Planning Plant Investigations

7.2

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Anchoring Phenomenon

Tiny seedlings grow and transform into trees with a great quantity of matter.

Lesson Concept

Plan an investigation that would provide evidence to explain where all the matter in a tree comes from when it begins as a small seedling.

Investigative Phenomenon

Continuation of the anchoring phenomenon: Tiny seedlings grow and transform into trees with a great quantity of matter.

Standards

Refer to Appendix 7.2 for NGSS, CCSS (ELA), and California ELD Standards.

7.2 Planning Plant Investigations

Storyline Link

This lesson follows Lesson 7.1: Tree Matter where students modeled their thinking of where the matter comes from that makes up a tree. The students build on their thinking by planning an investigation to test where the matter of a tree comes from. The students will not carry out the investigation but will use this planning to further understand the elements of a scientific investigation. The use of the crosscutting concept Systems and System Models is used to discuss the possible components that are involved in the phenomenon of a tree gaining mass. In the next lesson, they will obtain information from a resource that describes the historical investigations that eventually led to the understanding of photosynthesis. Pre-read the historical investigations in order to help guide your students to create investigations that mimic the actual investigations. Do not tell the students about the investigations. Students' understanding and use of the practice Planning and Conducting Investigations is limited to designing a plan. This will be their initial opportunity in the unit to consider independent and dependent variables and controls, tools that they need to gather data, how measurements will be recorded, and how many data are needed to support a claim. In 7.4: Investigating Gases they will have another opportunity to develop an investigation and carry it through to data collection.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

60 minutes

One 60-minute session

Materials

Whole Class

- ❑ Chart paper

Groups (Groups of 4)

- ❑ 7.2.G1: Plan an Investigation
- ❑ Sticky notes

Individual

- ❑ Science notebook

Advance Preparation

1. Make copies of **7.2.G1: Plan an Investigation** (optional)

Procedure

Engage (45 minutes)

Plan an investigation that would provide evidence to explain where all the matter in a tree comes from when it begins as a small seedling.

1. During Lesson 1: Tree Matter, students modeled their initial thinking of where the matter comes from that makes up a tree.

   Ask students to review their models from Lesson 7.1: Tree Matter. Ask students to consider whether they are satisfied with their model's ability to explain the phenomenon. Where is the model limited? What additional information would strengthen their model? Students should also consider the system described in the model. Ask students to consider which components of the system are uncertain and in need of further investigation.

TEACHER NOTE

The student suggestions might vary depending on whether you provided choices for the students in Lesson 7.1: Tree Matter or if you made the initial question open-ended. If you use an open-ended question, students often suggest that the tree gets its mass from the soil, water, or nutrients but rarely mention air or carbon dioxide. The students may have had lessons in fifth grade around the DCI LS1.C: Organization for Matter and Energy Flow in Organisms: *Plants acquire their material for growth chiefly from air and water*. (5-LS1-1) If they have, they may have suggested air as the source for the matter that makes up a tree. The idea of this lesson is that students plan an investigation to test their ideas. In Lesson 7.3: Historical Investigations, the students will obtain information about the historical investigations that led to the understanding of photosynthesis.

2. Have a class discussion about the student ideas. Allow all ideas. Do not confirm or dismiss any ideas at this time. The idea of photosynthesis will be uncovered in future lessons.

TEACHER NOTE

If students are struggling to share their models, you may need to do a think-aloud in front of the class first. Verbally describe, as if you were thinking aloud, the components seen in the model (*I have included a tree, because that is the thing that is growing*) and ideas they were not sure how to include (*I wanted to show the tree GROWING but was unsure how to do that so I just made a small tree and then a bigger tree*). Some students may need more processing time or opportunities to practice communicating their ideas. You may want to have students discuss their models in small groups before going to a whole-class discussion. This will give English Learners a different linguistic register in which to communicate. It will also allow students more processing time with peers and an opportunity for you to interact with students and ▶ to assess their ideas about the phenomenon and their model.

