the other end of the item.  
4. Repeat.

What is the height and width of each item?

1. 
   - **Height:** 24 mm  
   - **Width:** 70 mm

2. 
   - **Height:** 11 mm  
   - **Width:** 41 mm

3. 
   - **Height:** 51 mm  
   - **Width:** 45 mm

**EXPERIMENTAL SET-UP**

**Changing Variable:** Light amount

**Controls** (variables you will hold constant):
- Seed Type / Fast Plant  
- Nutrient type / no nutrients  
- Soil type / potting soil  
- Amount / no amount  
- Liquid amount / no amount  
- Time / 3 days

**PROCEDURE**

1. Set 5 fast plants in potting soil and measure.
2. Pour 100 mL of water on each plant and no nutrients.
4. Wait 3 days.
5. Measure plant height and subtract to find how much the plant grew.

*If changing variable is nutrient amount step 2 example: Put A) 25 mL, B) 50 mL, C) 40 mL, D) 15 mL and E) 5 mL of sugar into the graduated cylinder then add water to 100 mL and pour over plant.*
Set-Up:

SciTrek Lead:

Set-up the light level boxes (levels 0-4) if needed, in ascending order with the light turned on sitting on top of the boxes with the front lids removed. Set up an additional lamp for level 5 lighting, note this will not be in a box. Do not plug extension cords into other extension cords.

If the classroom has a document camera, ask the teacher to use it for the technique discussion (page 4, student notebook). If the classroom does not have a document camera, then tape the example poster-size notebook pages to the front board.

SciTrek Volunteer:

Set out student notebooks.

- If students are not in the classroom before SciTrek starts, set out the notebooks and a ruler where students should sit when they come into the classroom.
- If students are in the classroom before SciTrek starts, pass-out the notebooks and a ruler to students in their regular seats, they will move into their groups after the technique discussion.

Get your groups plants and set them aside to use when students are ready to start their experiments.
Introduction:
(2 minutes – Full Class – SciTrek Lead)

If needed, while you are doing the introduction have the SciTrek volunteers pass-out SciTrek notebooks/nametags to students along with a ruler. Students will move to their group spots after the technique discussion.

Ask students what they did the last SciTrek meeting. They should reply, “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 that we are investigating?” The students should reply: What variable(s) affect plant growth? Ask the class how we will tell if a variable affects plant growth? How did we know that potting soil was a “better” soil to grow plants in than rocks? They should reply that they will look at the height of the plants to be able to tell how different soils affected plant growth. Tell students “one way that we can be more precise about determining the height of the plant is to use a ruler to measure it. We will now practice using rulers before you start planning and carrying out your experiment.”

Technique:
(10 minutes – Full Class – SciTrek Lead)

Make sure that each student has a ruler and has their notebook turned to page 4. Place an example 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 the students, “Does anyone know what units these rulers measure in?” (millimeters) Show the students which side of the ruler corresponds to 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? (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 and confirm that the eraser is 70 mm long and 24 mm wide.

Have the students complete 2 and 3 by themselves. As students are working, volunteers should walk around and help students that are struggling. Make sure the students are making their measurements in mm.

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 3mm.
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 what math can we use to determine how much the plants have grown. Students should tell you subtraction. Tell students the next day SciTrek will be coming back and as a class determine how much time this will be. They will need this for one of their controls.

Tell students in their groups the first thing that they will do is remind their group leader what question they picked to investigate as well as the variable values that they picked. They will then use this information to come up with an experimental set-up and a procedure. When designing a procedure, they will start by getting plants that are 3 days old from their group leader. Once their procedure and results table are filled out they can start their experiment. If needed, tell students they should take their notebook and a pencil and get into their groups.

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

Once the 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.

Have students turn to page 5 in their notebooks while you turn to page 5 of the group notepad. Ask your group what they decided was going to be their changing variable and record this on the group notepad. After, have students copy the changing variable into their notebooks.

