Module 2: Plants

2nd Grade

About the Instructions:

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

Activity Schedule:

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

Day 1: Observation Activity/Observations/Question/Materials Page (60 minutes)*
Day 2: Experimental Set-Up/Procedure/Results Table/Experiment (60 minutes)*
Day 3: Experiment/Graph/Results Summary (60 minutes)
Day 4: Poster Making (60 minutes)
Day 5: Poster Presentations (60 minutes)
Day 6: Draw a Scientist/Tie to Standards/Content Assessment (60 minutes)*
*This schedule assumes the teacher has given the observation assessments before SciTrek comes on Day 1 and Day 6 of the module, **and** has done the technique activity before SciTrek comes on Day 2.

The exact module dates and times are posted on the SciTrek website (chem.ucsb.edu/scitrek/elementary) under the school/teacher. The times on the website include transportation time to and from the SciTrek office (Chem 1204). Thirty minutes are allotted for transportation before and after the module, therefore, if a module was running from 10:00-11:00, then the module times on the website would be from 9:30-11:30.

Student Groups:

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

NGSS Performance Expectation Addressed:

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

Common Core Mathematics Standards Addressed:

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

object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.)

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

Learning Objectives:

1. Students will be able to list at least two variables that affect plant growth.
2. Students will be able to use a ruler to make repeated measurements of an object, and compare the measurements to determine the difference.
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 they acted 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 approximately five students.

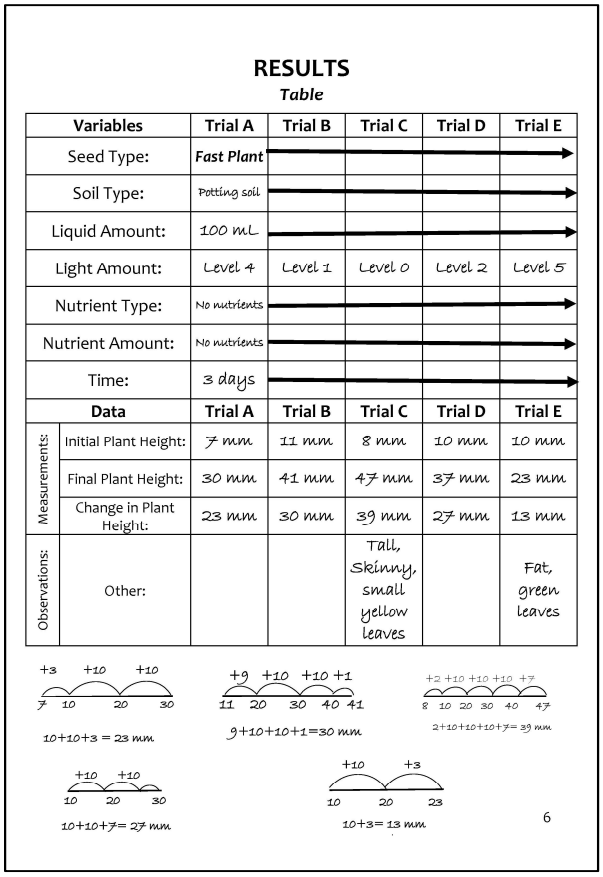
1. Year 1
    a. Classroom teacher <u>leads a group</u> (Role: Group Lead; this role is referred to as a volunteer in these instructions)
2. Year 2
    a. Classroom teacher <u>co-leads the modules</u> with a SciTrek staff member (Role: Co-Lead)
        i. Classroom teacher will be responsible for leading entire class discussions (Ex: observation activity).
        ii. Classroom teacher will be responsible for time management.
        iii. Classroom teacher will be responsible for overseeing volunteers and helping any groups who are struggling.
        iv. Classroom teacher will be responsible for all above activities. The SciTrek co-lead will only step in for emergencies.
        v. The SciTrek co-lead will run the tie to standards activity.
3. Year 3 and beyond
    a. Classroom teacher <u>leads the modules</u> (Role: Lead)
        i. Classroom teacher will be responsible for leading entire class discussions (Ex: observation activity).
        ii. Classroom teacher will be responsible for time management.
        iii. Classroom teacher will be responsible for overseeing volunteers and helping any groups who are struggling.
        iv. A SciTrek staff member will co-lead the tie to standards activity with the classroom teacher for year 3.

SciTrek staff is counting on teacher involvement. Teachers should notify the SciTrek staff if they will not be present on any day(s) of the module. Additional steps can be taken to become a SciTrek lead faster than the proposed schedule above. Contact scitrekelementary@chem.ucsb.edu to learn more.

In addition, teachers are required to come to UCSB for the module orientation, approximately one week prior to the start of the module. Contact scitrekelementary@chem.ucsb.edu for exact times and dates, or see our website at 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 who will be helping in their classroom. If you are not able to come to the orientation at UCSB, you must complete an online orientation. Failure to complete an orientation for the module will result in loss of priority registration for the following year.

Prior to the Module (at least 1 week):

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



RESULTS

Table

Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:	30 mm	41 mm	47 mm	37 mm	23 mm
	Change in Plant Height:	23 mm	30 mm	39 mm	27 mm	13 mm
Observations:	Other:			Tall, Skinny, small yellow leaves		Fat, green leaves

During the Module:

Note: We **highly recommend** you complete the initial observation assessment prior to **Day 1** of the module, the technique activity prior to **Day 2** of the module, and the final observation assessment prior to **Day 6** of the module.

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

Days 1-4:

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

Days 2-3:

Have a spot in your classroom where 7 lights can be plugged in (at least 3 plugs, we will provide extension cords), and placed on top of ~5 Xerox boxes. These lamps will need to be kept **on** until the next SciTrek meeting.

Days 5-6:

Have 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 (approximately one week before your module, exact orientation times are found at: chem.ucsb.edu/scitrek/elementary). This will allow the SciTrek staff to provide you with all needed materials.

Day 1:

If you would like to have more time for your students to make observations and choose their changing variable, you can do one or both of the following activities before SciTrek arrives:

1) Observation assessment **(highly recommended)**
2) Observation activity

Day 2:

If you would like to have more time for your students to design their experiments, you can go over the technique activity before SciTrek arrives **(highly recommended).**

Day 5:

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

Day 6:

If you would like more time for the tie to standards activity, you may give the observation assessment before SciTrek arrives **(highly recommended).**

Materials Used for this Module:

1. Wisconsin Fast Plants seeds (Amazon)
2. 9 oz clear plastic cups (Smart and Final) with 0.5-inch hole drilled in the center of the bottom
3. 20 oz clear plastic cups (Smart and Final)
4. 3 oz cups any material (grocery store)
5. Multipurpose terry towel 14 in x 17 in (Home Depot) cut into 5 cm x 15 cm pieces
6. Kellogg's Raised Bed and Potting Mix (Home Depot)
7. Vermiculite (Home Depot)
8. Aquarium rocks (Petco)
9. Water
10. Sugar solution (mixture with half Karo light corn syrup, and half water)
11. Saturated salt solution (boil water, and then add in as much salt as you are able to dissolve in the solution—about 36 g of salt for every 100 mL of water)
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 pipettes (droppers) (Fisher part number: 13-711-7M)

16. Metric Ruler 30 cm/300 mm (Carolina Biological part number: 702613) Note: Cover cm part with masking tape so students measure in millimeters.
17. Individual Plant Light (Carolina Biological part number: 666900)
18. Light bulbs (60 W equivalent LED (800 lumen) light bulbs) (Philips part number: 046677455507). Note: 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 20 cm neutral density filter over the hole (Solar Graphics, www.coloredfilms.com, filter cut in half). The different amounts of light are made by having the light from a 60 W equivalent LED bulb go through the filters: SGXND 5 (level 1), SGXND 20 (level 2), SGXND 50 (level 3), and SGXND 70 (level 4). Level 0 is a Xerox box with no holes and no light and level 5 full light and no Xerox box is used. A picture of one of the boxes is shown below. A picture of one of the boxes is shown below.

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

Module Notes:

~7 days prior to Day 1 of the module:

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

3 days prior to Day 2 of the module:

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

Types of Documents:

Notebook:

One given to every student and is filled out by the student. The lead will use a notebook to write in as an example for students. The notebook the lead uses is referred to as the class notebook in these instructions.

Notepad:

One given to every group and is filled out by the volunteer. In these instructions, the examples are narrower and taller than the notebook pages.

Picture Packet:

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

In these instructions, all other example documents are labeled.

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

Note: We **highly recommend** teachers complete the observation assessment prior to Day 1 of the module. The suggested times in the lesson plan below are assuming the observation assessment was given prior to SciTrek's arrival.

Schedule:

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

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

Materials:

(4) Volunteer Boxes:

- ☐ Student nametags
- ☐ (7) Notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ (3) Materials pages (one for each possible variable, 3 total)
- ☐ (2) Pencils
- ☐ (7) Mechanical pencils
- ☐ (2) Grease pencils
- ☐ Wet erase marker
- ☐ Scotch tape
- ☐ Paper towels

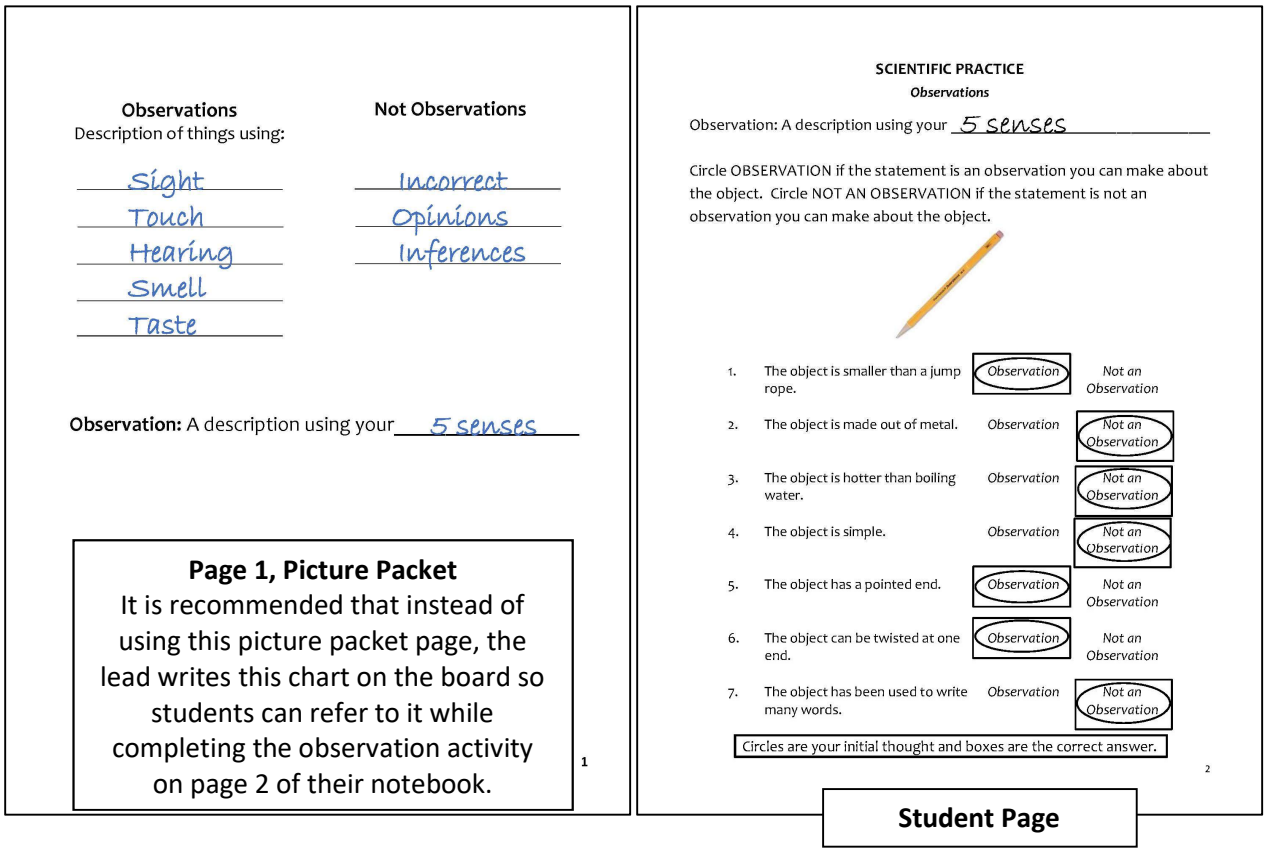
Other Supplies:

- ☐ (4) 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 notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat
- ☐ Observation assessment (if teacher did not take assessments then (25) assessments and (25) cotton balls)
- ☐ Time card
- ☐ (3) Materials pages (one for each possible variable, 3 total)
- ☐ (2) Pencils
- ☐ (2) Grease pencils
- ☐ (2) Wet erase markers
- ☐ Black pen
- ☐ (4) Markers (orange, blue, green, purple)
- ☐ Scotch tape
- ☐ Paper towels
- ☐ Water (at least 200 mL)
- ☐ (3) 100 mL Graduated cylinders
- ☐ (2) 250 mL Graduated cylinder
- ☐ 20 oz Cup unmarked
- ☐ 9 oz Cup with hole in bottom
- ☐ (2) 3 oz Colored cups
- ☐ Cloth strip
- ☐ Vermiculite
- ☐ Dropper
- ☐ (2) Polarizing filters

Notebook Pages, Notepad Pages, and Picture Packet Page:



Observations
Description of things using:

Sight
Touch
Hearing
Smell
Taste

Not Observations

Incorrect
Opinions
Inferences

Observation: A description using your 5 senses

1

SCIENTIFIC PRACTICE
Observations

Observation: A description using your 5 senses

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

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

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

2

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

Student Page

SCIENTIFIC PRACTICE

Observations

Observation: A description using your 5 senses

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

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

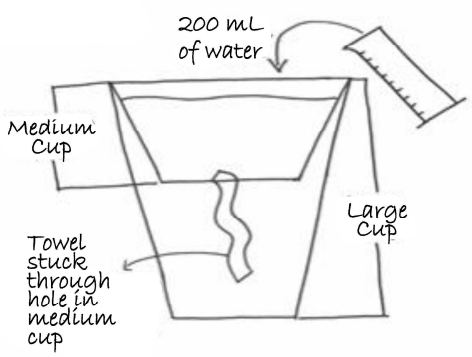
Circles are your initial thought and boxes are the correct answer.

2

Lead Page

OBSERVATIONS

Experimental Set-Up:



- 2 small cups of soil in medium cup
- Water poured through soil
- Cup put under full light

1

OBSERVATIONS

Seeds Planted: Today

Cup A:
- Potting soil
- Water is dirty
- Soil is damp

Cup B:
- Vermiculite
- Water is clear
- Soil is damp

Cup C:
- Rocks
- Water is clear
- Soil is dry

Other Observations:
- Vermiculite had least amount of water in big cup, absorbed the most water
- Rocks had most amount of water in big cup, absorbed the least water

2

OBSERVATIONS

Seeds Planted: 7 days ago

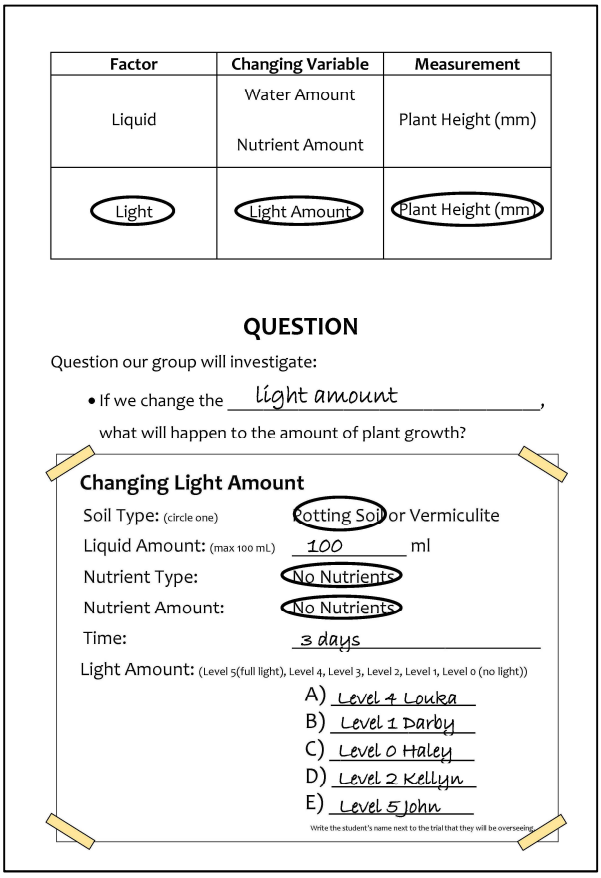
Cup 1:
- Potting soil
- Plant
- Soil is damp

Cup 2:
- Vermiculite
- Plant
- Soil is damp

Cup 3:
- Rocks
- No plant
- Soil is dry

Other Observations:
- Plant in potting soil is the tallest.
- Less water in the large cups with seeds planted seven days ago, than planted today

3



Factor	Changing Variable	Measurement
Liquid	Water Amount Nutrient Amount	Plant Height (mm)
Light	Light Amount	Plant Height (mm)

QUESTION

Question our group will investigate:

- If we change the light amount,

what will happen to the amount of plant growth?