3. During the class discussion, elicit and make public student ideas about components that enter the system (the tree). Students might suggest soil, water, nutrients, air, and maybe even carbon dioxide. (Do not suggest air or carbon dioxide if the students don't bring it up.) Ask students to think about if and how matter is flowing in their model. What do they currently think about how matter might be tracked in terms of amount of weight before it enters the system, during its time in the system, and after it leaves?
4. In their small groups (3–4 students) ask the students to think about how they would plan and carry out an investigation to test their ideas of which components are entering the system such as soil, water, nutrients, etc. Ask students what information they would want to gather to improve their models. Allow teams time to discuss their ideas and generate consensus. Suggest that teams sketch their current thinking for investigation ideas. English Learners will benefit from the option to express their ideas in a different modality, such as drawing images. Tell students to record their ideas from the group discussion in their science notebook.
5. Conduct a whole-class discussion. Ask students to review their notes and think about what things they considered when developing their investigation plan. What makes an investigation scientific? Listen for student responses that mention that investigations should produce data (grade K–2 band), have fair tests where variables are controlled, and have more than one trial (grade 3–5 band). If students are not aware of these elements of a scientific investigation you may need to adjust the lesson to address where students are in the practice of planning and conducting an investigation. Record their ideas on chart paper so they can be referenced later in the lesson.

TEACHER NOTE

This is the first point in the unit that students are engaging in the practice of planning and conducting an investigation. In Lesson 7.3: Historical Investigations, students will focus on planning an investigation that will then be extended through comparisons of historical investigations. In Lesson 7.4: Investigating Gases, students plan and conduct an investigation about gases that are exchanged within a plant. Students may need support in identifying independent and dependent variables in their designs rather than simply considering which variables will be controlled (grade 3–5 band). In the grade 3–5 band, students are asked to consider what data is needed to serve as the basis for evidence. In this lesson, students may also need support in identifying what they will measure and what tools are needed to gather the data. If students are struggling to identify variables, they can brainstorm the possible things they could change in the experiment (independent variable) by writing each on a different sticky note. They can also identify all the possible things they could measure on different sticky notes. With the sticky notes in two clumps (things we could change and things we could measure), instruct students to identify ONE sticky note in the "things we could change " clump. Explain that this is their independent variable. All the other sticky notes in that clump are controls, or things that they should make sure do not change. Do the same with the "things we could measure" clump and explain that these are dependent variables. However, you may decide to allow students to measure more than one dependent variable. This sticky note strategy could be modified for English Learners by adding symbols or drawings to the text on the sticky note. For students above the target level, measuring multiple dependent variables in the lesson is an option as well.

6. Direct students to again focus on their small group model Students should be encouraged to consider their current model of the system and look for areas where their model may be limited. What evidence would improve their model? Listen in and guide the discussion to encourage the students to be explicit in describing variables and controls, tools needed, what will be measured, how much data is needed, and how the data support the claim. Continue recording ideas that have class consensus. When reasonable, represent ideas with both visuals and words. For example, if a group suggests having two plants, one a control and the other experimental with less soil, draw a picture of two plants with varying amounts of soil below the sentence.

7. Allow time for the groups to share their ideas with the whole class. If you observed particularly useful conversations regarding variable control or tools from the small group, you can ask those teams to share some of their discussion. After a few teams have shared their ideas, tell the students to listen to the ideas of other students so they can add new ideas to their science notebook.

TEACHER NOTE

During the discussion, probe students to find out what they would measure and what different results would mean depending upon where the matter came from. For example, if the students suggest that soil makes up the matter of the tree, the students could think about how they would measure soil before and after a seedling grows into a tree and compare the mass of the leftover soil with the mass of the tree. If the students suggest water makes up the matter of a tree, they could plan an investigation where they keep track of the water they add to the tree. The idea of this lesson is to have the students think through the investigations that actually occurred in history. They don't know about these investigations yet but will read about them in Lesson 7.3: Historical Investigations. Because they are encouraged to wonder how someone might go about finding out if the matter of the tree came from soil, water, nutrients, air, etc., they will be very interested in reading about the historical investigation in Lesson 7.3: Historical Investigations.