Ask your group what controls and values they selected. Write the control on the left side of the slash and the value of the control on the right side of the slash (example: 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 they need to include to complete their experiment. If students struggle, ask them when we are going to measure the plants. Students should be able to say today and when SciTrek comes back. Ask them what control this would be. They should be able to come up with time. Tell them the number of days before SciTrek comes back.

**Procedure:**

(19 minutes – Groups – SciTrek Volunteers)

Tell students they will now generate a procedure for their experiment. Ask students what a procedure is. They should tell you that it is a set of steps to conduct an experiment. Then, help students generate a procedure. Keep the procedure as brief as possible while still including the important information (key control values, changing variable values, and what data they will collect). An example step if light amount is the changing variable would be: “Put plants under level A) 4, B) 1, C) 0 (no light), D) 2, and E) 5 (full) lights.” Have students dictate the procedure to you while you transcribe it onto the group notepad. As each step is completed, have students copy it from the group notepad into their notebooks. Make sure that you do not continue on to the next step until each student has completed writing that step. An example procedure can be seen above.

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 fill up the graduated cylinder to the correct liquid amount. Therefore, your step in your procedure should read: Put A) 25 mL, B) 50 mL, C) 40 mL, D) 15 mL, and E) 5 mL of sugar into the graduated cylinder then add water to 100 mL and pour over plant.

**Results Table:**

(5 minutes – Groups – SciTrek Volunteers)

Fill out the variable section of the results table while students fill out the same section in their notebook. When writing the values, make sure that for controls, they only write the value of the control in Trial A.
and then draw an arrow through the remaining trials; for the changing variable, they write the value in each of the boxes. An example results table can be seen below.

![Example Results Table](image)

**Experiment:**

*(15 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 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 can be used to mark on the graduated cylinder to remind students how much liquid they need. Make sure that when students pour the water that they pour it 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. (Example, if you would like a total liquid amount of 100 mL and Trial A had 30 mL of nutrient, add 30 mL of nutrient to the graduated cylinder, and then add 70 mL of water to get a total liquid amount of 100 mL.)

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 the next time SciTrek is here they will get to measure how tall their plants have grown and get to determine the change in plant height.

Clean-Up:

Before you leave, have students attach their nametags to their notebooks and place them in the group box. Leave all plants and lights in the class; make sure that all lights are left on. Bring all other materials back to UCSB. In addition, put your lab coat into your group box.

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 in

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:

**RESULTS Table**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
<th>Trial E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Type</td>
<td>Plant</td>
<td>Soil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Type</td>
<td>Potting</td>
<td>Soil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid Amount</td>
<td>100 ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Amount</td>
<td>level 5</td>
<td>level 1</td>
<td>level 0</td>
<td>level 2</td>
<td>level 5</td>
</tr>
<tr>
<td>Nutrient Type</td>
<td>No</td>
<td>Nutrients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrient Amount</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>3 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Height</td>
<td>9mm</td>
<td>11mm</td>
<td>8mm</td>
<td>10mm</td>
<td>10mm</td>
</tr>
<tr>
<td>Change in Plant Height</td>
<td>30mm</td>
<td>41mm</td>
<td>41mm</td>
<td>31mm</td>
<td>23mm</td>
</tr>
<tr>
<td>Plant Diameter</td>
<td>23mm</td>
<td>30mm</td>
<td>39mm</td>
<td>27mm</td>
<td>15mm</td>
</tr>
<tr>
<td>Taller leaves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fat-tam leaves</td>
</tr>
</tbody>
</table>

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

**RESULTS Graph**

My experiment shows, *plants in the dark grew taller than plants in the light because the plant in no light (level 0) grew 39 mm and the plant in full light (level 5) only grew 13 mm.*

**RESULTS Graph and Summary**

My experiment shows, *plants shrunk.*

**RESULTS Graph and Summary**

My experiment shows, the less sugar you add to a plant the taller the plant because when we added 50 mL of sugar, the plant shrunk 13 mm and when we added 0 mL of sugar the plant grew 24 mm.
**Set-Up:**

SciTrek Volunteer:

Set out student notebooks.