Changing Light Amount

Soil Type: (circle one) Potting Soil or Vermiculite

Liquid Amount: (max 100 mL) 100 ml

Nutrient Type: No Nutrients

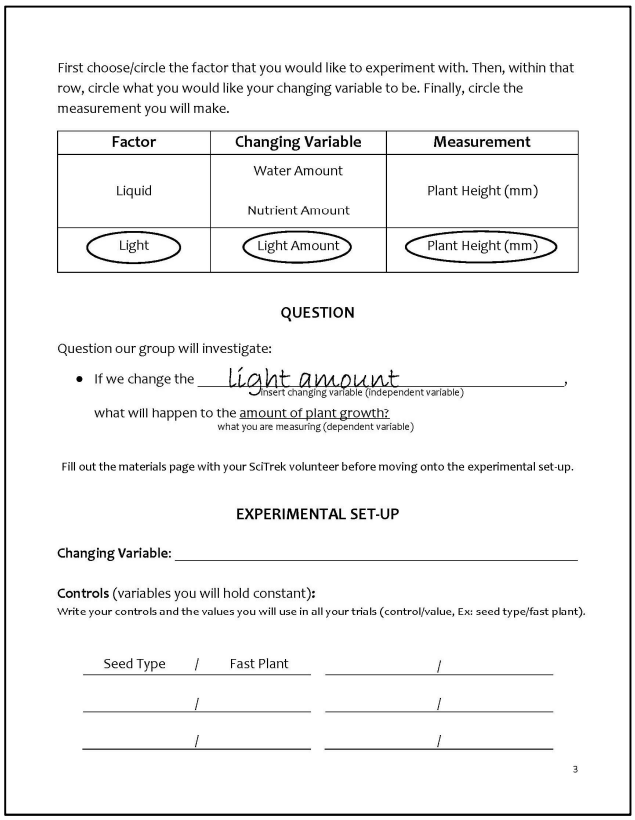
Nutrient Amount: No Nutrients

Time: 3 days

Light Amount: (Level 5(full light), Level 4, Level 3, Level 2, Level 1, Level 0 (no light))

A) Level 4 Louka
B) Level 1 Darby
C) Level 0 Haley
D) Level 2 Kellyn
E) Level 5 John

Write the student's name next to the trial that they will be overseeing.



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

Factor	Changing Variable	Measurement
Liquid	Water Amount Nutrient Amount	Plant Height (mm)
Light	Light Amount	Plant Height (mm)

QUESTION

Question our group will investigate:

- If we change the light amount (insert changing variable (independent variable)),

what will happen to the amount of plant growth? (what you are measuring (dependent variable))

Fill out the materials page with your SciTrek volunteer before moving onto the experimental set-up.

EXPERIMENTAL SET-UP

Changing Variable: _____

Controls (variables you will hold constant)**:**
Write your controls and the values you will use in all your trials (control/value, Ex: seed type/fast plant).

Seed Type / Fast Plant		/
/	/	/
/	/	

3

Preparation:

SciTrek Lead:

1. Get the observation assessments and put them in the lead box.
2. Make sure volunteers are writing their names and group colors on the whiteboard.
3. Make sure volunteers are passing out nametags.
4. Make sure volunteers are setting up for the initial observation.
5. Set up the document camera for the observation activity (page 1, picture packet and page 2, notebook).
6. It is recommended that you copy page 1 of the picture packet onto the board. This way students can look at this observation chart while they are doing the observation activity.
7. Assemble the experimental set-up demonstration.
    a. Fill two 100 mL graduated cylinders with 100 mL of water each.
    b. Fill two 3 oz. cups completely full of vermiculite.
    c. Plug in the lamp.
    d. Set out materials above, along with large cup, medium cup with hole, and cloth strip, in a place that students can see.
8. Have two polarized filters and a 250 mL graduated cylinder available to show students during the observation discussion.

SciTrek Volunteers:

1. On the front whiteboard in the classroom, write your name, and the color of the group (orange, blue, green, or purple) you will be working with.
2. Pass out nametags.
3. Assemble the experimental set-up (shown in picture below) on a tray.
    a. Get three plants (one of each: 1) potting soil, 2) vermiculite, 3) rocks) that are 7 days old, and place on tray.
    b. Get three plants (one of each: A) potting soil, B) vermiculite C) rocks) that were just made, and place on tray.
4. Have notebooks and mechanical pencils available to pass out.

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

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

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

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

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

"Before we start with the module, we will determine how your ideas on observations are developing." Pass out the observation assessment and a cotton ball to each student, and have them write their name, teacher's name, and date at the top of the assessment. Tell students, "When doing this assessment, you should work individually, so there should be no talking." As you are giving the assessment, walk around the room, and verify students have written their name on their assessments.

At the top of the page, have students write in what the definition of an observation is. Read the instructions aloud for questions *2-8* to students. Then, read each of the statements and tell students, "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." When they are finished, collect the assessments and the cotton balls and verify the students' names are on the papers.

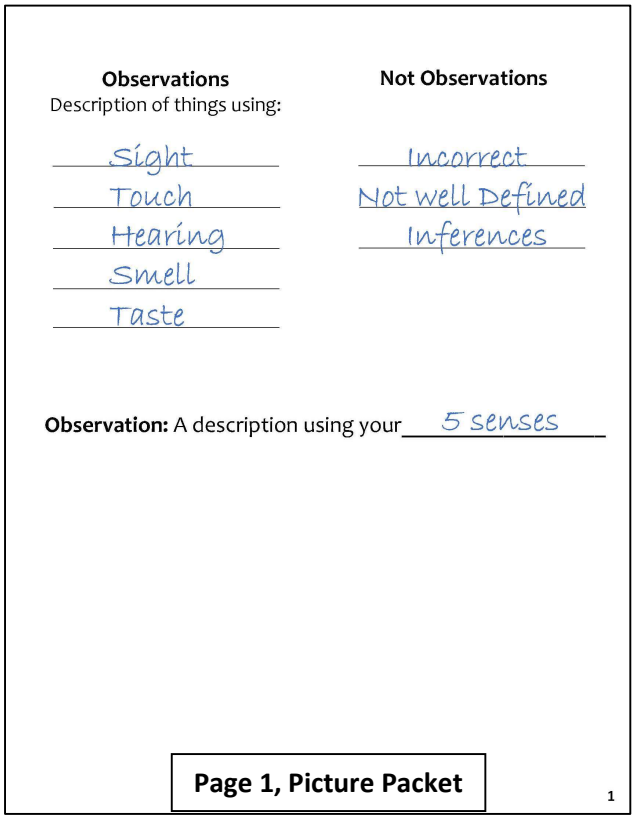
Observation Activity:
(12 minutes – Full Class – SciTrek Lead)

Have volunteers pass out a notebook to each student.

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

Tell the class, "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 that have already been growing."

If the chart from page 1 of the picture packet is not copied onto the board, then put page 1 of the picture packet under the document camera (shown below). Tell students, "Scientists make many observations." Ask students, "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, an observation is a description using your 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 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.



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

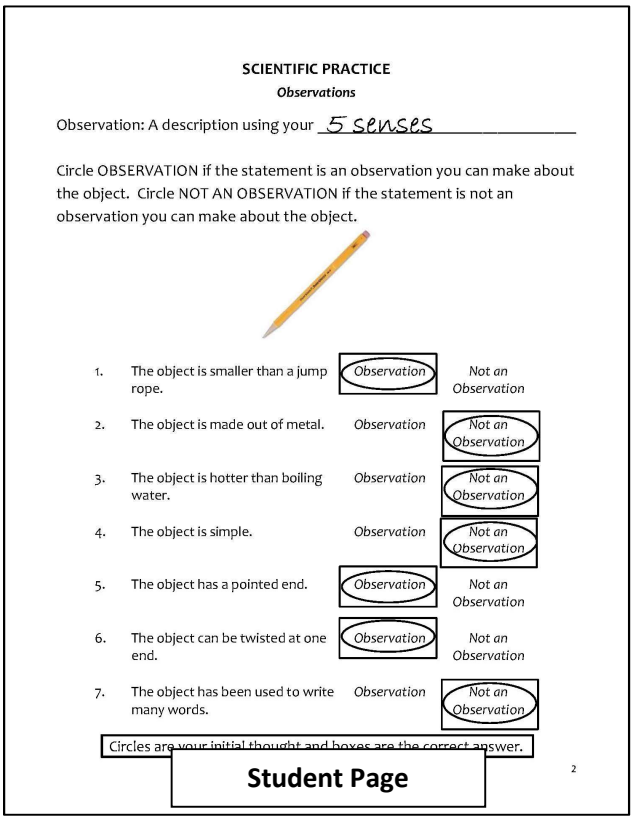
Have the volunteers pass-out a mechanical pencil, found in their group boxes, to each student.

Tell students, “We are now going to do an activity where you look at a list of possible observations about the object you just received (mechanical pencil). You will then decide whether each statement is an observation, or not an observation, about the object.”

Have students turn to page 2 of their notebooks, and place the class 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. Tell students, “We will go over each of the statements as a class.” Read each statement to students, then give them ~15 seconds to circle the answer. For each statement, have a student share whether they think the statement is an observation or not. Then, have the class vote using thumbs up/thumbs down if they agree/disagree with the student’s reasoning. If many students in the class disagree with the response of the original student, have another student explain why they disagree. If needed, let them have “mini conferences” with the students that are sitting in their area. After the class has come to a consensus, tell students, “We will now box the correct answer. Even if you got the answer wrong you should not erase your original answer because this will let you see which concepts/categories you are struggling with.” Box the correct answer on the class notebook for students to copy.

For each statement that is an observation, have students identify the sense (touch, taste, smell, hearing, or sight) that was used to make the observation. Write this in the margins of the class notebook. For each statement that is not an observation, have students identify why the statement is not an observation (incorrect observation, opinion, or inference). Write down why the statement is not an observation in the margins of the class notebook. Students do not need to write these in the margins in their notebook. See the example below for the student and lead pages.



SCIENTIFIC PRACTICE

Observations

Observation: A description using your 5 senses

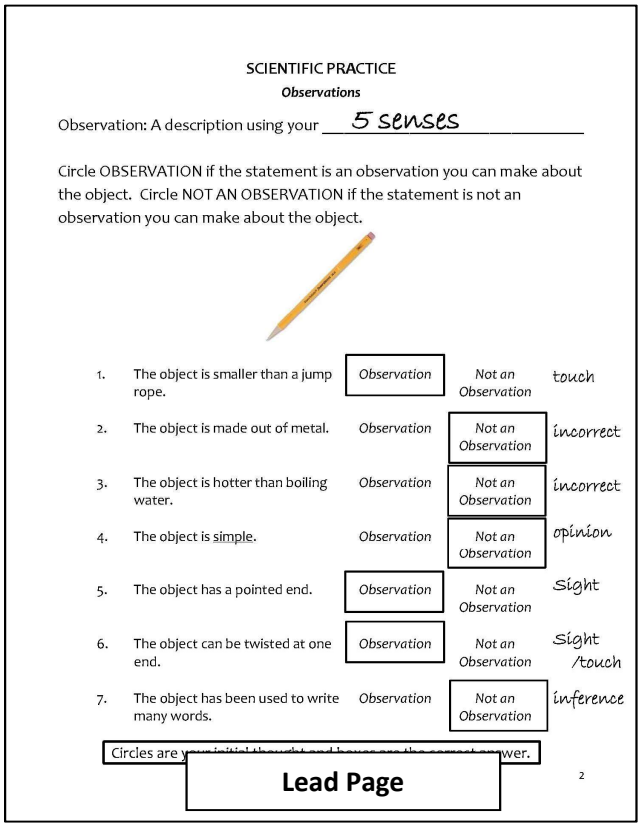
Circle OBSERVATION if the statement is an observation you can make about the object. Circle NOT AN OBSERVATION if the statement is not an observation you can make about the object.

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

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

2

Student Page



SCIENTIFIC PRACTICE

Observations

Observation: A description using your 5 senses

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

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

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

2

Lead Page

Below are the answers to 1-7 on page 2 in detail.

1: The object is smaller than a jump rope.

Is the statement an observation, or not an observation?

Observation

What sense did you use to make this observation?

Sight

2: The object is made out of metal.

Is this statement an observation, or not an observation?

Not an observation

Why is this statement not an observation?

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

What sense did you use to tell this?

Sight

3: The object is hotter than boiling water.

Is this statement an observation, or not an observation?

Not an observation

Why is this statement not an observation?

The object is cooler than boiling water, not hotter (Incorrect observation).

What sense did you use to tell this?

Touch

4: The object is simple.

Is this statement an observation, or not an observation?

Not an observation

Why is this statement not an observation?

Some people might think that mechanical pencils are simple, but others might think they are complex (not well defined/opinion).

5: The object has a pointed end.

Is this statement an observation, or not an observation?

Observation

What sense did you use to make this observation?

Sight

6: The object can be twisted at one end.

Is this statement an observation, or not an observation?

If you have twisted one end of the pencil, then the statement is an observation.
If you have not tested this yet, then, the statement is not an observation, it is an inference.
Note: Make sure that all students twist the end of the object making this statement an observation. Tell students, “Sometimes inferences can be turned into observations by testing them.”

What sense did you use to make this an observation?

Touch and sight

7: The object has been used to write many words.

Is this statement an observation, or not an observation?

Not an observation

Why is this statement not an observation?

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, it could only be used to draw pictures.

Once students have completed the observation activity, see if they can give you one or two more observations about the object. While students are giving other observations, the volunteers should walk around and collect the mechanical pencils from students and put them back in their group boxes.

Observation Discussion:
(7 minutes – Full Cass – SciTrek Lead)

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

Tell students, “In order to find out how the soil type affects plant growth, I planted seeds in three different soil types (potting soil, vermiculite, and rocks), 7 days ago, and I am now going to show you all how I 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 students. First, ask students, “Do you remember what this soil is called?” They worked with vermiculite in their first module so they may know the name. If the students don’t remember, tell them, "This is a special type of soil called vermiculite.” Have them say the

word vermiculite with you so that they remember the word. Pour two small (3 oz) cups of vermiculite into the medium cup. Place an imaginary seed into the cup of vermiculite (students should think the seed is real). Tell students, "The seed I have just planted is called a fast plant." Have a student tell you the amount of water in each of the graduated cylinders (100 mL each), and then slowly, in a circular fashion, pour the 200 mL of water on the vermiculite. Place the cup system under the lamp, and turn the light on.

Tell students, "You will first share, with your volunteer, observations about what I just showed you, which is the experimental set-up. Then, you will make observations of the seeds that were just planted this morning, which will be in lettered cups. Finally, you will finish by making observations about the plants that are 7 days old, which are in numbered cups. It is important to only generate observations, and not inferences, or opinions. You will now get in your groups." Tell each colored group where to go, and to bring their notebook and a pencil.

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

Observations:
(17 minutes – Groups – SciTrek Volunteers)

Once students come over to your group, have them sit in boy/girl fashion. Verify the table is set up as described in the set-up section.

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

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

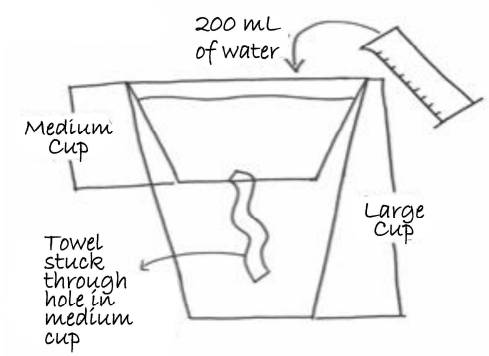
After your group has made observations about the lettered cups, have students make observations of the cups that were planted seven days ago, which are labeled by numbers, and record these on page 3 of the group notepad. Repeat the process by recording the contents of each cup, and then general observations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

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

An example filled out initial observations is shown below.

OBSERVATIONS

Experimental Set-Up:



- 2 small cups of soil in medium cup
- Water poured through soil
- Cup put under full light

1

OBSERVATIONS

Seeds Planted: Today

Cup A:
- Potting soil
- Water is dirty
- Soil is damp

Cup B:
- Vermiculite
- Water is clear
- Soil is damp

Cup C:
- Rocks
- Water is clear
- Soil is dry

Other Observations:
- Vermiculite had least amount of water in big cup, absorbed the most water
- Rocks had most amount of water in big cup, absorbed the least water

2

OBSERVATIONS

Seeds Planted: 7 days ago

Cup 1:
- Potting soil
- Plant
- Soil is damp

Cup 2:
- Vermiculite
- Plant
- Soil is damp

Cup 3:
- Rocks
- No plant
- Soil is dry

Other Observations:
- Plant in potting soil is the tallest.
- Less water in the large cups with seeds planted seven days ago, than planted today

3

Question Discussion:
(3 minutes – Full Class– SciTrek Lead):

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

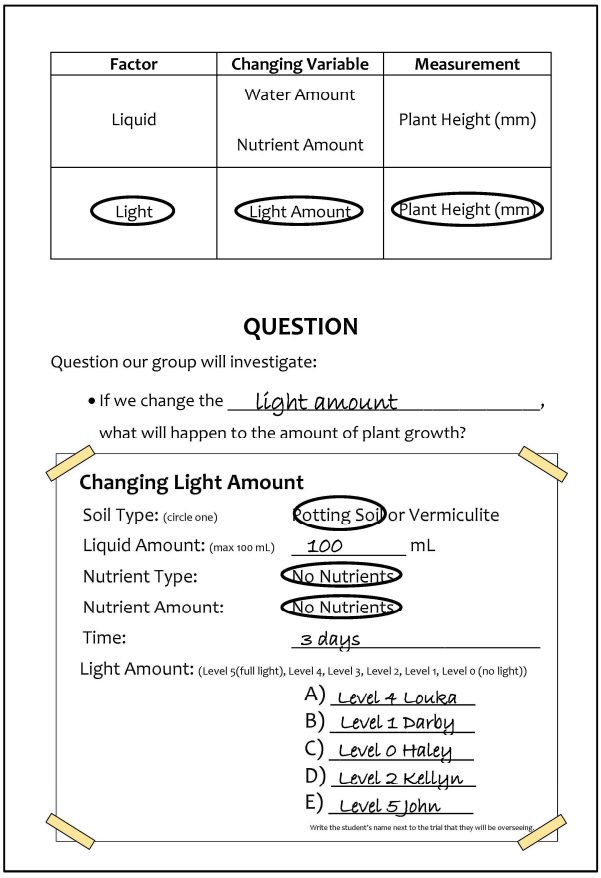
Review, with the whole class, how the plants changed over time. Ask students, “Does soil type affect plant growth, and what evidence do you have to support this?” Possible student response: soil type affects plant growth, because we observed the plants in the different soil types were different heights.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

Tell students, “Now, you are going to pick a variable, with your group, to investigate.” Make sure students understand that variables are parts of the experiment that can be changed. Tell students, "You can choose to explore whether something about the liquid, or light, affects the amount of plant growth. If you are interested in exploring how something about the light affects plant growth, you can change the light amount. To manipulate the light amount, you 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. Tell students, “If you are interested in exploring how something about the liquid affects plant growth, you can manipulate either the water amount, or the nutrient amount. The nutrients that you will be able to choose from include sugar, fertilizer, and salt. If you are interested in exploring how water amount affect plant growth, you will get to use the special 250 mL graduated cylinder, which is over double the size of the graduated cylinders that the other students will use in their experiments.” Show students the larger graduated cylinder. Tell students, “You will now vote for the changing variable you will explore, which will allow you to determine your group’s experimental question.”