8. Students will now use their preliminary ideas and the ideas gained from the class discussion to enhance their plan for their investigation. Tell students to work individually or in groups to plan an investigation. Suggest that students use template **7.2.G1: Plan an Investigation** (scaffold for English Learners or students working below grade level) or allow the students to plan in their science notebooks. Since the plan won't be carried out, the students don't need to be limited by classroom supplies and time. However, students should produce clear and coherent written plans that convey a clear sequence of events.

Explain (15 minutes)

Plan an investigation that would provide evidence to explain where all the matter in a tree comes from when it begins as a small seedling.

9. This is the first time students are planning an investigation in this unit. Students will increase their use of variables, controls, and measurement tools throughout the unit. In this initial plan, it is important that students consider what question they are trying to answer as well as what evidence they want to collect and construct a plan that matches the cause-and-effect relationship between the two. If students need additional support, consider having them work in small groups, rather than individually, to allow for peer-to-peer collaboration. While groups are working, you can provide additional guidance to groups or individuals. As students near consensus, remind them to record their plan in their science notebook for use later.

TEACHER NOTE

This step of the lesson is about having the students be sure they have included the elements of a scientific investigation for the grade 6–8 band. Two different ways of achieving this are suggested here.

1. Have the students find each element of a scientific investigation (the questions listed below) in their preliminary plan that they created during steps 5–7, make a note next to the element, and add the elements that they have not included.
2. Use **7.2.G1: Plan an Investigation** and have the students work individually or in groups to complete it. Students who are investigating the same thing such as soil making up the matter can be put in groups to complete their plan for the investigation on **7.2.G1: Plan an Investigation**.

   <u>Elements of a Scientific Investigation</u>

   a. What are you trying to figure out? *Expected Student Response (ESR): If the type of soil or amount of water or type of nutrients, etc. will affect the amount of matter within a plant.*
   b. What is the plan for your investigation? *ESR: We are going to set up several tests that will isolate the factor that we think causes the plant to add all of its matter over time as it grows from a seedling to a large tree.*
   c. What are the independent and dependent variables? *ESR: The independent variable is the type of soil or amount of water or type of nutrients, etc. The dependent variable is the change in mass or matter in the plant.*
   d. What variables will you control? *ESR: Possible variables that can be controlled can include the intensity of light, type of seeds, amount of water, soil type, temperature, etc.*
   e. What tools are needed to do the gathering? What tools are needed to gather the data? *ESR: a triple beam balance or scale to measure the mass, a thermometer, photometer, etc.*

TEACHER NOTE (Continued)

f. How will measurements be recorded? *ESR: Data will be collected using the tools listed above and recorded in the science notebook or data will be collected using collaborative digital spreadsheets.*

g. How much data is needed to support your claim? *ESR: Multiple data will be recorded from the experiments which include the mass, the temperature of the soil, the intensity of light, etc.. A minimum of 5 tests will be made to provide evidence for our claim.*

h. How accurate are your methods for collecting data? *ESR: We will use the same methods for collecting data throughout the experiment to ensure accurate results.*

i. Draw a picture of your plan for your investigation.

j. Think of the different results you might get. What will the results tell you about what you were trying to figure out? *ESR: We are trying to determine how a plant gets all of its matter and increases in mass. Our data will show if the matter came from the soil/water/nutrients/light. If our results are inconclusive, we might need to reevaluate our data collecting methods and/or run more tests to collect more data.*

k. Why is it important for us as scientists to figure out how trees gain their mass? How could our research positively benefit our community?

**ESR Expected Student Response*

Students explain their plan to other groups. This could be done as a whole class or in small groups. Encourage the students to be explicit about how their investigations fit the elements of a scientific investigation listed in #2 in the Teacher Note above and also in the **7.2.G1: Plan an Investigation.** Tell students that they will be providing feedback to each other during this sharing. Students will need support or protocols for providing feedback to each other. A suggested feedback protocol is provided.

a. Structured Talk Scaffold

   1. Group/Person A explains their idea verbally and shows representations/drawings. Group or person B listens.
   2. Group/Person B builds on what was shared verbally and shows representations/drawings.
   3. Group/Person A responds to those ideas or challenges.
   4. This is repeated with Group/Person B sharing their ideas and plans.

b. These sentence frames for feedback can be placed on a card to support student discussion and feedback.