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

Get your groups plants and have them ready to give to students.

**Introduction:**

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

If needed, while you are doing the introduction have the SciTrek volunteers set out the SciTrek 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 we have been working on the last two meetings and what they have learned. They should be able to tell you that they have been exploring plant growth and they found that soil type affects the plant height, soils that absorb more water allows 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 growth by measuring the plant heights. Ask students how they will determine how much their plant has grown since the start of their experiments. Students should say that you can subtract the initial height of the plant from 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.

If needed, tell the students to get into their groups.

**Experiment:**

*(30 minutes – Groups – SciTrek Volunteers)*

Pass-out the plants to each student, making sure that each student gets the plant that he/she was 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 sample group notepad below).

Ask the students how they will figure out how much the plant has grown over the last couple of days. They should say that if they take the final plant height and subtract the initial plant height from it, the difference will be the height that the plant has grown. 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. Students only need to record the change in plant height in their notebooks, not the math, to determine the change.

For groups with nutrient amount using salt or sugar as their changing variable, large amounts of these will cause the plant to shrink. Still find the difference between the two plants. Make sure that you record it as a positive number but put a star next to it (example: 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, number/size of leaves, etc. These can be recorded in the results table under “other observations”.

**Graph:**

*(10 minutes – Groups – SciTrek Volunteers)*

Once the results table has been completed and each student has every trial filled out, pass out 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 can be used as an example. On the bottom line, have students write the value of their changing variable (example: level 5), not the trial letter or the changing variable (example: A or light amount). This way when the pieces are rearranged, they will be able to see the values for each of the trials. Have students draw a line showing the appropriate plant height, as well as write in the value of the 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 on the written in measurement. Once each student has completed their graph piece for their plant, 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 only see the y-axis for the first graph piece.
After the pieces of the graph are taped into the group notepad, ask the students what their changing variable was. 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 summarize their findings. Challenge students to think about how their changing variable did or did not affect plant growth.

When writing their results summary, make sure that students start the statement with a claim about the trend or pattern in their data and then write “because” and use data to back up the claim. The data from this experiment is in the form of measurements.

If the values of their changing variable have an order (example: 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 (example 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 fertilizer a plant has, the taller 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 the experiment, write the word “because” and follow it with supporting data (when 1 mL of fertilizer was added the plant grew 5 mm taller and when 5 mL of fertilizer was added the plant grew 25 mm taller). The supporting data should be the two most convincing data points, typically the minimum and maximum plant height.

The results summary is still valid, and important, if it shows 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 notebooks on page 7.

Once students have filled out their results summary, have them fill in the sentence frame (page 8): “I acted like a scientist when__________.” This response should be unique and specific for each of the students and should not be “when I did an experiment.” If students are having trouble with this sentence frame, ask them what they did during each SciTrek visit.

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

Tell students that during the next SciTrek visit 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:

Before you leave, have students attach their nametags to their notebooks and place them in the group box. Take all plants, lights, and boxes back to UCSB. In addition, put your lab coat into your group box.

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 (full page)

Poster Parts:
- □ Scientists’ names
- □ Question
- □ Experimental set-up

- □ Sticker set for how to present graph (changing light amount or water/nutrient amount)
- □ (2) Pencils
- □ (2) Paperclips
- □ Wet erase markers
- □ Highlighter
- □ Scissors
- □ (2) Glues

□ 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

□ (5) Paperclips
□ (2) Glues
□ Scotch tape
□ Poster Part Packet with 1 packet of each poster color

□ (2) Pencils
□ (2) Wet erase markers

□ (2) Highlighters
□ Scissors
□ (2) Glues

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

- □ (2) Sticker sets for how to present graph (changing light amount or water/nutrient amount)
- □ (2) Pencils
- □ (5) Paperclips
- □ (2) Wet erase markers

### Set-Up:

SciTrek Lead:
Ask the classroom teacher for a place to leave the student posters in the classroom.