Question:
(11 minutes – Groups – SciTrek Volunteers)

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

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



Factor	Changing Variable	Measurement
Liquid	Water Amount Nutrient Amount	Plant Height (mm)
Light	Light Amount	Plant Height (mm)

QUESTION

Question our group will investigate:

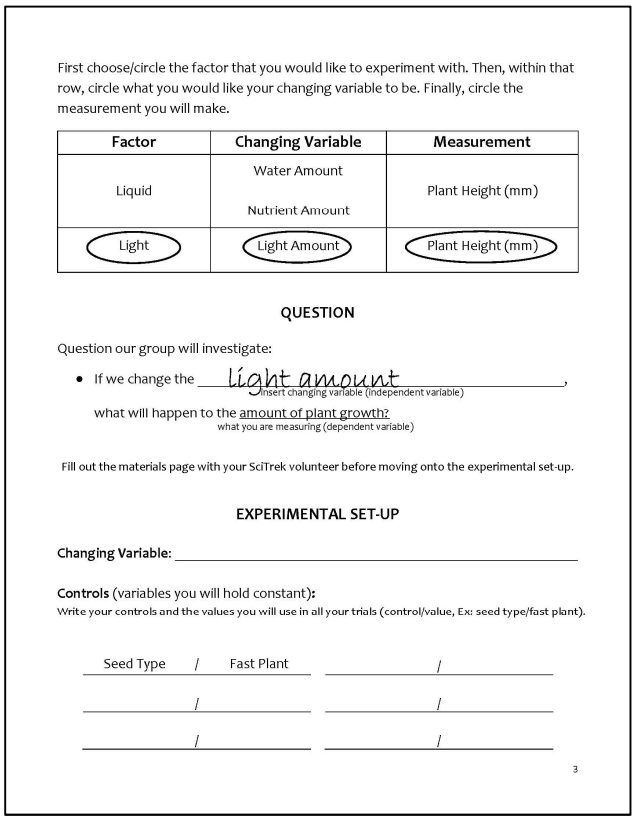
- If we change the light amount,
  what will happen to the amount of plant growth?

Changing Light Amount

Soil Type: (circle one) Potting Soil or Vermiculite
Liquid Amount: (max 100 mL) 100 mL
Nutrient Type: No Nutrients
Nutrient Amount: No Nutrients
Time: 3 days
Light Amount: (Level 5(full light), Level 4, Level 3, Level 2, Level 1, Level 0 (no light))

A) Level 4 Louka
B) Level 1 Darby
C) Level 0 Haley
D) Level 2 Kellyn
E) Level 5 John

Write the student's name next to the trial that they will be overseeing.



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

Factor	Changing Variable	Measurement
Liquid	Water Amount Nutrient Amount	Plant Height (mm)
Light	Light Amount	Plant Height (mm)

QUESTION

Question our group will investigate:

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

Fill out the materials page with your SciTrek volunteer before moving onto the experimental set-up.

EXPERIMENTAL SET-UP

Changing Variable: _____

Controls (variables you will hold constant)**:**
Write your controls and the values you will use in all your trials (control/value, Ex: seed type/fast plant).

Seed Type / Fast Plant		/
/	/	/
/	/	

3

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

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

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

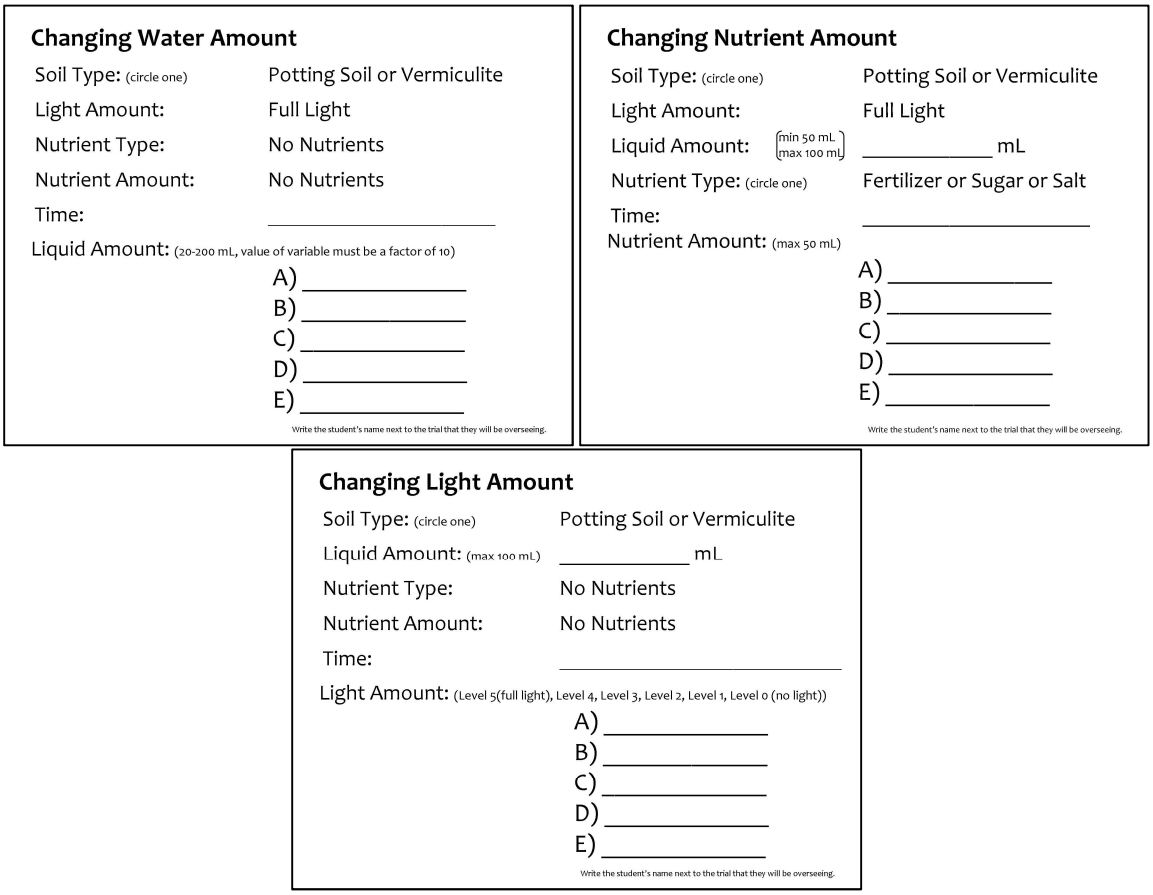
You can use the wet erase pen to mark amounts on the graduated cylinder.

Get the materials page (shown below) that corresponds to the changing variable that your group selected, and tape it into the group notepad. Have students use the materials page to choose the values of their controls and changing variable.

When selecting the values of the changing variable, ask students, “Do you think a wide or a narrow range of values would help you more effectively answer your question?” Make sure they understand that a wide range of values will make it easier for them to see a difference in their results, and thus have a better understanding of the answer to the class question. For each changing variable value, write the student’s name who will be in charge of the trial next to the value.

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

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



Changing Water Amount

Soil Type: (circle one) Potting Soil or Vermiculite
Light Amount: Full Light
Nutrient Type: No Nutrients
Nutrient Amount: No Nutrients
Time: _____
Liquid Amount: (20-200 mL, value of variable must be a factor of 10)
A) _____
B) _____
C) _____
D) _____
E) _____
Write the student's name next to the trial that they will be overseeing.

Changing Nutrient Amount

Soil Type: (circle one) Potting Soil or Vermiculite
Light Amount: Full Light
Liquid Amount: (min 50 mL, max 100 mL) _____ mL
Nutrient Type: (circle one) Fertilizer or Sugar or Salt
Time: _____
Nutrient Amount: (max 50 mL)
A) _____
B) _____
C) _____
D) _____
E) _____
Write the student's name next to the trial that they will be overseeing.

Changing Light Amount

Soil Type: (circle one) Potting Soil or Vermiculite
Liquid Amount: (max 100 mL) _____ mL
Nutrient Type: No Nutrients
Nutrient Amount: No Nutrients
Time: _____
Light Amount: (Level 5(full light), Level 4, Level 3, Level 2, Level 1, Level 0 (no light))
A) _____
B) _____
C) _____
D) _____
E) _____
Write the student's name next to the trial that they will be overseeing.

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

Tell students, "You have taught me a lot about how soil type affects plant height. I now know that potting soil produces the largest plant."

Tell students, "Next session, you will get to design a procedure based on your question, and then start your experiments to help us answer the class question: 'What variables affect plant growth?'"

Clean-Up:

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

Lead Note: Give the class notebook to the teacher to use for the technique activity.

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

Note: We **highly recommend** teachers complete the technique activity prior to Day 2 of the module. The suggested times in the lesson plan below are assuming that the technique activity was completed prior to SciTrek's arrival.

Schedule:

Times if teacher did Technique Activity prior to SciTrek:	***Times if SciTrek must do Technique Activity:***
Introduction (SciTrek Lead) – 2 minutes	Introduction (SciTrek Lead) – 2 minutes
Experimental Set-Up (SciTrek Volunteers) – 10 minutes	Technique (SciTrek Lead) – 10 minutes
Procedure (SciTrek Volunteers) – 20 minutes	Experimental Set-Up (SciTrek Volunteers) – 7 minutes
Results Table (SciTrek Volunteers) – 5 minutes	Procedure (SciTrek Volunteers) – 19 minutes
Experiment (SciTrek Volunteers) – 21 minutes	Results Table (SciTrek Volunteers) – 5 minutes
Wrap-Up (SciTrek Lead) – 2 minutes	Experiment (SciTrek Volunteers) – 15 minutes
	Wrap-Up (SciTrek Lead) – 2 minutes

Materials:

(4) Volunteer Boxes:

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

Other Supplies:

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

Lead Box:

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

Notebook Pages and Notepad Pages:

TECHNIQUE

Rulers

Rulers are used to measure lengths of different items.

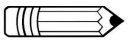
How to measure an item using a ruler:

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.

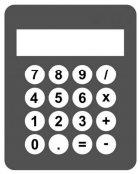
What is the height and width of each item?

1. 

Height: 24 mm Width: 70 mm

2. 

Height: 11 mm Width: 41 mm

3. 

Height: 57 mm Width: 45 mm

4

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

Factor	Changing Variable	Measurement
Liquid	Water Amount Nutrient Amount	Plant Height (mm)
(Light)	(Light Amount)	(Plant Height (mm))

QUESTION

Question our group will investigate:

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

Fill out the materials page with your SciTrek volunteer before moving onto the experimental set-up.

EXPERIMENTAL SET-UP

Changing Variable: light amount

Controls (variables you will hold constant)**:**
Write your controls and the values you will use in all your trials (control/value, Ex: seed type/fast plant).

Seed Type	Fast Plant	Nutrient Type	No Nutrients
Soil Type	Potting Soil	Nutrient Amount	No Nutrients
Liquid Amount	100 mL	Time	3 Days

3

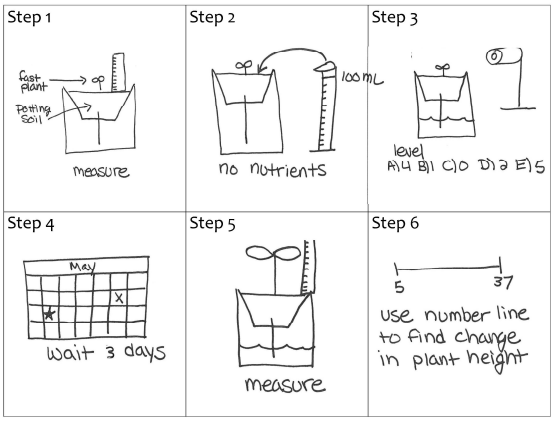
EXPERIMENTAL SET-UP

Changing Variable: Light amount

Controls (variables you will hold constant):

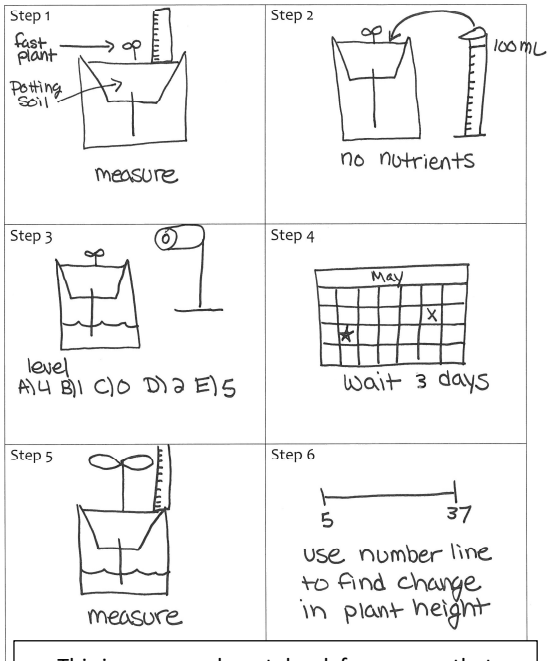
Seed Type	Fast Plant	Nutrient Type	No Nutrients
Soil Type	Potting Soil	Nutrient Amount	No Nutrients
Light Amount	100 mL	Time	3 Days

PROCEDURE



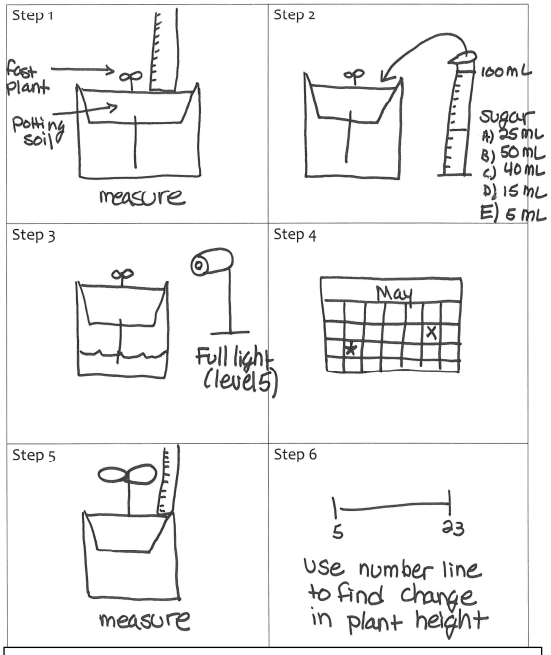
5

PROCEDURE



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

PROCEDURE



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

RESULTS

Table

Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:					
	Change in Plant Height:					
Observations:	Other:					

6

RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial A*. Then, draw an arrow through each box to indicate the variable is a control.

Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting Soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 Days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:					
	Change in Plant Height:					
Observations:	Other:					

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

6

Preparation:

SciTrek Lead:

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

SciTrek Volunteers:

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

Note: Set notebooks where students will sit during the module, even if another student is currently at that desk. If needed, students will move to these spots after the Introduction.

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

If students are not in their groups, tell them, "A notebook will be put on your desk, which is not your notebook and you should not move it. You will move to your groups after the introduction."

Ask students, "What did we do and learn during out last meeting?" Possible student response: we made observations about plants that were just planted, and plants that were 7 days old. In addition, students should say that they came up with a question that they are going to design an experiment around. Remind students that each group's research is going to help answer the class question. Ask the class, "What is the class question we are investigating?" Students should reply, "What variables affect plant growth?"

If the teacher has not done technique activity, do technique activity before continuing (instructions below). If the classroom teacher did the technique activity with students already, ask students, "What activity did you complete in your notebook between the last time SciTrek was here and now?" Possible student response: we learned how to measure things in millimeters.

Ask students, "How could knowing how to use a ruler help us in determining what variables affect plant growth?" Make sure, by the end of the conversation, students know that they will measure the plant in millimeters before they start their experiment, and after their experiment is over, and subtract the two numbers to determine the plant growth.

Tell students, "Today the first thing you will do in your groups is remind your volunteer what question you chose to investigate, as well as the variable values you picked. You will then use this information to generate an experimental set-up, and a procedure. When designing a procedure, you will start by getting plants that are 3 days old from your volunteer. You will then set up the experiment, and measure the plants again when SciTrek comes back. Let's figure out together the number of days that the plants will be able to grow between today, when you start the experiment, and when you will measure the plant growth, which will be when SciTrek comes back next." As a class, determine how much time (in days) this

will be. This value will be one of their controls. Tell students, “Once your procedure and results table are filled out, you can start your experiments.”

