THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

To Grow or Not to Grow

Where do plants get the materials they need to grow?

GRADE 5

Life Science

VAN ANDEL EDUCATION INSTITUTE

VAEI.ORG

INQUIRY-BASED SCIENCE

Life Science

To Grow or Not to Grow

Grade Level/ Content	5/Life Science
Lesson Summary	In this lesson, students conduct an investigation to determine what materials a plant needs to grow.
Estimated Time	2, 45-minute class periods
Materials	Young, fast-growing plants (we suggest using Wisconsin Fast Plants available at Wisconsin Fast Plants); watering system (this can be manual or you can build-your-own deli container watering system); 3 oz plastic containers; transparent air-tight container; consistent light source; soil; Investigation Plan; Observation Form; journal
Secondary Resources	• Wisconsin Fast Plant Diagram • Biology for Kids • Crash Course Kids: Who Needs Dirt? • Blue Sky Science
NGSS Connection	**5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water.
Learning Objectives	• Students collect and analyze data to determine the materials a plant needs to grow. • Students provide an explanation that identifies air and water as the primary materials a plant needs to grow.
Cross-Curricular Project Connections	Garden Planning, Dinner Party

Where do plants get the materials they need to grow?

Plants are all around us. They are used for decoration, medicines, wood, food, and so much more. Scientists are continually looking for ways to improve the disease resistance of plants to protect them as a vital resource. Wisconsin Fast Plants were developed by Professor Emeritus Paul H. Williams at the University of Wisconsin. He bred these plants as a research tool for improving similar crops such as mustard, radish, cabbage, broccoli, and more.

He selected plants that had characteristics most suitable for laboratory and classroom use, such as short life cycles, easy to grow, and small size. After 20 years of development, Dr. Williams had reduced the 6-month life cycle of the plant to just 5 weeks! The shortened life cycle has proven effective in research and has led to advances in cellular and molecular plant research. In this lesson, students will use Wisconsin Fast Plants to determine what a plant needs to grow.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

At least 4 days before the lesson, plant the Fast Plant seeds. Allow them to sprout. Each group will choose 5 plants of approximately the same height and plant them in the plastic containers according to the **Investigation Plan**.

Each student team will need the following:

- 5, 3oz plastic containers
- 5 young, fast-growing plants (we suggest using Wisconsin Fast Plants available at Wisconsin Fast Plants)
- Watering system (this can be manual or you can build-your-own deli container watering system)
- Consistent light source
- Soil
- Transparent air-tight container
- Investigation Plan
- Observation Form
- Journal

Part 2

INVESTIGATION FACILITATION

Question

Introduce the investigation question.

Where do plants get the materials they need to grow?

CURIOSITY

To nurture student curiosity, have various plants placed around the room for student observations. You may also choose to show a time lapse video of the Wisconsin Fast Plants life cycle. Ask students: *What do you notice? What can plants tell us? What do you wonder about?*

Personal Knowledge

Students capture what they already know about plants and what materials plants need to grow.

- Have students share what they already know about plants and the materials they need to grow.
- Generate a class list.
- More than likely, students will identify light as a material plants need to grow. Light is not matter, but resist the urge to correct this idea. The difference between air, water, and light will be addressed after students complete the investigation.

COLLABORATION

Conduct a *Think, Draw, Pair, Share* to encourage student participation. Have students think about what they know about plants and the materials plants need to grow. Then, have students capture their thinking as a drawing. Challenge them to include labels and descriptions. After a designated time, have them share their drawings with a partner. Choose a few groups to share with the class.

Prediction

Students communicate an expected outcome, based on prior knowledge.

- Have students write their predictions in their journal.
- Ask them to use the prompt: *I predict* _____ *because* _____.

Secondary Knowledge

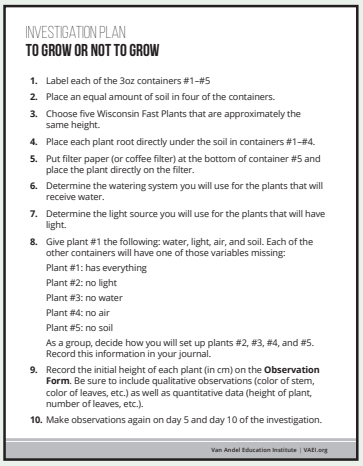
Students learn the life cycle of the Wisconsin Fast Plant.