SciTrek Volunteer:
Set out student notebooks.
- • If students are not in the classroom before SciTrek starts, set out the notebooks where students should sit when they come into the classroom.
- • If students are in the classroom when SciTrek starts, set out the notebooks 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 the SciTrek volunteers set out the SciTrek 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 the students that 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 them 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 the experiment they did to their volunteer along with what they found out. They should try to do this without looking at their notebooks.

If needed, tell students to get into their groups.

**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 experiments that they did not do.

**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 part. Use the following guidelines when assigning poster parts:

<table>
<thead>
<tr>
<th>Number of Students in Group</th>
<th>Poster Division</th>
</tr>
</thead>
</table>
| 5                           | 1. Question  
  2. Experimental Set-Up  
  3. Procedure  
  4. Results Graph*  
  5. Results Summary |
|                             | Student that finishes 1st completes the results table (not presented) |
| 6                           | 1. Question  
  2. Experimental Set-Up  
  3. Procedure (Presents 1st half of procedure)  
  4. Results Table (Presents 2nd half of the procedure)  
  5. Results Graph*  
  6. Results Summary |
| 7                           | 1. Results Table (Presents names)  
  2. Question  
  3. Experimental Set-Up  
  4. 1st Half of Procedure  
  5. 2nd Half of Procedure  
  6. Results Graph*  
  7. Results Summary |

*Procedure can be cut in half.

*Give the results graph to the student that is most confident in presenting.
Once all writing sections are completed, have students draw a picture of their experiment or how they acted like a scientist.

In the students’ notebooks, highlight and number the section 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.

### #3 Experimental Set-Up

**Changing Variable: Light Amount**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Changing Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Amount</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Procedure

1. Set 5 test plants in potting soil and
2. Pour 100 mL of water on each plant and no nutrients.
3. Put plants under ideal light, 81.1, 60%, and R.I.S. light.
4. Soil: 3 days.

Measure plant height and record in final page under the plant growth.

### #4 Procedure

1. Set 5 test plants in potting soil and
2. Pour 100 mL of water on each plant and no nutrients.
3. Put plants under ideal light, 81.1, 60%, and R.I.S. light.
4. Soil: 3 days.

Measure plant height and record in final page under the plant growth.

### #5 Results and Summary

**Graph and Summary**

**Graph 1:**

- **Changing Variable:** Light Amount
- **Measurement:** Change in Plant Height (mm)

**Graph 2:**

- **Changing Variable:** Light Amount
- **Measurement:** Change in Plant Height (mm)

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

**Changing Light Amount**

The plant under light level ________ grew ________ mm.

**Changing Water/Nutrient Amount**

The plant with ________ mL of ________ grew ________ mm.

(You should fill this blank out for the student)
Then practice reading the five sentences with that student. For the poster below, the sentence would be: The plant under light level 5 grew 40 mm. Leave the “changing variable value” and “measurement” blanks empty. An example of the sentence frame for a group that changed the nutrient amount would be: The plant with 50 mL of salt water grew 0 mm. Make sure you fill in the second blank of the sentence frame for changing water/nutrient amount (example: salt water) for the student in the sentence frame but leave the other blanks (“changing variable value” and “measurement”) empty.

As soon as students have completed some of their pieces, start gluing them onto the large poster paper exactly as they are arranged in the example below. 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.

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 the 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 SciTrek visit and that you are looking forward to hearing about all of their experiments.
Clean-Up:

Before you leave, have students attach their nametag to their notebook and place them in the group box. Leave student posters in the classroom. Bring all materials back to UCSB. In addition, put your lab coat into your group box.

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
- Highlighter

Lead Box:
- (3) Extra student notebooks
- Lead instructions
- Plants picture packet
- Lead lab coat
- Scotch tape
- Teacher evaluation
- Time card
- (2) Sticker sets for how the present graph (changing light amount or changing water/nutrient amount)
- (2) Wet erase markers
- (4) Paperclips
- (2) Highlighters
- Scotch tape

*Student posters should already be in the classroom.
Set-Up:

SciTrek Lead:

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.