Technique:

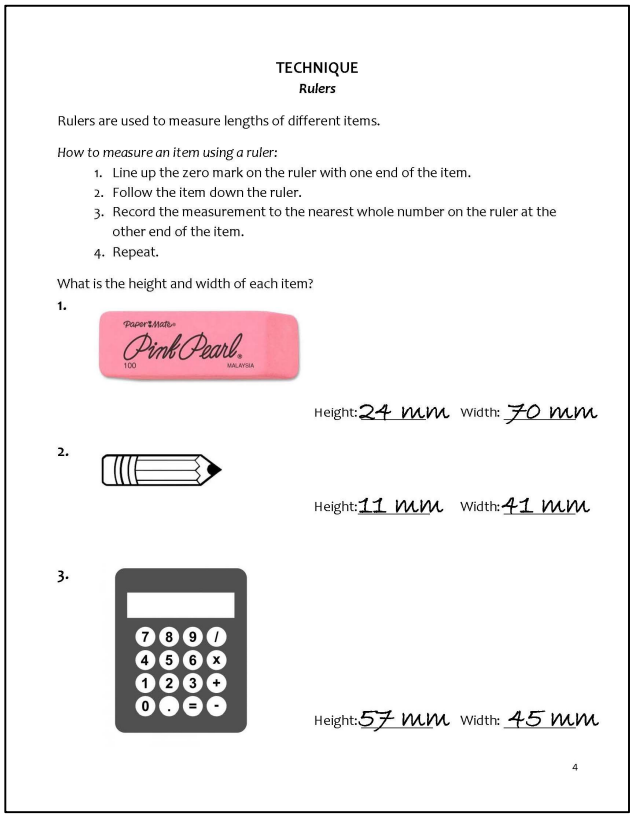
(10 minutes – Full Class – Done By Classroom Teacher Prior to SciTrek)

Make sure that each student has a ruler, and has their notebook turned to page 4. Place the class notebook under the document camera and turn to page 4. Tell the class, “Rulers can be used to measure lengths, widths, or heights of objects.” Ask students, “Does anyone know what units these rulers measure in?” They should reply “millimeters.” Tell students, “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 you could make using this ruler?” They should reply, “300 mm.”

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

Have students complete *2* and *3* by themselves.

Once students have completed the measuring activity, have them share their results with the class. Once an answer is shared, have the rest of the class vote whether 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 class notebook under the document camera. Tell students, “It is okay if your measurements differ by up to 3 mm.”



TECHNIQUE

Rulers

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: 57 mm Width: 45 mm

4

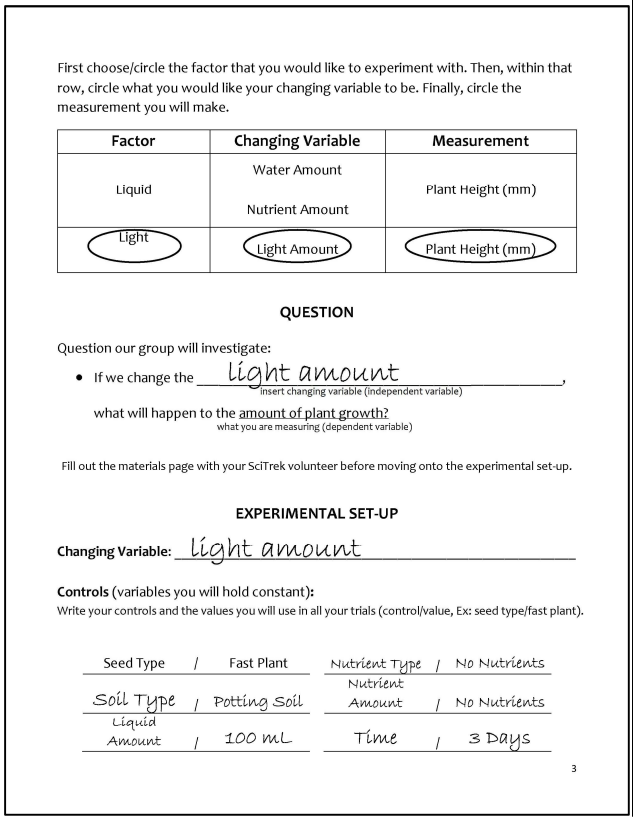
Experimental Set-Up:
(10 minutes – Groups – SciTrek Volunteers)

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

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

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

After going through the controls laid out on the materials page, there will be one blank left in the experimental set-up. Ask students, "What other information will you need to include to complete your experiment?" If students struggle, ask them, "When will we measure the plants?" Students should reply, "Today, and the day SciTrek comes back." Ask them, "What type of control would this be?" They should reply, "Time." Remind them the number of days before SciTrek comes back. An example filled out experimental set-up is shown below.



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

Factor	Changing Variable	Measurement
Liquid	Water Amount Nutrient Amount	Plant Height (mm)
(Light)	(Light Amount)	(Plant Height (mm))

QUESTION

Question our group will investigate:

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

Fill out the materials page with your SciTrek volunteer before moving onto the experimental set-up.

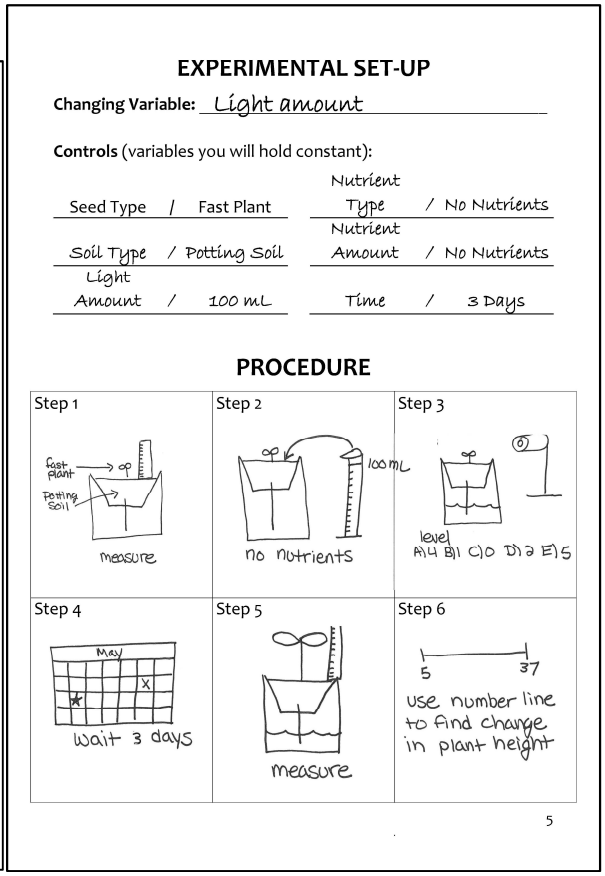
EXPERIMENTAL SET-UP

Changing Variable: light amount

Controls (variables you will hold constant)**:**
Write your controls and the values you will use in all your trials (control/value, Ex: seed type/fast plant).

Seed Type	/ Fast Plant	Nutrient Type	/ No Nutrients
Soil Type	/ Potting Soil	Nutrient Amount	/ No Nutrients
Liquid Amount	/ 100 mL	Time	/ 3 Days

3



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	Nutrient Amount	/ No Nutrients
Light Amount	/ 100 mL	Time	/ 3 Days

PROCEDURE

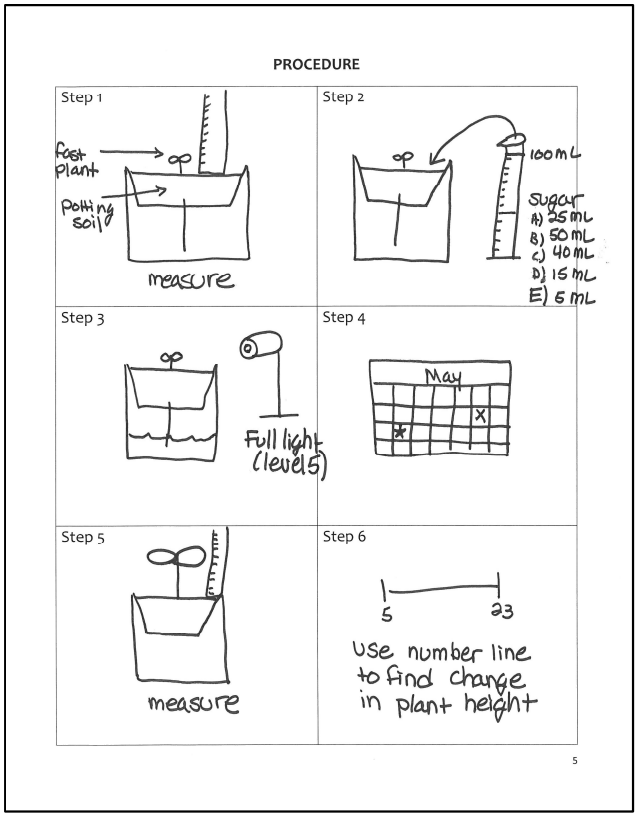
Step 1 fast plant potting soil measure	Step 2 100 mL no nutrients	Step 3 level A) 4 B) 1 C) 0 D) 2 E) 5
Step 4 May wait 3 days	Step 5 measure	Step 6 5 37 use number line to find change in plant height

5

Procedure:
(20 minutes – Groups – SciTrek Volunteers)

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

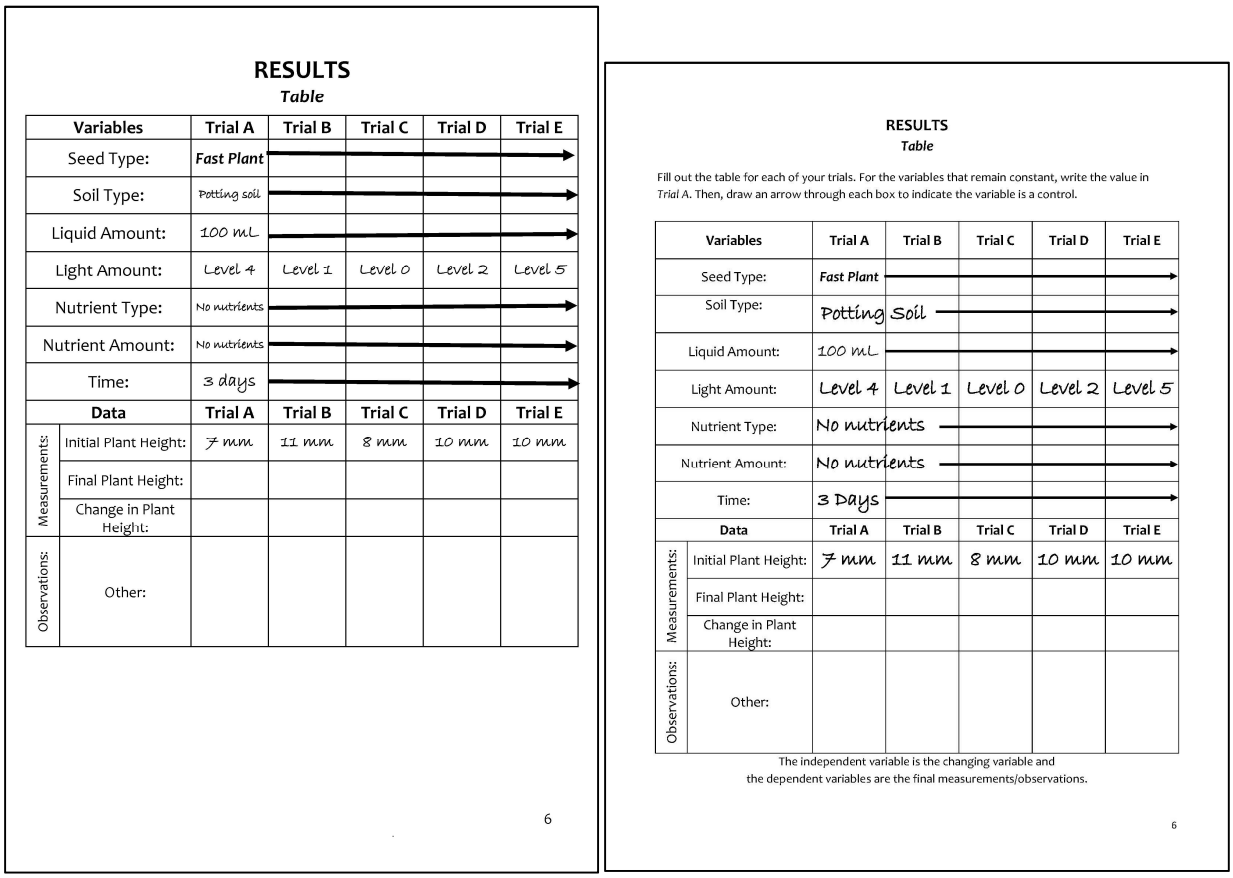
Note: If your group is changing nutrient amount, you will add the desired amount of nutrient to the graduated cylinder, and then use water to continue filling up the graduated cylinder to the correct liquid amount. The procedure below shows how you can draw this for step 2.



Results Table:
(5 minutes – Groups – SciTrek Volunteers)

Fill out the variables section of the results table while students fill out the same section in their notebooks. When writing the values, make sure, for controls, they only write the value of the control in

the trial A box, then, draw an arrow through the remaining trials' boxes. For the changing variable, they should write the value in each trial's corresponding box. An example filled out results table is shown below.



RESULTS

Table

Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:					
	Change in Plant Height:					
Observations:	Other:					

6

RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial A*. Then, draw an arrow through each box to indicate the variable is a control.

Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting Soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 Days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:					
	Change in Plant Height:					
Observations:	Other:					

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

6

Experiment:

(21 minutes – Groups – SciTrek Volunteers)

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

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

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

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

Tell students, "During the next session, you will get to measure how tall your plants have grown, and determine the change in plant height."

Clean-Up:

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

Day 3: Experiment/Graph/Results Summary

Schedule:

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

Materials:

(4) Volunteer Boxes:

- ☐ Nametags
- ☐ Notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ (8) Partial graph pieces
- ☐ (2) Pencil
- ☐ (2) Grease pencil
- ☐ Scotch tape
- ☐ Paper towels
- ☐ (5) Rulers (mm)

Other Supplies:

- ☐ (4) Notepads
- ☐ (3) Tubs to take plants back to UCSB

Lead Box:

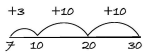
- ☐ (3) Extra notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat
- ☐ Time card
- ☐ (8) Partial graph pieces
- ☐ (2) Pencils
- ☐ (2) Grease pencils
- ☐ (2) Wet erase markers
- ☐ Black pen
- ☐ Scotch tape
- ☐ Paper towels
- ☐ (4) Rulers (mm)

Notebook Pages and Notepad Pages:

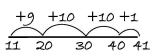
RESULTS

Table

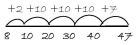
Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:	30 mm	41 mm	47 mm	37 mm	23 mm
	Change in Plant Height:	23 mm	30 mm	39 mm	27 mm	13 mm
Observations:	Other:			Tall, skinny, small yellow leaves		Fat, green leaves



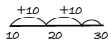
10+10+3 = 23 mm



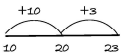
9+10+10+1=30 mm



2+10+10+10+7= 39 mm



10+10+7= 27 mm



10+3= 13 mm

6

RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial A*. Then, draw an arrow through each box to indicate the variable is a control.

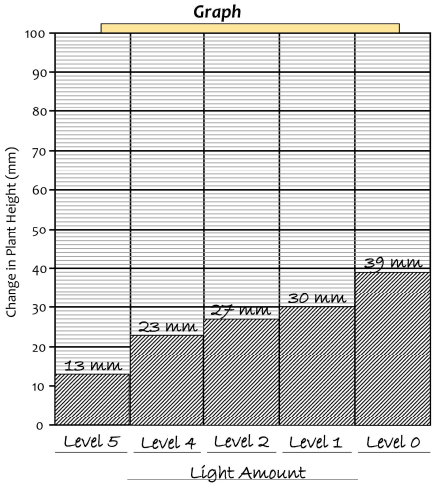
Variables		Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:		*Fast Plant*	→	→	→	→
Soil Type:		Potting Soil	→	→	→	→
Liquid Amount:		100 mL	→	→	→	→
Light Amount:		Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:		No nutrients	→	→	→	→
Nutrient Amount:		No nutrients	→	→	→	→
Time:		3 Days	→	→	→	→
Data		**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements:	Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
	Final Plant Height:	30 mm	41 mm	47 mm	37 mm	23 mm
	Change in Plant Height:	(23 mm)	30 mm	39 mm	27 mm	13 mm
Observations:	Other:			Tall skinny, small yellow leaves		Fat, green leaves

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

6

RESULTS

Graph

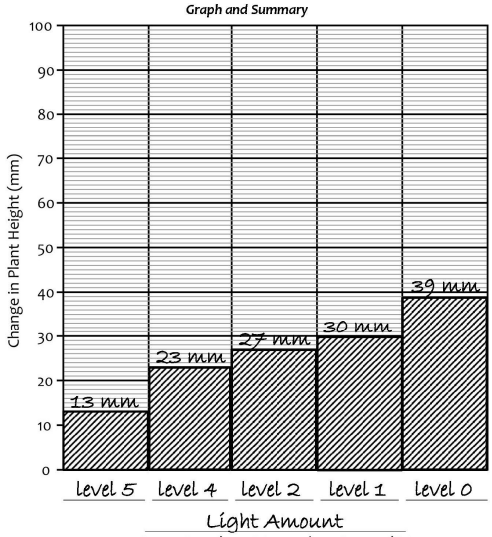


My experiment shows plants in the dark will grow taller than plants in the light, because the plant in light level 0 (dark) grew 39 mm, and the plant in light level 5 (fill light) grew 13 mm.