- Introduce students to the Wisconsin Fast Plant and why it is ideal to use in research.
- Show students the Wisconsin Fast Plant Diagram. Have students review the diagram and check for understanding. Ask: *How do you think this life cycle relates to other plants? Have you ever planted anything at home? If so, how long did it take to grow?*

Investigation Plan

Students conduct an investigation to determine what materials a Wisconsin Fast Plant needs to grow.

- Have students work in teams of 4.
- Review the Investigation Plan as a class.
- Discuss the controls and variables for the investigation. Challenge the groups to determine how they will remove light and air from their respective plants. Have them write this information in their journal.
- Have students follow the **Investigation Plan** and record their quantitative and qualitative observations.



INVESTIGATION PLAN

TO GROW OR NOT TO GROW

1. Label each of the 3oz containers #1–#5
2. Place an equal amount of soil in four of the containers.
3. Choose five Wisconsin Fast Plants that are approximately the same height.
4. Place each plant root directly under the soil in containers #1–#4.
5. Put filter paper (or coffee filter) at the bottom of container #5 and place the plant directly on the filter.
6. Determine the watering system you will use for the plants that will receive water.
7. Determine the light source you will use for the plants that will have light.
8. Give plant #1 the following: water, light, air, and soil. Each of the other containers will have one of those variables missing:
   Plant #1: has everything
   Plant #2: no light
   Plant #3: no water
   Plant #4: no air
   Plant #5: no soil
   As a group, decide how you will set up plants #2, #3, #4, and #5. Record this information in your journal.
9. Record the initial height of each plant (in cm) on the **Observation Form**. Be sure to include qualitative observations (color of stem, color of leaves, etc.) as well as quantitative data (height of plant, number of leaves, etc.).
10. Make observations again on day 5 and day 10 of the investigation.

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Investigation Plan

CRITICAL THINKING

Use the Fair Test checklist to help students think critically about the investigation plan. Help them understand that a good investigation plan must include a test that is repeatable, generates quality data, and minimizes error. The more critically students think about their investigation plan, the more confident they will be in their results.

RICH LANGUAGE

Review or introduce the terms *control*, *independent variable*, and *dependent variable*. Each group will have one *control* set-up that includes the following: water, soil, air (CO_2), and light. The other four plants will each have one variable missing. These are the experimental set-ups. They will be collecting their data 3 times over 10 days (*independent variable*) and determining how removing one of the variables affects the height (*dependent variable*) of each plant.

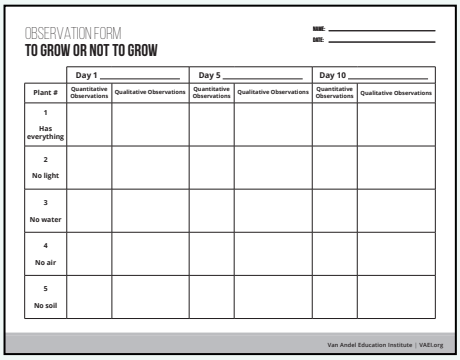
Observation

Students record their observations as they monitor their Wisconsin Fast Plant growth.

- Have students monitor and observe their plants on Day 1, Day 5, and Day 10 of the investigation.
- Ask students to record quantitative data (height of plant, number of leaves, etc.) and qualitative data (color of leaves, color of stem, etc.) on the Observation Form.
- Encourage students to take pictures if possible.

INTEGRITY

Encourage students to record data objectively. Discourage them from trying to represent their data visually too soon. Disciplined researchers collect data first and then analyze it. This helps to avoid biased data.


OBSERVATION FORM
TO GROW OR NOT TO GROW
NAME: _____
DATE: _____

	Day 1 _____		Day 5 _____		Day 10 _____	
Plant #	Quantitative Observations	Qualitative Observations	Quantitative Observations	Qualitative Observations	Quantitative Observations	Qualitative Observations
1 Has everything						
2 No light						
3 No water						
4 No air						
5 No soil						

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Observation Form

Part 3 INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

Students make sense of their data by organizing it and representing it visually.

Have students analyze their data. They may wish to use the Data Analysis prompt as a guide.

- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning. Have them use math as appropriate, such as calculating the height change over 10 days for each plant and/or graphing the height change for each plant. Challenge students to indicate the independent (days) and dependent (height) variables on their graphs.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.

Secondary Knowledge

Students use secondary sources to understand what materials a plant needs to grow.

Biology for Kids

Crash Course Kids: Who Needs Dirt?