Organize the posters so that groups that had the same changing variable present back to back.

Give the classroom teacher the “Evaluation of the SciTrek Program by Participating Teachers” form. Ask the teacher to fill this form out and give it back to you the next time you are there.

SciTrek Volunteer:

Set out the SciTrek notebooks/nametags. Today students will be sitting in their regular classroom seats during poster presentations.

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

Tell students that today they will present their poster 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 the students that 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)

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.

Once students have gotten to your group, have students explain what they did and what they learned from their experiment. 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 to predict the height of the plant if they poured 250 mL of water over the plant (this would be an amount of water that they did not test). Possible answer: 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 your 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 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.

**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 that we have been working on solving?” Students should tell you, “What variables affect plant growth?” Ask the class, “Why are we interested in answering this question?” Students should say that if they can determine the variables that affect plant growth, they 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 tell you each group’s changing variable after the group says their question so that you can record it. You will then record the values of the changing variable and the data that was taken when the group presents the 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. 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 SciTrek 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?” Each group should answer approximately five questions (one question per student).

Below is an example of notes that the lead could have taken during the poster presentations.

![Image of data chart]

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 seen below. Do not expect students to know highlights from experiments that were not run.

- The brighter the light, the shorter the plant (for plants under ~10 days old)
- Plants that are under brighter lights are greener and have more leaves than plants under dimmer lights
- The amount of water does not affect the height of the plant, unless there is no water in the reserve cup and then the plant will die.
- The greater the amount of salt, the shorter the plant
- The greater the amount of sugar, the shorter the plant. This is because the sugar causes the soil to become sticky and the plant can no longer grow.
- The larger the amount of fertilizer the taller the plant. This effect is really small and might not be observed by students

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

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

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

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, so 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 SciTrek 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 SciTrek volunteer.

**Clean-Up:**

Before you leave, collect the plastic nametag holders and put them in the group box. Students can keep the paper part of their nametag. Collect notebooks and place them in the group box. Leave student posters in the classroom. Bring all materials back to UCSB. Remove tape from the lid of your group box and place inside. In addition, remove all materials from lab coat pockets, remove your nametag, unroll lab coat sleeves, and put your lab coat in the dirty clothes bag at UCSB.

**Day 6: Observation Assessment/Tie to Standards/Content Assessment**

**Schedule:**

- Observation Assessment (SciTrek Lead) – 10 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
- (25) Observation assessments
- (25) Content Assessment
- Time card
- (2) Pencils
- (25) Rulers (mm)
- (25) Black beads
- (2) Wet erase markers

**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
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>Potting 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.

3. What do plants in the light need to grow? Water

4. Do plants grow in the dark?

Plot the data for the plants with water and with no water in the dark.

5. What did plants in the dark need to grow? Water

6. Label the following picture of plants in the light with water with the correct day number (0, 5, 10, or 15 days) on which they were taken.

   - Day 0
   - Day 5
   - Day 10
   - Day 15

7. Label the following picture of plants in the dark with water with the correct day number (0, 5, 10, or 15 days) on which they were taken.

   - Day 0
   - Day 5
   - Day 10
   - Day 15
Set-Up:

SciTrek Lead:

Collect the “Evaluation of the SciTrek Program by Participating Teachers” form from the teacher. If they have not filled out the form, ask them to do it during the tie to standards activity. 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 example poster-size notebook pages to the front board.

Have 6 plants ready to show students.

Pass-out notebooks to students. If you do not have time to get set-up before the start of the module ask the teacher to pass-out the notebooks during the observation assessment.

At end of the day get the lab coat form the teacher.

Observation Assessment:
(10 minutes – Full Class – SciTrek Lead)

“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 the 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.

8. Is water or light more important for plant growth?
   - WATER
   - LIGHT

9. Which would you predict to be taller at day 10, a plant in the light with water or a plant in the dark with water?
   - DARK
   - LIGHT

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

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

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

13. What other variables might affect plant growth? (List at least 2)
    1. soil amount
    2. temperature
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 students’ names are on the top of the papers.