7

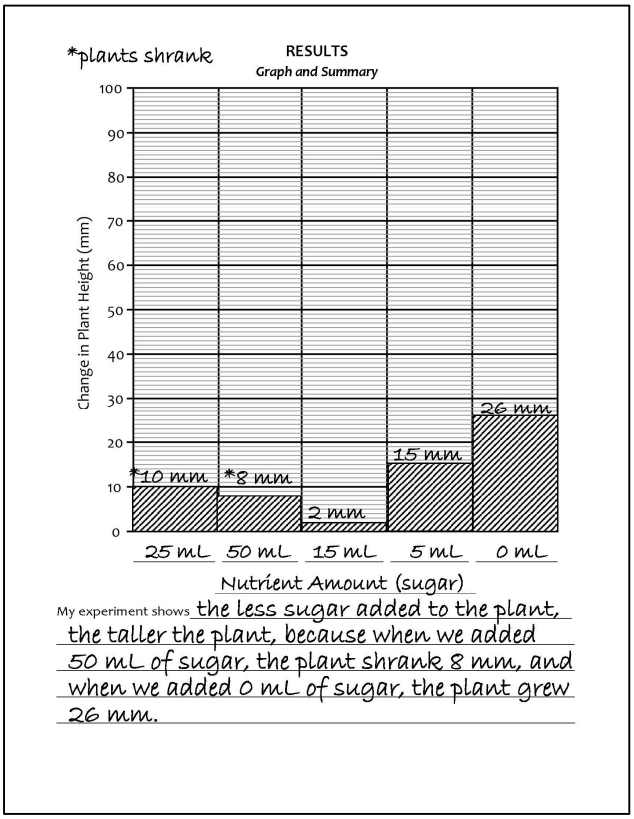
RESULTS

Graph and Summary



My experiment shows plants in the dark will grow taller than plants in the light, because the plant in light level 0 (dark) grew 39 mm, and the plant in light level 5 (full light) grew 13 mm.

7



Preparation:

SciTrek Lead:

1. Make sure volunteers setting out notebooks.
2. Remove the plants from the boxes and give them to the appropriate volunteer.
3. Turn off lights, put lamps in boxes, and stack boxes to be returned to SciTrek. (This can be done after the module.)

SciTrek Volunteers:

1. Set out notebooks/nametags.
2. Get your groups' plants, and have them ready to give to students.

Note: Set notebooks where students will sit during the module even if another student is currently at that desk. If needed, students will move to these spots after the introduction.

Introduction:

(2 minutes – Full Class – SciTrek Lead)

If students are not in their groups, tell them, "A notebook will be put on your desk, which is not your notebook and you should not move it. You will move to your groups after the introduction."

Ask the class, "What have we been working on the last two meetings, and what have we learned?" Possible student response: we have been exploring plant growth, and we found that soil type affects the plant height; soils that absorb more water allow plants to grow taller. They should also state they designed, and started to carry out, an experiment to test another variable that might affect plant growth. Have each group tell you the variable that they are investigating.

Tell the class, "Today you are going to observe your plant's growth by measuring the plant heights again after some time." Ask students, "How will you determine how much your plant has grown since the start

of your experiments?" Possible student response: we can measure the plant, and then use a number line to find the difference between the initial height of the plant, and the final height of the plant. Tell students, "After you are finished with your experiments and recording your results, you will then use the data to make a graph to see how your changing variable has, or has not, affected plant growth, and then explain this in a results summary."

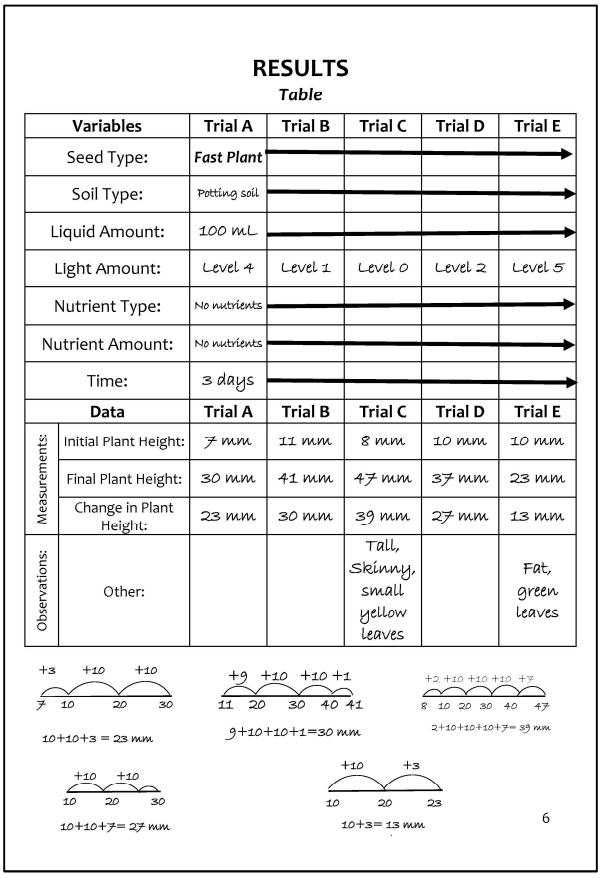
Experiment:
(30 minutes – Groups – SciTrek Volunteers)

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

Ask students, "How will we figure out how much the plants have grown over the last couple of days?" Possible student response: we can use a number line to find the difference between the initial and final heights of the plants. As a group, do the math for each of the trials on the bottom of page 6 in the notepad, making sure to use the appropriate subtraction method as dictated by the teacher. If more room is needed for number lines, use the backside of a notepad page. Students only need to record the change in plant height in their notebooks, not the process to determine the change.

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

Encourage students to make observations about their plant other than plant height, such as relative amount of liquid in each cup, color of leaves/stem, number/size of leaves, etc. These can be recorded in the results table under other.

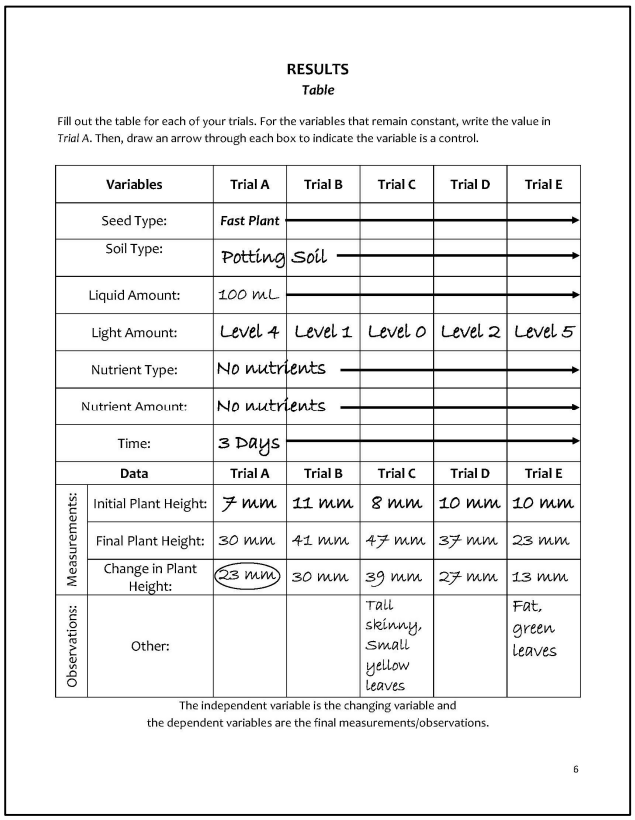


RESULTS

Table

Variables	Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:	*Fast Plant*	→	→	→	→
Soil Type:	Potting soil	→	→	→	→
Liquid Amount:	100 mL	→	→	→	→
Light Amount:	Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:	No nutrients	→	→	→	→
Nutrient Amount:	No nutrients	→	→	→	→
Time:	3 days	→	→	→	→
Data	**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements: Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
Measurements: Final Plant Height:	30 mm	41 mm	47 mm	37 mm	23 mm
Measurements: Change in Plant Height:	23 mm	30 mm	39 mm	27 mm	13 mm
Observations: Other:			Tall, skinny, small yellow leaves		Fat, green leaves

6



RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial A*. Then, draw an arrow through each box to indicate the variable is a control.

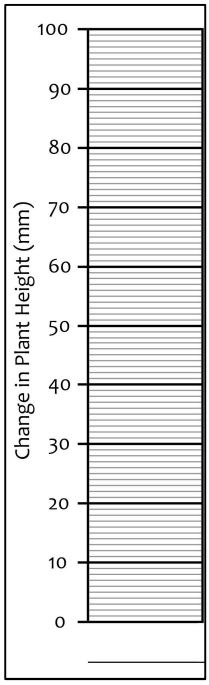
Variables	Trial A	Trial B	Trial C	Trial D	Trial E
Seed Type:	*Fast Plant*	→	→	→	→
Soil Type:	Potting Soil	→	→	→	→
Liquid Amount:	100 mL	→	→	→	→
Light Amount:	Level 4	Level 1	Level 0	Level 2	Level 5
Nutrient Type:	No nutrients	→	→	→	→
Nutrient Amount:	No nutrients	→	→	→	→
Time:	3 Days	→	→	→	→
Data	**Trial A**	**Trial B**	**Trial C**	**Trial D**	**Trial E**
Measurements: Initial Plant Height:	7 mm	11 mm	8 mm	10 mm	10 mm
Measurements: Final Plant Height:	30 mm	41 mm	47 mm	37 mm	23 mm
Measurements: Change in Plant Height:	23 mm	30 mm	39 mm	27 mm	13 mm
Observations: Other:			Tall skinny, Small yellow leaves		Fat, green leaves

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

6

Graph:

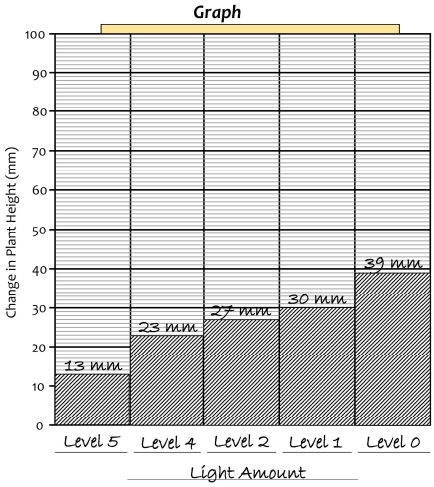
(10 minutes – Groups – SciTrek Volunteers)



Pass out one partial graph piece to each student, and have them fill out the piece for the plant they measured. To help students know what to graph, circle the change in plant height for their trial with the wet erase pen (see results table picture in experiment section). There is an extra partial graph piece in the group box that you should use as an example. On the bottom line, have students write the value of their changing variable (Ex: level 5), not the trial letter or the changing variable (Ex: A or light amount). This way, when the pieces are rearranged, they will be able to see the changing variable values for each of the trials to help them identify any patterns. Have students draw a line across the column showing the appropriate change in plant height, write in the numerical value of the change in plant height on top of the line, and then quickly shade below the line. If the plant shrank, have them graph the positive number, and put a star next to the written in measurement. Once each student has completed their graph piece, have students help you arrange the partial graph pieces so they are in increasing order as done in the example below. If your group had plants that shrank, 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 pieces.

RESULTS

Graph

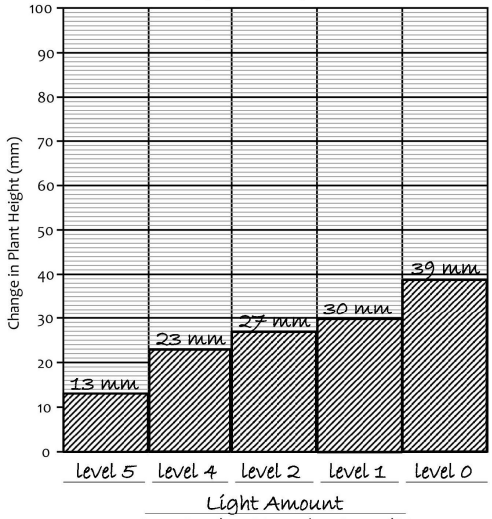


My experiment shows plants in the dark will grow taller than plants in the light, because the plant in light level 0 (dark) grew 39 mm, and the plant in light level 5 (fill light) grew 13 mm.

7

RESULTS

Graph and Summary



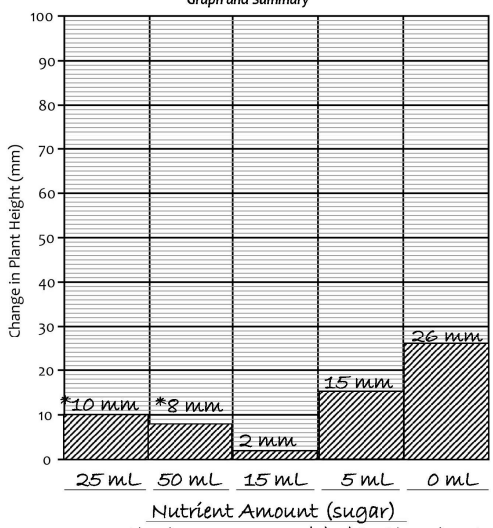
My experiment shows plants in the dark will grow taller than plants in the light, because the plant in light level 0 (dark) grew 39 mm, and the plant in light level 5 (full light) grew 13 mm.

7

*plants shrank

RESULTS

Graph and Summary



My experiment shows the less sugar added to the plant, the taller the plant, because when we added 50 mL of sugar, the plant shrank 8 mm, and when we added 0 mL of sugar, the plant grew 26 mm.

Note: When plants shrink, often the values of the changing variable for the plants that died are not in order (see graph to left). This is because plants can only shrink as much as they initially grew. For instance, at the start of the experiment if a plant started at 3 mm and 50 mL of sugar was poured over the plant, it would likely die and shrivel to the level of the potting soil. This would correspond to a change in height of 3 mm (starting height – final height). Say that for another trial, the initial plant height was 5 mm and then 25 mL of sugar was poured over the plant and it died. The change in height would be 5 mm. This does not mean that plants shrink more with 25 mL of sugar than with 50 mL of sugar. It just means that the sugar killed both plants.

After the pieces of the graph are taped into the group notepad, ask students, “What is our changing variable?” Record this answer as the x-axis title, and have students copy this into their notebooks.

Results Summary:
(16 minutes – Groups – SciTrek Volunteers)

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

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

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

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

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

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

Tell students, "Next session, you will make a poster to share your results with the class. These posters will help us learn about what variables affect plant growth."

Clean-Up:

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

Day 4: Poster Making

Schedule:

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

Materials:

(4) Volunteer Boxes:

- ☐ Nametags
- ☐ Notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ Poster diagram
- ☐ Appropriate sticker for how to present graph (changing light or water/nutrient amount)
- ☐ (2) Pencils
- ☐ (2) Paperclips
- ☐ (2) Grease pencil
- ☐ Highlighter
- ☐ Scissors
- ☐ (2) Glues
- ☐ Poster parts pack (scientists' names, question, experimental set-up, procedure, results table, results graph, results summary, (6) *I acted like a scientist when*, (6) picture spaces)

Other Supplies:

- ☐ (4) Notepads
- ☐ Poster paper tube

Lead Box:

- ☐ (3) Extra notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Poster diagram
- ☐ Lead lab coat
- ☐ Time card
- ☐ (2) Sticker sets for how to present graph (changing light and water/nutrient amount)
- ☐ (2) Pencils
- ☐ (2) Grease pencil
- ☐ (5) Paperclips
- ☐ (2) Wet erase markers
- ☐ Black pen
- ☐ (2) Highlighters
- ☐ Scissors
- ☐ (2) Glues
- ☐ Scotch tape
- ☐ (1 each color) Poster part packs

Preparation:

SciTrek Lead:

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

SciTrek Volunteers:

1. Set out notebooks/nametags.

Note: Set notebooks where students will sit during the module even if another student is currently at that desk. If needed, students will move to these spots after the introduction.

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

If students are not in their groups, tell them, "A notebook will be put on your desk, which is not your notebook and you should not move it. You will move to your groups after the Introduction."

Ask the class, "What is the class question that we have been investigating?" Students should reply, "What variables affect plant growth?" Tell students, "If you have not filled in the results summary or *I acted like a scientist when*, you need to finish these. Then, you will explain your experiment, without looking at your notebook, to your volunteer, and tell them what these results taught you about plant growth."

Tell students "When scientists complete their experiment, they make a poster to present their work to other scientists. Each group will create a poster to present to the class during the next session. This presentation will be your chance to tell the class what your group has discovered about the class question. You should write as neatly as possible on the poster parts, so that the other class members can read your poster. You will now start working with your group to explain your experiment to your volunteer, and then make a poster."