   - I am not sure I understood ______. Can you tell me more?
   - I agree with ______ because ______.
   - I disagree with ______ because ______.
   - What you said ______ about ______ made me wonder ______.
   - I want to build on your idea about ______.

10. Ask questions about what the students are measuring and what the different results would indicate. For example, if students plan an investigation to find out if soil makes up the mass of the tree, then they should mention that they will measure the soil before and after the tree grows. Also, they should say that if the mass of the tree does not match the mass of the missing soil, then that would be evidence that the mass came from somewhere else. Ask students to consider the system under investigation. How is their design related to identifying specific components of the system? How will their design produce fair and accurate information that will help to improve their model?

11. Five minutes before the end of the class, direct students look at their initial model in their science notebook from day one and add any new ideas or wonderings they have to their model. Tell them that they will be adding to this model throughout their learning experiences.

12. End class by returning to the questions that were generated during Lesson 7.1: Tree Matter. Ask the members of the class if they have any additional questions or wonderings to add.

13. ▶ You may wish to collect science notebooks at this point to informally evaluate and identify trends in student progress towards Planning and Conducting Investigations or System and System Models. You may consider focusing on a small section of **7.2.G1: Plan an Investigation** as a review before moving on in this unit. For example, if while reviewing the science notebooks you identify a mismatch between what students say they are trying to figure out and the evidence being collected, you may need to review the cause-and-effect relationships in an investigation plan or review the system components and which component their investigation is testing. You could identify some representative samples of high, medium, and low understanding of these elements of a scientific investigation and review with the class before moving on to Lesson 7.3: Historical Investigations. You could also use this science notebook analysis to guide their work in the next lesson by selecting a few areas of weakness to focus on, such as providing additional support when considering historical investigations.

Toolbox Table of Contents

Plan an Investigation

Group Members:

1. What are you trying to figure out?

2. What is the plan for your investigation?

3. What are the independent and dependent variables?

4. What will you control?

5. What tools are need to gather the data?

6. How will measurements be recorded?

Plan an Investigation (continued)

7. How many data are needed to support your claim?

8. How accurate are your methods for collecting data?

Draw a picture of your plan for your investigation.

Think of the different results you might get. What will the results tell you about what you were trying to figure out?

Appendix 7.2

Planning Plant Investigations

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Planning and Carrying Out Investigations
• Plan an investigation individually and/or collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

DISCIPLINARY CORE IDEAS (DCI)
LS1.C Organization for Matter and Energy Flow in Organisms
• Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.

CROSSCUTTING CONCEPTS (CCC)
Energy and Matter
• Matter is conserved because atoms are conserved in physical and chemical processes.
• Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems. (From Grade 3–5)

Appendix 7.2

Common Core State Standards (CCSS)

CCSS ELA WRITING AND ELA SPEAKING AND LISTENING
ELA-LITERACY.W.7.3.C Use a variety of transition words, phrases, and clauses to convey sequence and signal shifts from one time frame or setting to another.
ELA-LITERACY.W.7.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
ELA-LITERACY.SL.7.1.B Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.
CCSS ELA WRITING
CCSS.ELA-LITERACY.W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.
CCSS.ELA-LITERACY.W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

California English Language Development (ELD) Standards

CA ELD		
Part 1.7.1 Exchanging Information/ideas		
EMERGING	**EXPANDING**	**BRIDGING**
P.1.7.1 Engage in conversational exchanges and express ideas on familiar topics by asking and answering yes-no and wh- questions and responding using simple phrases.	**P.1.7.1** Contribute to class, group, and partner discussions by following turn-taking rules, asking relevant questions, affirming others, adding relevant information, and paraphrasing key ideas.	**P1.7.1** Contribute to class, group, and partner discussions by following turn-taking rules, asking relevant questions, affirming others, adding relevant information and evidence, paraphrasing key ideas, building on responses, and providing useful feedback.