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. Then collect the papers from students’ verifying that their names are on the top of the papers.

**Tie to Standards:**
*(40 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 an example notebook on the document camera and turn to page 8.

Ask the class what a prediction is. They should realize that a prediction is the best guess we are able to make about a system using previous knowledge. Ask them if they think the growth of plants is predictable. They should say 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 for 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 example 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 example 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 (8 minutes)

Ask the students to predict what they 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. Ask the rest of the class if they agree/disagree with thumbs up/thumbs down. 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 would not grow at all over a given amount of time. An example of this graph can be seen below on the left.

Now ask the students to predict what they 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. Ask the rest of the class if they agree/disagree with thumbs up/thumbs down. 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 (9 minutes)

Have the students turn to page 9 in their notebooks. 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 the plant was on day 0. They should respond 0 mm. Show them where 0 mm is on the graph and draw a line and write the numeric value on top of the line. Repeat this process for the other three points. Then have students explain what happened and what these 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 either light or water to grow.
Place the class prediction graph (page 3, picture packet) over the example 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 the students how tall the plant was on day 0. They should respond 0 mm. Put your finger at zero and tell the students to tell you to stop once you reach the appropriate level for day 0. Once you have reached the level draw a line. Ask the students how tall the plant was on day 5. They should respond 23 mm. Repeat the process by putting your finger at zero and telling 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, and write the numeric value over the line and quickly shade below. Tell the students when they are shading in 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 the 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 example notebook to have students compare their prediction to the actual results.

Ask the 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 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 (4 minutes)

Have students predict what they 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. Ask the rest of the class if they agree/disagree with thumbs up/thumbs down. Once the class has reached a consensus, use their ideas to make a bar 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.

![Graph of dark/no water plant growth](image)

Ask the students to predict what they 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. Ask the rest of the class if they agree/disagree with thumbs up/thumbs down. 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.

![Graph of dark/water plant growth](image)

After you have completed the graph 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 notebooks. 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. SciTrek volunteers can walk around and help students if needed. While students are plotting the data, remove the notebook from the document camera and plot the data on the example notebook. After ~3 minutes put the example notebook under the document camera and have students check their graph. Example student work is seen below. After the data has been plotted, ask the 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 this data compares 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 example 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. SciTrek volunteers can walk around and help students if needed. 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 the 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 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 example notebook to have students compare their prediction to the actual results.

Ask the 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 they 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 they 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 notebooks. Tell students that you 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 days of your experiment. But your pictures got out of order and you would like them to 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 the appearance of plants differs when they were in the light and in the dark. Students should respond that the plants that were in the dark were taller but that they were also less green, skinny, and had very small leaves. Students should say that 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 notebooks.

Ask students if they think water or light is more important for plant growth and why. One possible student answer is 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 page 9 and 10 of the student notebook. Circle water for the answer to question 8.

Ask the 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 the 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.

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.

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 the 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 they changed in their own experiments (water amount, nutrient amount, light amount).

Now that all students know the definition of a variable, ask them what other variables 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 example notebook.

Temperature
Type of soil
Size of container
Type of plant
Amount of soil

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 that 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 SciTrek notebooks and to place the notebook in the corner of their desk. Pass out the Content Assessment and a ruler to each student. Tell students to put 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 the students that you have enjoyed working with them, and that you hope they continue to see themselves as scientists and explore the world around them.

**Clean-Up:**

Bring all materials back to UCSB.

**Extra Practice Solutions:**

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EXTRA PRACTICE
Observations

Observation: A description using your 5 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
   - Not an observation

2. The boy is wearing a black shirt:  
   - Observation
   - Not an observation

3. The measuring cup is taller than the oil bottle:  
   - Observation
   - Not an observation

4. Cooking is exciting:  
   - Observation
   - Not an observation

5. There are equal number of measuring cups and bottles:  
   - Observation
   - Not an observation

6. The boy's hair is black:  
   - Observation
   - Not an observation

7. The boy is making something to eat:  
   - Observation
   - Not an observation