Experimental Discussion:
(17 minutes – Groups – SciTrek Volunteers)

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

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

Poster Making:
(36 minutes – Groups – SciTrek Volunteers)

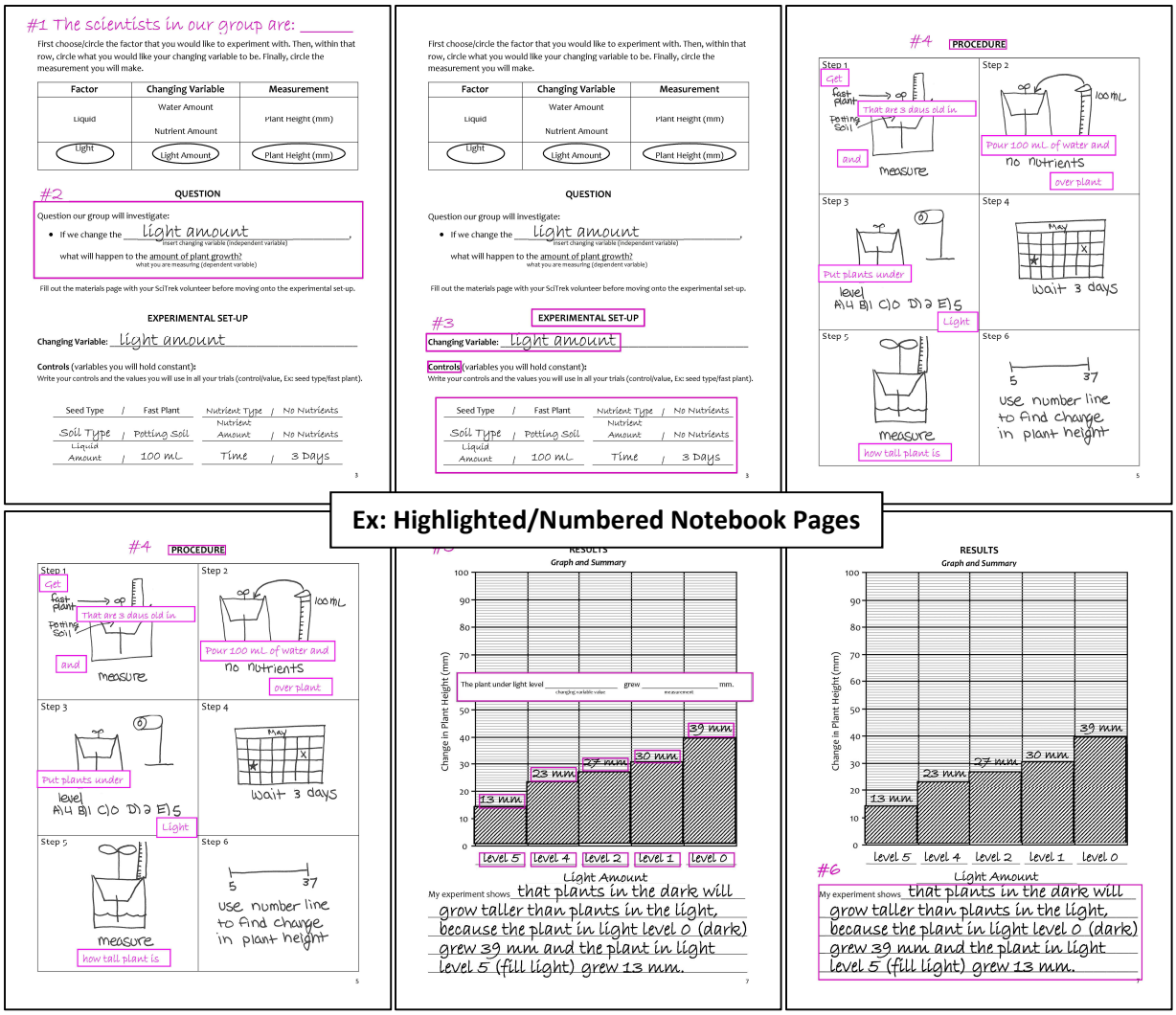
Pass out the writing portions (general poster parts and *I acted like a scientist when*), and have students write their names on them and complete them. In addition, have each student write their name on the scientists' names poster part. Use the following guidelines when assigning poster parts:

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

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

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

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



Ex: Highlighted/Numbered Notebook Pages

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

Changing Light Amount:

The plant under light level_____ grew_____ mm.
changing variable value | measurement

Changing Water/Nutrient Amount:

The plant with _____mL of _____ grew_____ mm.
changing variable value | (you should fill this blank out for the student) water/nutrient | measurement

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

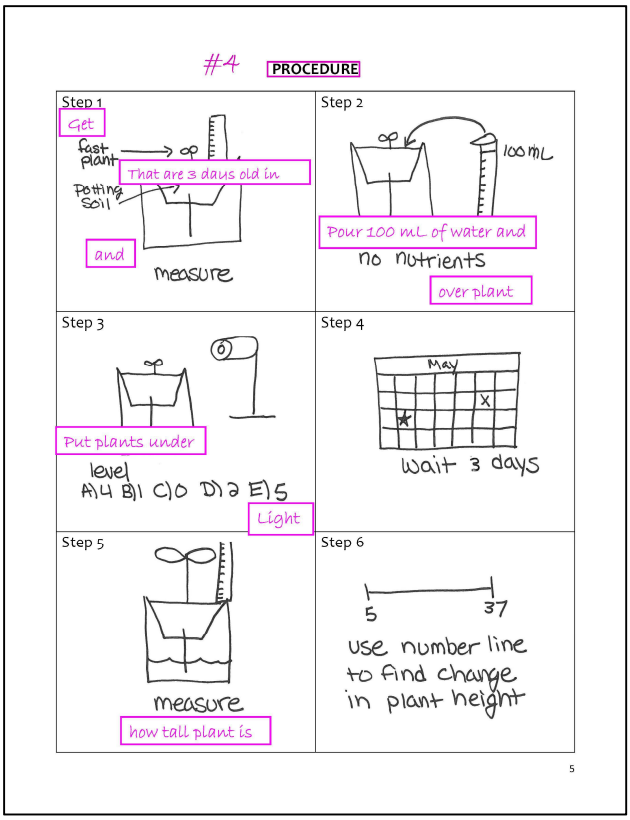
Ask the student who is presenting the procedure to tell you in their own words what they did in each step, and then you (the volunteer) write their words on each picture to form complete sentences. In the procedure below on the left, the boxed words were added to the student's notebook. Therefore, the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

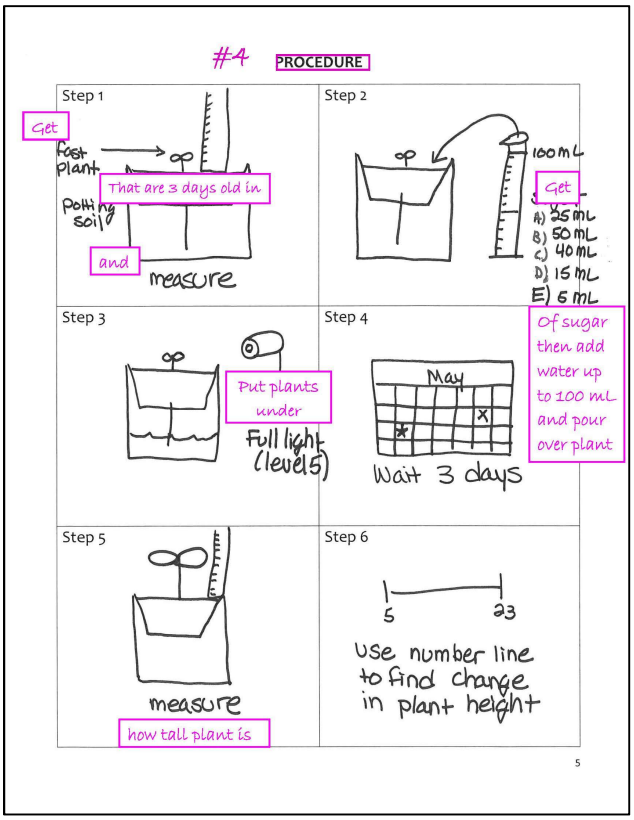
Step 1: Get fast plants that are 3 days old in potting soil and measure.
Step 2: Pour 100 mL of water and no nutrients over plant.
Step 3: Put plants under level A) 4, B) 1, C) 0, D) 2, and E) 5 light.
Step 4: Wait 3 days.
Step 5: Measure how tall plant is.
Step 4: Use number line to find change in plant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

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

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

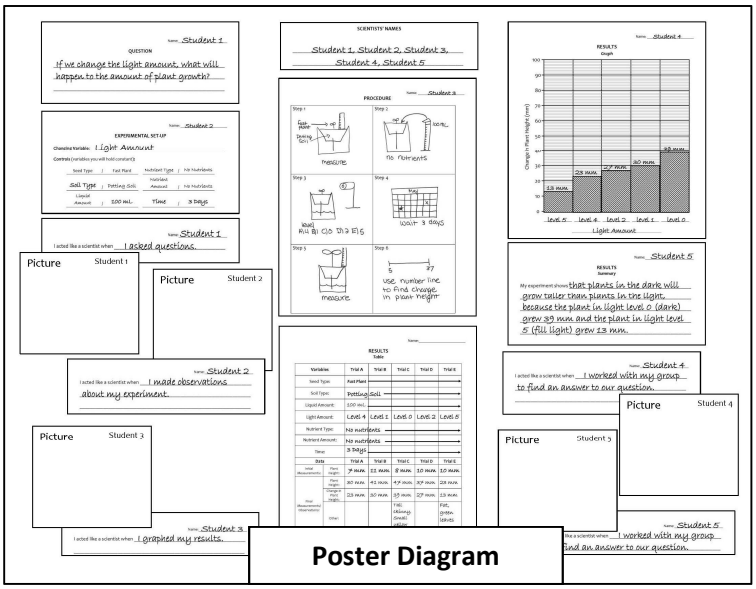
Note: Students should not copy the boxed words onto the poster part.





As soon as students have completed some of their pieces, start gluing them onto the large poster paper, in landscape orientation, exactly as they are arranged in the example below. Do not allow students to glue the poster parts on the poster. Do not wait until students have completed all the pieces to start gluing them onto the poster.

Once the poster is complete, have students start practicing for the presentation. Make sure students read from their notebooks, instead of from the poster.



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

If there is additional time, tell students, "Other students will ask you questions during your poster presentations. We should think about what questions you might be asked, and then think of the answers to those questions, so that you will be prepared during your presentation."

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

Ask students the following questions:

How did you act like a scientist during this project?
What did you do, that scientists do?

After discussing how they acted like scientists, and talking about how everyone does things that scientists do in their everyday lives, tell students, "Next session, you will present your findings to the class, and I am looking forward to hearing about all of your experiments."

Clean-Up:

1. Collect notebooks with attached nametags.
2. Leave posters in the classroom.
3. Place all other materials into your group box, and bring them back to UCSB.

Day 5: Poster Presentations

Schedule:

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

Materials:

(4) Volunteer Boxes:

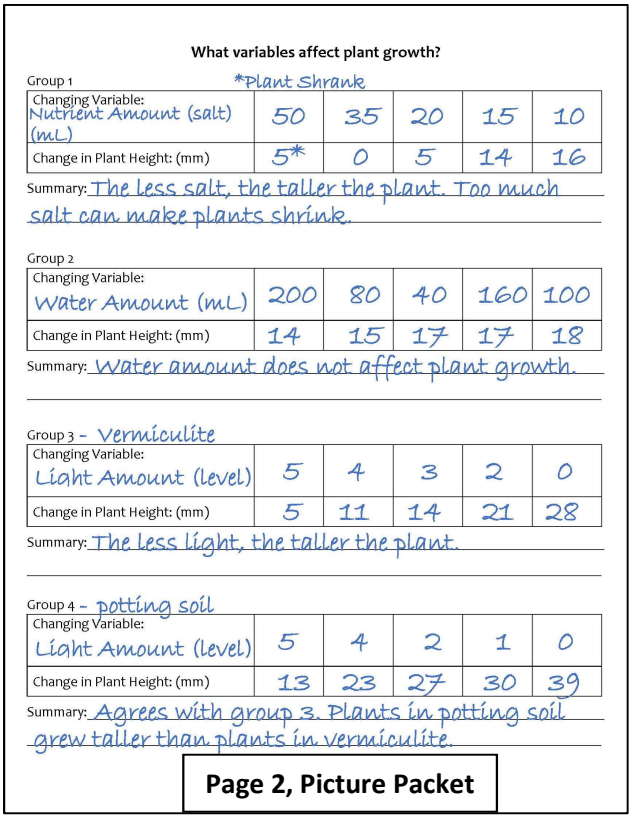
- ☐ Nametags
- ☐ Notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ (2) Pencils
- ☐ (2) Paperclips
- ☐ Highlighter

Lead Box:

- ☐ (3) Extra notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat
- ☐ Time card
- ☐ (2) Sticker sets for how to present graph (changing light and water/nutrient amount)
- ☐ (2) Pencils
- ☐ (2) Wet erase markers
- ☐ (4) Paperclips
- ☐ (2) Highlighters
- ☐ Scotch tape

*Student posters should already be in the classroom.

Picture Packet Page:



What variables affect plant growth?

Group 1 *Plant Shrank

Changing Variable: Nutrient Amount (salt) (mL)	50	35	20	15	10
Change in Plant Height: (mm)	5*	0	5	14	16

Summary: The less salt, the taller the plant. Too much salt can make plants shrink.

Group 2

Changing Variable: Water Amount (mL)	200	80	40	160	100
Change in Plant Height: (mm)	14	15	17	17	18

Summary: Water amount does not affect plant growth.

Group 3 – Vermiculite

Changing Variable: Light Amount (level)	5	4	3	2	0
Change in Plant Height: (mm)	5	11	14	21	28

Summary: The less light, the taller the plant.

Group 4 – potting soil

Changing Variable: Light Amount (level)	5	4	2	1	0
Change in Plant Height: (mm)	13	23	27	30	39

Summary: Agrees with group 3. Plants in potting soil grew taller than plants in vermiculite.

Page 2, Picture Packet

Preparation:

SciTrek Lead:

1. Make sure volunteers are setting out notebooks.
2. Assign volunteers a new group to work with. This will allow students to explain what they found and practice their poster with a new person.
3. Set up the document camera for the *Notes on Presentations* (page 2, picture packet).
4. Organize posters so experiments featuring the same changing variable are presented back to back and posters are presented from simplest to understand, to most difficult to understand (suggested order: nutrient amount (salt water, sugar water, fertilizer), water amount, light amount).

SciTrek Volunteers:

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

Note: Set notebooks where students will sit during the module even if another student is currently at that desk. If needed, students will move to these spots after the Introduction.

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

If students are not in their groups, tell them, "A notebook will be put on your desk, which is not your notebook and you should not move it. You will move to your group after the Introduction."

Tell students, "Today you will present your posters to the class. 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. Today, you will work with a new volunteer. You will have 15 minutes to discuss your experiments, and results, as well as practice presenting your posters with your groups. When you present you should read from your notebooks, not the posters. After practicing, you will return to your normal classroom seats."

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

Have volunteers rotate groups.

If the posters are not already in order, the lead should organize posters so experiments featuring the same changing variable are presented back to back and posters are presented from simplest to understand to most difficult to understand (suggested order: soil amount, liquid thickness, soil type).

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

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

If there is additional time, tell the group, "Other students will ask you questions during your poster presentations. We should think about what questions you will be asked and then think of the answers to those questions so that you will be prepared during their presentation."

Do not let poster practice go over 15 minutes.

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

Have students return to their original class seats. Ask the class, "What is the question we have been investigating?" Students should reply, "What variables affect plant growth?" Ask the class, "Why are we interested in answering this question?" Possible student response: if we can determine the variables that affect plant growth, we could grow taller and healthier plants. Tell students, "During the presentations, I will take notes, but you will have to help me by telling me the changing variable of the group after they say their question. I will also record the group's changing variable values, and the plant growth." Turn to page 2 in the picture packet.

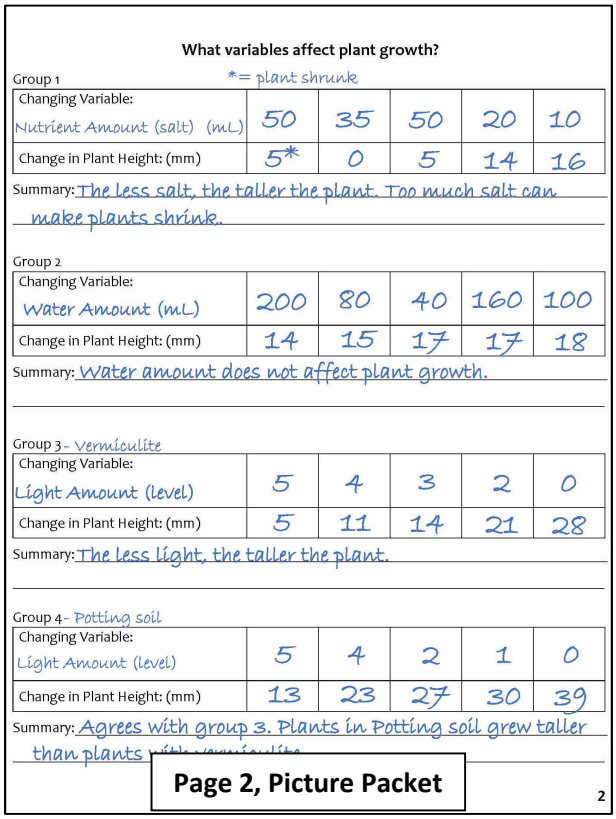
Tell students, "You will get the chance to ask scientific questions after the presentation. These questions are important, because you will have to summarize what you learned from the group so I can record it on the group notes. Therefore, your questions should focus on helping you be able to summarize the group's findings."

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

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

When students are done asking questions, have them summarize what the group found. This is challenging for 2nd graders, therefore, you need to break it down into the following four questions. 1) What was the group's changing variable? 2) (point to the notes where you recorded the values of the changing variable) What pattern do you see in the (insert changing variable)? 3) (point to the notes where you recorded the change in plant height) What pattern do you see in the change in plant height? 4) Can someone put what we learned into a sentence? If they are still having trouble, give them the sentence frame "As the (insert changing variable) (insert pattern) the plant height grows (more/less)" Ex: As the light amount gets lower, the plant height grows more. Once they have generated a summary, record this on the notes page.

An example filled out notes on presentations, is shown below.



What variables affect plant growth?

Group 1 *= plant shrunk

Changing Variable: Nutrient Amount (salt) (mL)	50	35	50	20	10
Change in Plant Height: (mm)	5*	0	5	14	16

Summary: The less salt, the taller the plant. Too much salt can make plants shrink.

Group 2

Changing Variable: Water Amount (mL)	200	80	40	160	100
Change in Plant Height: (mm)	14	15	17	17	18

Summary: Water amount does not affect plant growth.

Group 3 - Vermiculite

Changing Variable: Light Amount (level)	5	4	3	2	0
Change in Plant Height: (mm)	5	11	14	21	28

Summary: The less light, the taller the plant.

Group 4 - Potting soil

Changing Variable: Light Amount (level)	5	4	2	1	0
Change in Plant Height: (mm)	13	23	27	30	39

Summary: Agrees with group 3. Plants in Potting soil grew taller than plants with vermiculite

Page 2, Picture Packet

2

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

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

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

- Soil type: Potting soil
- Nutrient amount: Could use fertilizer, but does not have large effect
- Water amount: Any
- Light amount: Dark

Ask students, "What values of variables would you need to get plants to grow the healthiest (greenest and most leaves) in 7 days?"

- Soil type: Potting soil
- Nutrient amount: Could use fertilizer, but does not have large effect
- Water amount: Any
- Light amount: Full

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

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

Tell students, "The mentors who have been working with you are undergraduate, and graduate, students who volunteer their time so that you can do experiments. This is the last day you will see your volunteers, so we should say thank you, and goodbye to them. I will come back and work with you one more day."