Blue Sky Science

From these resources, students will learn that plants acquire material (matter) for growth chiefly from air and water. Students will identify that the CO_2 in the air is the primary material plants take in for photosynthesis. Plants also need sunlight for photosynthesis, but sunlight is a form of energy (electromagnetic radiation) and not matter. Discuss the differences between air, water, and light. Students may still have questions

Continued

regarding the absence of soil from this list. Remind them that as long as a plant receives the minerals it needs, it does not matter where those minerals come from.

CURIOSITY

When curious people learn new information, they continue to ask questions and make connections. Develop curiosity by encouraging students to share their learning from secondary resources using a *Fact-Question-Connection* format. They should share one fact they learned, one question they still have, and one connection from what they learned to something they already know, something they are interested in, or something another classmate said. Students use this information in the reasoning portion of their explanation.

Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the Explanation prompt as a guide. Have them write their explanation in their journal.
- Have students develop a **Claim** to answer the question: Where do plants get the materials they need to grow?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

We claim that plants need water, air, and light to grow.

Evidence

After 10 days, our control plant grew the most (9 cm) and had large, bright green leaves with a thick purple stem. All the other four plants grew, but the plant without water (#3) died within 10 days. The plant without light (#2) grew $2\frac{1}{2}$ cm and had a very thin stem and lighter green leaves. The plant without air (#4) grew about 2 cm, but was flooded with water and the stem was very fragile and hard to measure. The plant without soil grew 3 cm, had 6 small, bright green leaves and a thicker stem than the plants with no light and no air.

After 10 Days

Reasoning

Investigation: We followed the investigation plan carefully. We used the same amount of water for the plants #1, #2, and #4. But for plant #5, we realized that it had no soil to hold the water and that it would drown if we gave it the same. We measured the height of the plant 3 times in 10 days. We compared our results to the control plant (Plant #1).

Science: From our class readings and discussions, we learned that plants get the materials they need mostly from air and water. Although plants also need light to grow, light is not considered matter, light is energy. Plants use the CO_2 from the air and light energy to make their own food through photosynthesis. Plants do

Continued

not need soil to grow as long as they get the nutrients they need. These nutrients can come from the water. This is how farmers use hydroponics to grow crops. Even though soil is not completely necessary, it does help a plant put down roots that provide structure for the plant.

- Once the explanation is written, have students discuss their results using a Present and Defend.

DISCOURSE

Have students conduct a Present and Defend to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning. If students are doing the same investigation plan, choose 1 or 2 groups to share.

Evaluation

Students reflect on the investigation.

Ask students:

- *What surprised you?*
- *What question would you like to investigate next?*

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Application

Students demonstrate understanding of what materials plants need to grow.

- Have students design and conduct their own investigation studying the effect of nutrients on a plant. Have students determine different ways to provide nutrients to a plant and identify which method of transport is most effective.

Assessment

Evaluate how well students:

- collect and analyze data to determine the materials a plant needs to grow.
- provide an explanation that identifies air and water as the primary materials a plant needs to grow.

Take This Lesson Across the Curriculum

Garden Planning

Your school has decided to build a community garden and has enlisted your help. Use your knowledge of what a plant needs to grow to help design and maintain the garden.

Reading/Language Arts	Math	Science	Social Studies
The Secret Garden Read *The Secret Garden* by Frances Hodgson Burnett. Discuss how the characters in the story bring a forgotten garden back to life. CCSS.ELA-LITERACY.RL.5.2	**How Much Space?** You decide to include 2 plant boxes in your garden space. Determine the volume (in cubic meters) needed for each box. CCSS.MATH.CONTENT.5.MD.C.5	**To Grow or Not to Grow** Use your knowledge of what plants need to grow to help design and maintain the garden. NGSS: 5-LS1-1	**Show Me the Money** Develop a fundraising campaign to cover the start-up costs for the school garden. NCSS: D2.Eco.3.3-5

Dinner Party

The best menus use the freshest ingredients. Learn about what foods are available at your local farmers market to plan a world-class dinner party and invite your friends!

Reading/Language Arts	Math	Science	Social Studies
RSVP Design and publish an invitation to send to your friends. CCSS.ELA-LITERACY.W.5.6	**How Much?** Use your knowledge of fractions to determine how much of each ingredient you will need to create your menu. CCSS.MATH.CONTENT.5.NF.A.1	**To Grow or Not to Grow** Use your knowledge of what plants need to grow to plan a world-class menu. NGSS: 5-LS1-1	**Farmers Market** Research what foods are available at your local farmers market to include in your menu planning. NCSS: D2.Geo.7.3-5

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

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