Have students remove the paper parts of their nametags (which they can keep) from the plastic holders and return the plastic holders to their volunteers.

Clean-Up:

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

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

Note: We **highly recommend** teachers complete the observation assessment prior to Day 6 of the module. The suggested times in the lesson plan below are assuming that the observation assessment was given prior to SciTrek's arrival.

Schedule:

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

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

Materials:

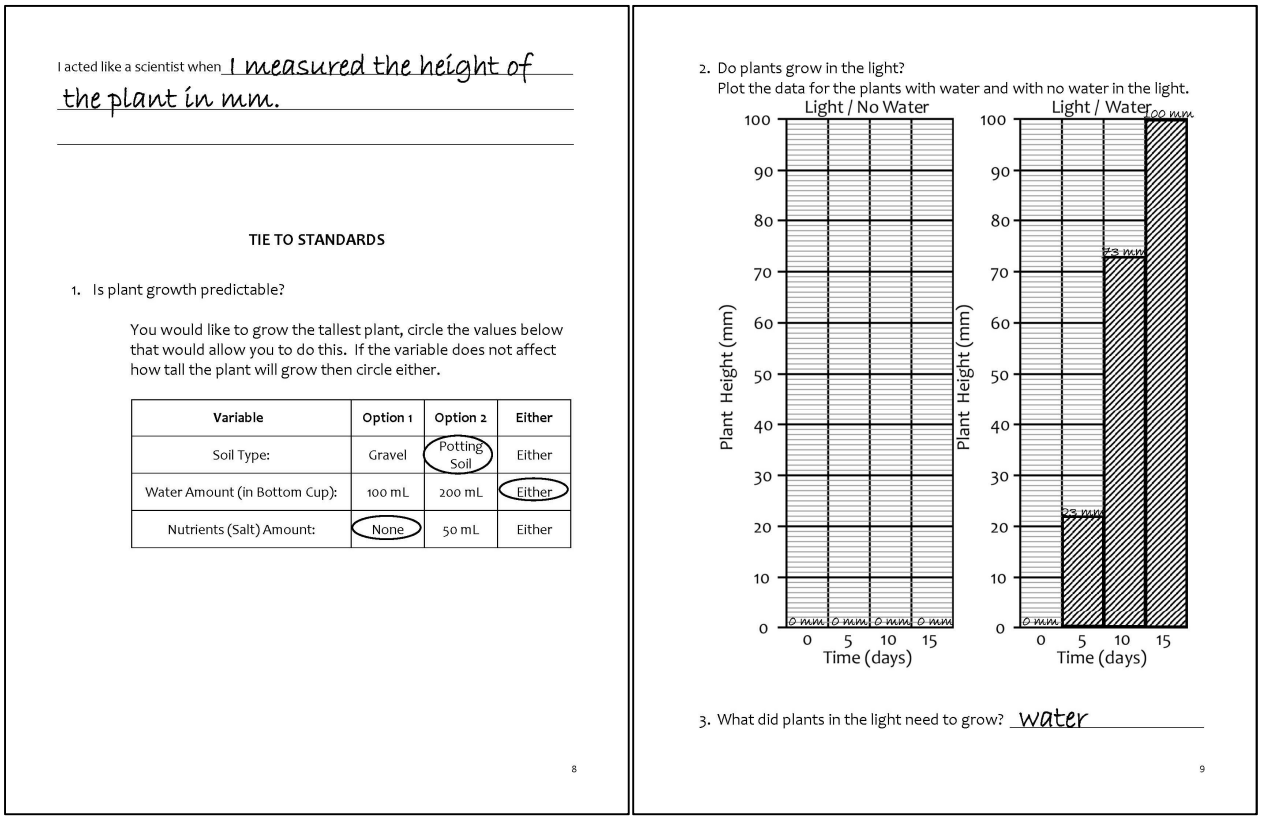
Lead Box:

- ☐ (3) Extra notebooks
- ☐ Notebooks
- ☐ Lead instructions
- ☐ Plants picture packet
- ☐ Lead lab coat
- ☐ Observation assessment (if teacher did not take assessments then (25) assessments and (25) black beads)
- ☐ (25) Draw a Scientist
- ☐ (25) Content Assessments
- ☐ Time card
- ☐ (2) Pencils
- ☐ (25) Rulers (mm)
- ☐ (2) Wet erase markers
- ☐ Black marker
- ☐ Teacher final survey QR code

Other Materials:

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

Notebook Pages:



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

TIE TO STANDARDS

1. Is plant growth predictable?

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

Variable	Option 1	Option 2	Either
Soil Type:	Gravel	Potting Soil	Either
Water Amount (in Bottom Cup):	100 mL	200 mL	Either
Nutrients (Salt) Amount:	None	50 mL	Either

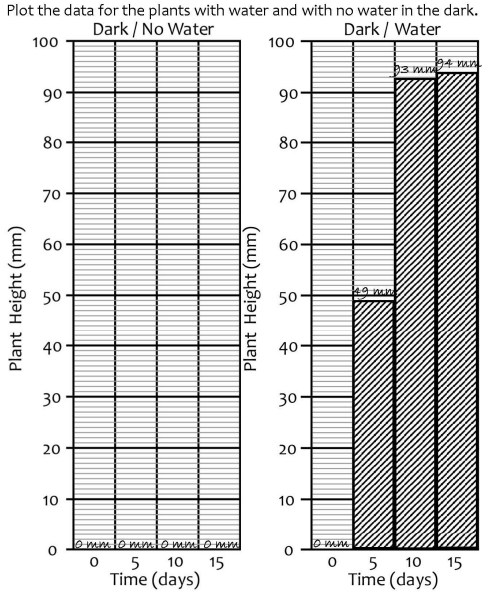
8

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

3. What did plants in the light need to grow? water

9

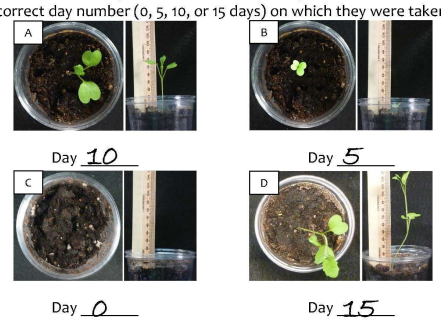
4. Do plants grow in the dark?
Plot the data for the plants with water and with no water in the dark.



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

10

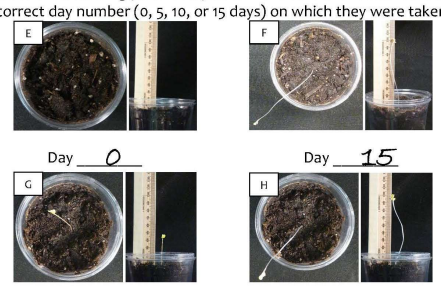
6. Label the following picture of plants in the light with water with the correct day number (0, 5, 10, or 15 days) on which they were taken.



Day 10 Day 5

Day 0 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 15

Day 5 Day 10

11

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 (greenest 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 that can be changed in an experiment.

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

1. Soil amount
2. temperature

12

Preparation:

SciTrek Lead:

1. Get the observation assessments, from the classroom teacher, and put them in the lead box.
2. If the teacher is not leading the tie to standards activity, do the following:

   a. Ask the teacher if they completed the SciTrek final survey. If not, give them the QR code from the lead box, and ask them to go to the website (at a later time), and fill out the evaluation of the program.
   b. Give the teacher an extra notebook, and have them fill it out with their students to follow along.
   c. Collect the teacher's lab coat, and put it in the lead box.
3. If you are a teacher and did not complete the SciTrek final survey, take the QR code from the lead box and fill out the evaluation of the program, at a later time.
4. Pass out notebooks to students or get the classroom teacher to pass them out.
5. Set up the document camera for the tie to standards activity, (pages 8-12, notebook, and pages 3-10, picture packet).
6. Have the 6 plants ready to show students.
7. Put your lab coat in the lead box, at the end of the day.

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

"Before we start our activity today, we will determine how your ideas on observations are developing. Pass out the observation assessment and a black bead, to each student, and have them write their name, teacher's name, and date at the top of the assessment. Tell students, "When doing this assessment, you should work individually so there should be no talking." As you are giving the assessment, walk around the room and verify students have written their name on their assessments.

At the top of the page, have students write in what they think the definition of an observation is. Read the instructions for questions *2-8* aloud to students. Then, read each of the statements and tell students, "Circle 'observation' for statements that are observations, or 'not an observation' for statements that are not observations." When they are finished with this section, collect the black beads.

Then, have the students answer the question "what is one thing a scientist does other than experiments?"

Question *10* asks students if they like science more, less, or the same after going through the SciTrek Program. Tell students, "For question *11*, you are going to tell me how much you feel like a scientist. This is an opinion question and has no right answer, therefore you should be totally honest." Show them the circles on the far left and tell them, "If you don't identify as a scientist at all, you should circle these circles." Show them the circles on the far right. Tell them, "If you feel like you are a scientist and do a lot of things that scientists do, you should circle these circles. If you feel somewhere in the middle, you should circle one of the options in the middle." Question *12* asks students whether or not they would like to get a job as a scientist, have them circle either yes, maybe, or no. Questions *13-18* ask about students' interests in various school subjects. Have them circle either very interesting, interesting, not interesting, or boring, for each. When students are finished, collect the assessments, and verify the student's names are on the top of the assessments.

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

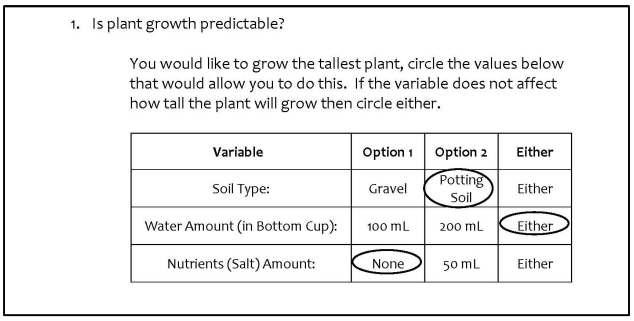
Pass out the draw a scientist paper. Have students write their name, teacher's name, and date on the top of the assessment. Give students **exactly 4 minutes** to draw a picture of a scientist. Once they are done, ask them to write on the bottom line who they drew a picture of. If it was no one specific,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

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

Plant Growth Predictability (5 minutes)

Tell the class, "I enjoyed your poster presentations last time. Today, we are going to revisit some of the variables that you have been investigating, and determine how they affect plant growth." Have students turn to page 8 of their notebooks. Place the class notebook on the document camera and turn to page 8.

Ask the class, "What is a prediction?" They should realize that a prediction is the best guess we are able to make about a system. Ask them, "Do you think plant growth is predictable?" They should reply, "Yes." Tell students, "I have started an experiment 7 days ago, and I brought in the plants from my experiment you all to observe. You will predict which of two plants grew taller under different growing conditions." Go over each of the predictions with the students. Have one student share which plant they think will be taller, and why. Then, have the class vote, using thumbs up/thumbs down whether they agree/disagree with the student. If many students are in disagreement, ask one of the disagreeing students what they think, and why. After, show the students the two plants and have them circle the plant that grew taller in their notebooks as you record the answer in the class notebook. An example can be seen below.



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.

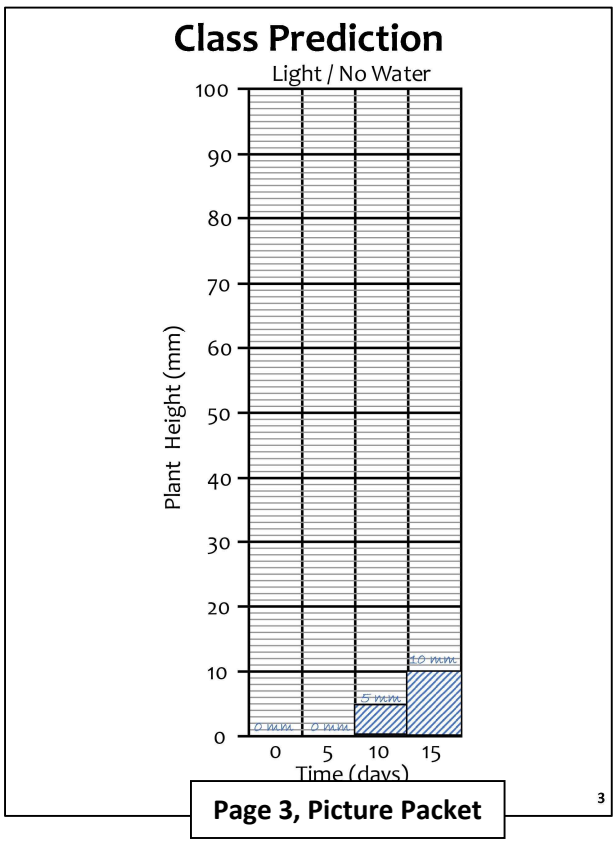
Variable	Option 1	Option 2	Either
Soil Type:	Gravel	Potting Soil	Either
Water Amount (in Bottom Cup):	100 mL	200 mL	Either
Nutrients (Salt) Amount:	None	50 mL	Either

Tell students, "Since you made such good predictions, I now know that plant growth is predictable, and that the amount of water (in the bottom of the cup) does not affect plant growth, but soil type, and nutrient amount, both affect plant growth. Knowing these things will help us determine optimal growing conditions for plants in the garden."

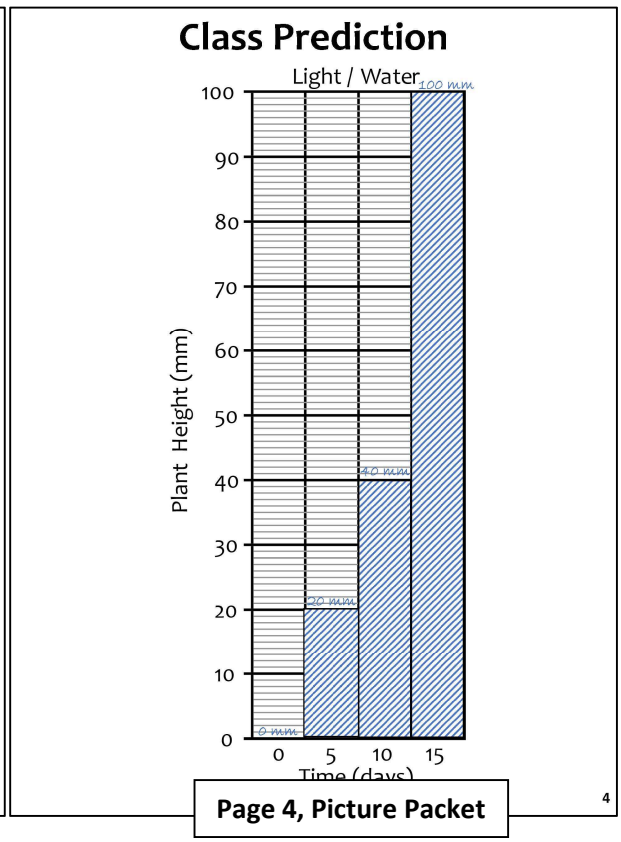
Tell students, "You are now going to make predictions about plant growth over time for plants that were grown in the light. I am going to record your predictions on graphs for you to reference later. After you make predictions, I will show you actual data that was collected, so you can compare your predictions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

Plants in the Light Prediction (10 minutes)

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



Page 3, Picture Packet



Page 4, Picture Packet

Now ask students, "What do you think a graph would look like for a plant that was in the light and had water?" Allow a couple of students to share their answers. Have the rest of the class use thumbs up/thumbs down to show whether they agree/disagree. Once the class has reached a consensus, use their ideas to make a bar graph (page 4, picture packet), and place that graph under the document camera. Typically, students predict that a plant in the light with water would continuously grow taller throughout a given amount of time. An example of this graph can be seen above on the right.

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

Have the students turn to page 9 of their notebooks. Tell students, "We are now going to look at data that I collected over the course of 15 days (page 5, picture packet) to see if your 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, "I used the same experimental set-up as you used for your own experiments." Have students look at the data in the table for *Light/No Water* and ask them, "How tall was the plant on day 0?" Students should reply, "0 mm." Show them where 0 mm is on the graph, draw a line, and write the numerical value on top of the line. Repeat this process for the other three points. Then, have students explain what happened, and what this means about plant growth. Students should notice that no plant growth took place for the seed that was in the light with no water. Therefore, plants need light, and/or water, to grow.

Experimental Data

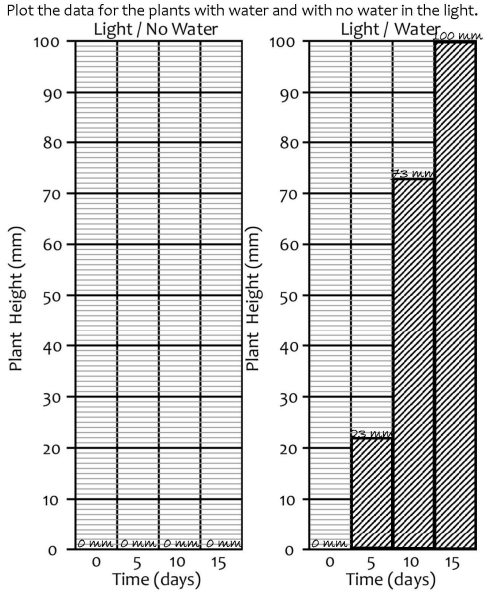
Day	Light No Water
Day 0	0 mm
Day 5	0 mm
Day 10	0 mm
Day 15	0 mm

Day	Light Water
Day 0	0 mm
Day 5	23 mm
Day 10	73 mm
Day 15	100 mm

Page 5, Picture Packet

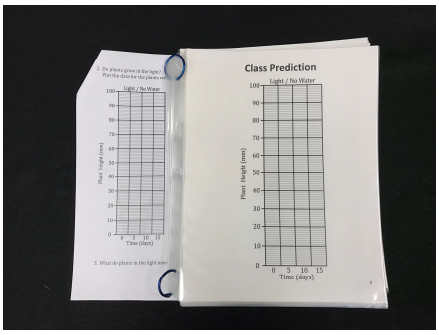
5

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



3. What did plants in the light need to grow? water

9



Place the class prediction graph (page 3, picture packet) over the class notebook to have students compare their predictions to the actual results picture below on right. Tell students not to focus on the numbers but to look at the overall trends.

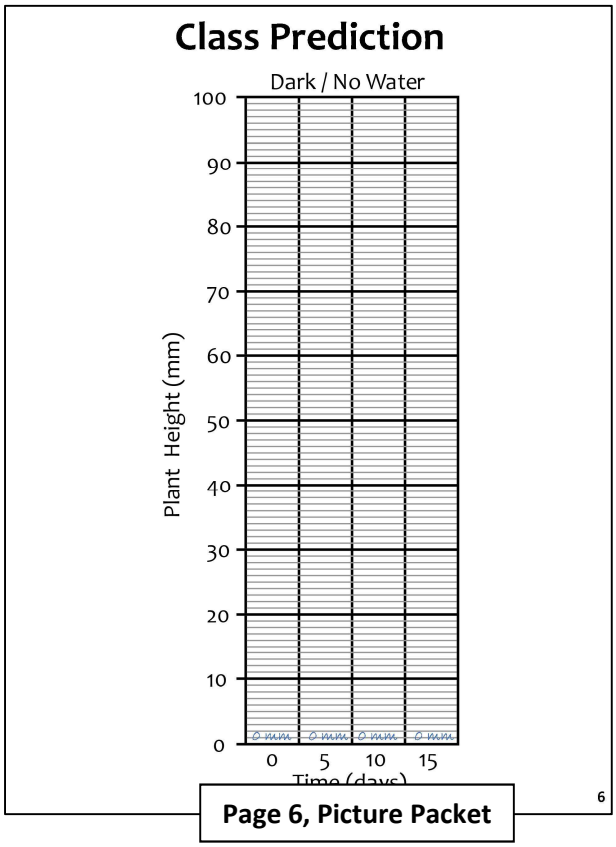
Tell students, “We are now going to plot the data for *Light/Water* (page 5, picture packet).” Again, reveal the points one by one. Ask students, “How tall was the plant on day 0?” Students should reply, “0 mm.” Draw a line at 0 mm, and write the numerical value on top of the line. Ask students, “How tall was the plant on day 5?“ Students should reply, “23 mm.” Put your finger at zero, and tell the students to tell you to stop once you reach the appropriate level for day 5. Once you have reached the level, draw a line, write the numerical value over the line, and quickly shade below. Tell students, “Try to shade in your graph faster than I shaded in the area.” Repeat the process for the other two data points. Example student work is seen above on the left. After the data has been plotted, ask students, “What happened to the seed in the light with water?” Students should notice that with light and water, the plant continued to get taller until day 15. Place the class prediction graph (page 4, picture packet) over the class notebook to have students compare their predictions to the actual results.

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

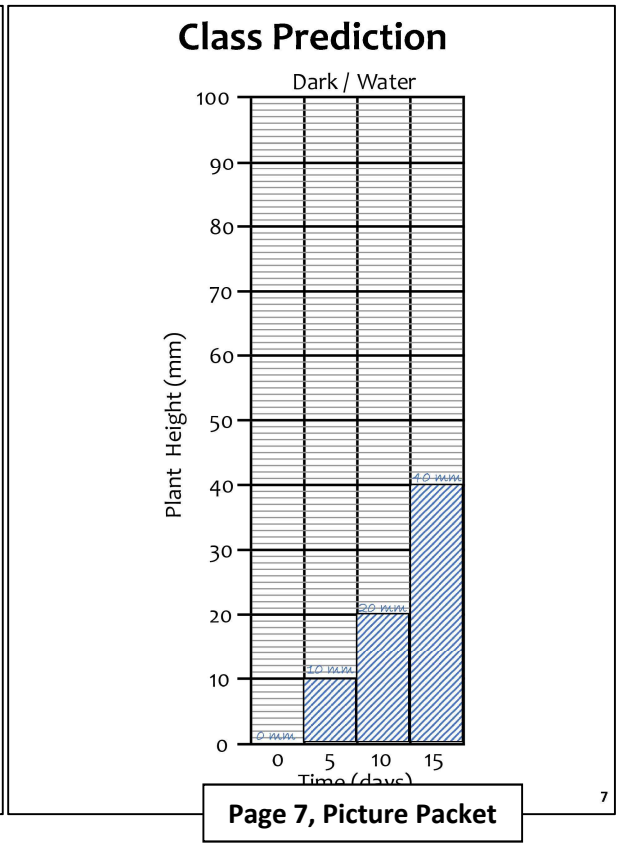
Now tell students, “You are going to make predictions about plant growth over time for plants that were grown in the dark. I am going to record your predictions on example graphs for you to reference later.” After they make predictions, you will show them the actual data that was collected, so they can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

Plants in the Dark Predictions (6 minutes)

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



Page 6, Picture Packet



Page 7, Picture Packet

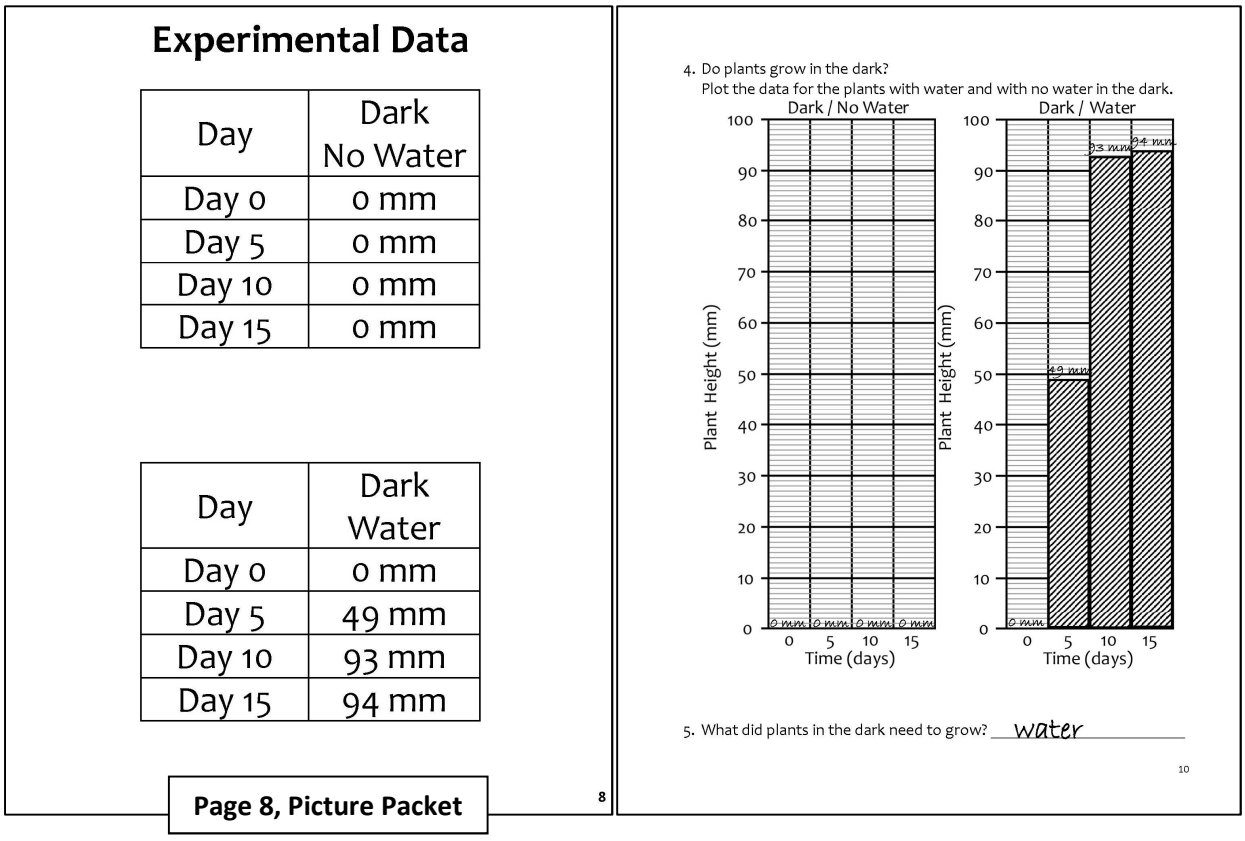
Ask students, “What do you think a graph would look like for a plant that was in the dark and had water?” Allow a couple of students to share their answers. Make sure students state whether the plant in the dark with water would be taller or shorter than the plant in the light with water. Have the rest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

After you have completed the predictions, tell the class, “You are now going to graph the data that I collected, to see if your predictions were 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 students turn to page 10 in their notebooks. Tell students, “We are now going to plot the data for *Dark/No Water*.” Have students graph the data for *Dark/No Water* on their own. If needed, volunteers can walk around and help students. While students are plotting the data, remove the class notebook from the document camera and plot the data on it off to the side. After about 3 minutes, put the class notebook under the document camera, and have students check their graphs. Example student work is

shown below. After the data has been plotted, ask students, “What happened to the seed in the dark without water?” Students should notice that there is no plant growth in the dark with no water. Ask students, “How does this data compare to plants in the light with no water?” They should see that the data is the same. Place the class prediction graph (page 6, picture packet) over the class notebook to have students compare their predictions to the actual results.



Experimental Data

Day	Dark No Water
Day 0	0 mm
Day 5	0 mm
Day 10	0 mm
Day 15	0 mm

Day	Dark Water
Day 0	0 mm
Day 5	49 mm
Day 10	93 mm
Day 15	94 mm

8

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

10

Page 8, Picture Packet

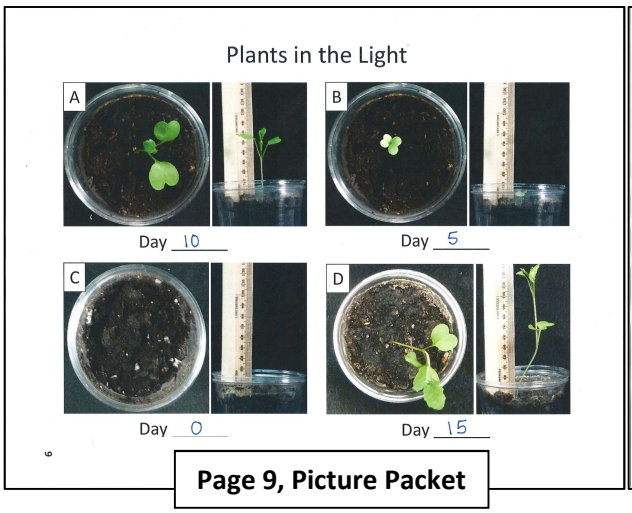
Tell students, “We are now going to plot the data for *Dark/Water*” (page 8, picture packet). For this graph, show the points one by one. As you reveal each point, give students about 30 seconds to try and graph the point on their own. If needed, volunteers can walk around and help students. While students are plotting the data, remove the class notebook from the document camera, and plot the data on it off to the side. Repeat this process for each of the points. Example student work is seen above. After the data has been plotted, ask students, “What happened to the seed in the dark with water?” Students should notice that in the dark with water, the plant continued to get taller until day 15. Ask students, “How does this data compares to plants in the light with water?” Students should see that the plant in the light did not grow as tall, or as fast, as the plant in the dark. Place the class prediction graph (page 7, picture packet) over the class notebook to have students compare their predictions to the actual results.

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

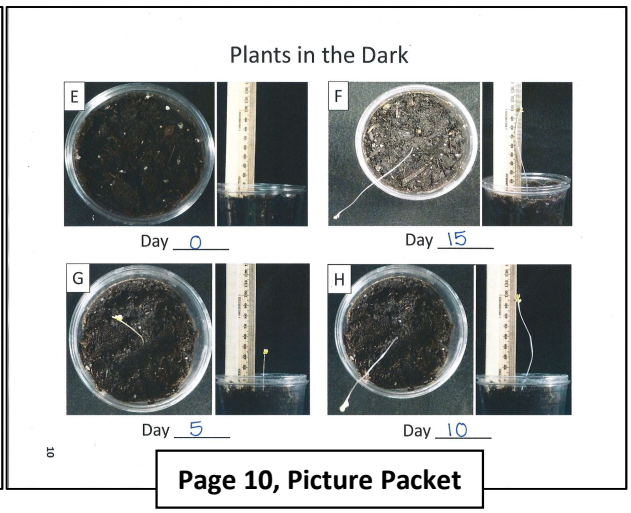
Ask students, “Why do you think plants in the dark with water grow faster than plants in the light with water?” Have a couple students share their responses with the class. Make sure by the end of the conversation, students understand that the plants in the dark might be growing at a faster rate to try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

Matching Plant Growth Pictures (4 minutes)

Have students turn to page 11 in their notebooks. Tell students, "I took pictures of the plants in the light with water (question *6*), and pictures of the plants in the dark with water (question *7*) during the 15-day experiment. Unfortunately, I got the pictures mixed up, and I need your help to 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, "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 whether they agree/disagree with the student. If many students are in disagreement, ask one of the students who is in disagreement what they think, and why. Once a class consensus has been reached, record the correct number of days under each picture.



Page 9, Picture Packet



Page 10, Picture Packet

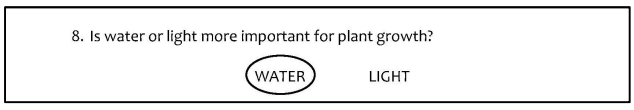
Repeat the process for the plants that were in the dark, question *7*, by using the colored pictures of the plants in the dark (page 10, picture packet). See example above on the right.

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

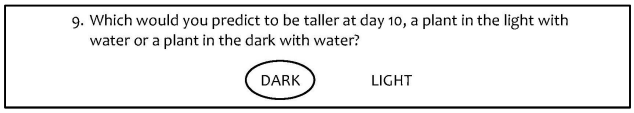
Ideal Conditions for Plant Growth (3 minutes)

Have students turn to page 12 in their notebooks.

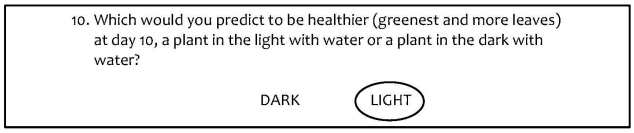
Ask students, "Do you think that water or light is more important for plant growth, and why?" Possible student response: water, because plants were not able to sprout without water, but they were able to sprout without light. If needed, turn back to the graphs on pages 9 and 10 of the class notebook.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



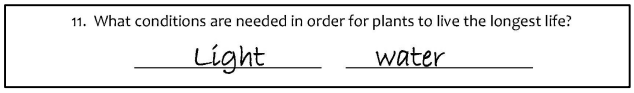
Ask students, "Which do you predict to be taller on day 10: a plant in the light with water, or a plant in the dark with water?" Students can look back at the data they graphed if they need help answering this question. Students should realize that on day 10, a plant in the dark would grow taller, because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



Now ask students, "What plant would you predict to be healthier (greenest and more leaves) on 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 *Light* 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 "light," and "water" for question *11*.



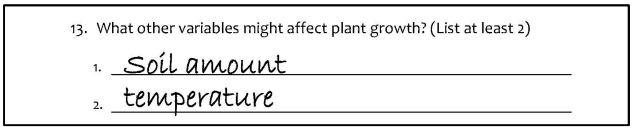
Variables (time permitting)

Only do this section with the class if there is time remaining. Make sure to leave 10 minutes for the content assessment.

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

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

Temperature
Soil type
Container type
Plant type
Soil amount



Tell students, "This module has taught me that plant growth is predictable, and that plants need water and light to grow and be healthy. In addition, you have given me a few ideas for other experiments that I

may be able to try out another time. Before I leave, I would like to see how your science content knowledge has changed."

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

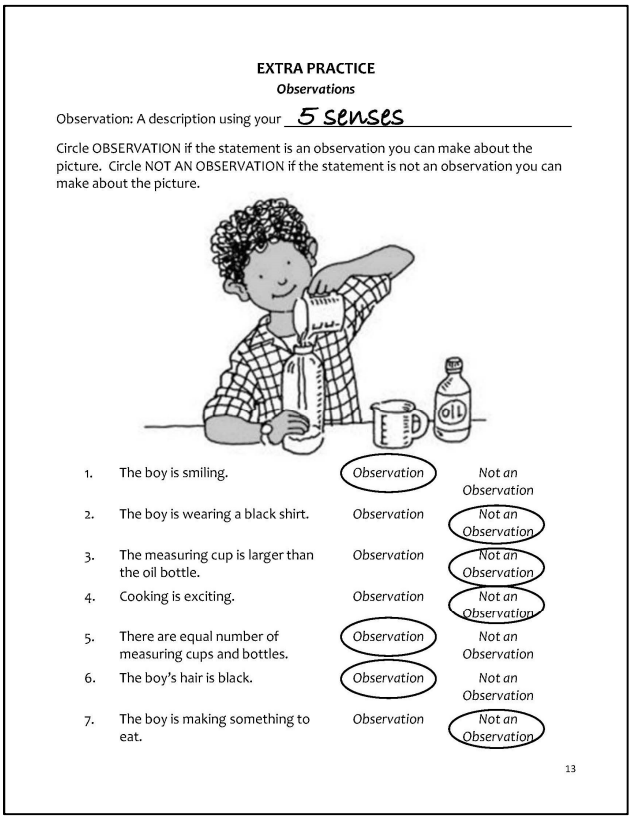
Tell students to close their notebooks and place them in the corner of their desk. Pass out the content assessment and a ruler to each student. Have students write their name, teacher's name, and date on the top of their paper. During the assessment, remind students to work individually. Read each of 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 they have written their names on the assessments.

Tell students, "You can keep their notebooks. I have enjoyed working and learning with you, and I hope you continue to see yourselves as scientists, and explore the world around you."

Clean- Up:

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

Extra Practice Solutions:



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 larger 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)

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