The Great Bean Race Unit Plan

Unit Overview

Unit Title

The Great Bean Race

Unit Summary

The Great Bean Race is on! Compete with classrooms from other regions to see which collaborative team can grow the tallest bean plant. Controlling for certain variables (including growth time and bean seeds), seven or eight teams in each classroom design and conduct a controlled bean-plant experiment to investigate ideal conditions for growth. Students synthesize bean-plant information into a newsletter that describes the project, their group bean plan, and facts about beans.

Subject Area

Science, Math

Grade Level

3–5

Higher-Order Thinking Skills

Investigation, Drawing Conclusions, Collaboration, and Self-direction

Approximate Time Needed

7 weeks, 2–3 hours of class time per week

Unit Foundation

Targeted Content Standards and Benchmarks

Arizona Content Standards:

Science Standards

- Theorize, plan, and carry out experiments, and analyze and report conclusions of those experiments
- Compare prior knowledge to the results of a scientific investigation
- Organize evidence of a change over time
- Develop models (illustrations and charts) to explain how objects, events, and processes work in the real world

Math Standards

- Select and use appropriate techniques to facilitate computation (including mental, estimation, paper-and-pencil, calculator, and computer methods) while solving problems and determining the reasonableness of results
- Collect and record data from surveys or experiments
- Organize (that is, sort, sequence, tally) information from surveys or experiments
- Construct, read, and interpret displays of data to make valid decisions, inferences, and predictions
- Make and label a graph (horizontal bar, vertical bar, picture graph, or tally chart) from organized data
- Read a thermometer in Celsius and Fahrenheit to the nearest degree
- Measure a given characteristic of an object using standard units of measure

Technology Standards

Productivity Tools

- Students use technology tools to enhance learning, increase productivity, and promote creativity
- Students use productivity tools to collaborate in constructing technology-enhanced models, preparing publications, and producing other creative works

Communications Tools

- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences
- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences

Research Tools

- Students use technology to locate, evaluate, and collect information from a variety of sources
- Students use technology tools to process data and report results
- Students evaluate and select new information resources and technological innovations based on the appropriateness to specific tasks

Student Objectives/Learning Outcomes

Science:

Students will be able to:

- Analyze variables of plant growth by completing plant lab activities
- Work like scientists to plan, conduct, analyze, and report the results of a discrete experiment
- Make sequential observational drawings of a plant to show how it changes as it grows
- Make periodic measurements, record plant height, and make a chart showing growth over time

Process and Technology Skills:

Students use science journals to:

- Document the methods of their investigation in an organized way, with a complete hypothesis, experimental design, results, and conclusion
- Write reflective responses to teacher queries throughout the course of the unit
- Draw diagrams and illustrations that show processes and effects
- Enter data in a spreadsheet, make charts that show growth over time, and interpret the meaning of the chart
- Work cooperatively in small groups

Students use desktop or online publishing software to:share research processes and findings using text, images, and visual displays of data

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Curriculum-Framing Questions

Essential Question	Is conquering the impossible possible?
Unit Questions	• What are the perfect conditions for growing a bean plant? • Why are plants important to us?

Content Questions	• What are the parts of a plant?
	• What does a plant need to live?
	  • What are the functions of different plant structures?
	  • What is photosynthesis?

Student Assessment Plan

Assessment Summary

A T-chart created by the students at the beginning of the unit provides information about students' understanding of the differences between fact and fiction as well as their prior knowledge of plant growth. The teacher uses a gauging student needs assessment several times throughout the unit to determine students' prior knowledge. Students keep journals throughout the unit and frequently update a Know-Wonder-Learn chart. These documents help the teacher determine how students' knowledge is progressing. Before project work begins, students complete a project plan to help them direct their own learning. Throughout their work on the project, students also use the project rubric to guide them. As students complete their plant logs, the teacher checks the logs to see if students need more instruction in data collection and recording. When student groups work on their newsletters to share their findings, they use the newsletter checklist to help them create newsletters

that meet all the expectations. Since this is a group project, students use the collaborative assessment to self-assess their work with others. When the project is completed, students reflect on their learning, and their final product is assessed using the project rubric.

Assessment Timeline

Before project work begins		Students work on projects and complete tasks		After project work is completed	
• T-chart • Journals • K-W-L Chart	• Gauging Needs Assessment • Group Plan • Project Plan	• Plant Log • Project Rubric • Newsletter Checklist	• Collaborative Assessment	• Reflection • Project Plan	• Project Rubric

Unit Details

Prerequisite Skills

- Functional keyboard and mouse skills (typing, navigating, copying, pasting, and saving on a computer)
- Basic knowledge of word processing software
- Ability to measure length in inches, capacity in milliliters, and degrees in Fahrenheit or Celsius.

Instructional Procedures

Preparing for the Unit

Six to Eight Weeks Prior to the Unit

Contact two classrooms in different regions to participate in the project, preferably engaging those in regions with different climactic conditions. To locate other classes for participation in The Great Bean Race, try www.epals.com* and www.kidsgardening.com*.

Three Weeks Prior to the Unit

Germinate lima beans with varying amounts of light (12 hours, 18 hours, and 24 hours) to demonstrate how the amount of light affects plant growth. Engage students in this work; it will be a good "teaser" for the unit to come.

Review and/or teach the following scientific terms:

- *Analyze*
- *Hypothesis*
- *Inference*
- *Processes*
- *Variable*

Send the project brochure home to introduce parents to project-based learning in your classroom.

Getting Started

Read the classic fairy tale *Jack and the Beanstalk* to students. Discuss the story and begin to talk about the realities and fantasies of the story. Fill out a class T-chart to compare fact and fiction, and to determine students' prior understanding of plant growth. Begin to probe students to think about how a beanstalk could grow so tall and so strong. Discuss the impossibilities of growing a beanstalk

that big, but discuss how you might go about trying to conquer the task to make it possible. Chart students' responses and keep the chart up throughout the unit. Introduce The Great Bean Race using the Bean Race slide presentation.

Germinate one lima bean seed for each student to be used later in the challenge. Loosely fold a moistened quarter-sheet of paper towel around each seed. Suspend the paper towel packet inside a sealable plastic baggie using a small bit of tape. Zip the bags closed, and, using a permanent marker, write a student's name on each baggie. Tape the bags to a window that gets at least indirect natural light.

Asking Questions and Tapping Prior Knowledge

Pose the Essential Question to students, *Is conquering the impossible possible?* Have students discuss the question in a Pair and Share grouping and prompt them to use examples that demonstrate their ideas. Ask students to think of things in their everyday lives that seem impossible and discuss ways they may be able to make those things possible. Bring the discussion back to the whole group and have students discuss what they talked about. Chart students' ideas and keep the chart up for students to refer to throughout the unit.

Introduce the science journal. Students use the journals to make observational drawings, write notes, and develop outlines and charts. Most importantly, students write journal responses to questions posed in class. Use the journal entries to monitor students' learning throughout the unit. Have students write their first journal entry by reflecting on the Essential Question on their own.

Have students begin to develop a Know-Wonder-Learn (K-W-L) chart about plants. Prompt questioning during this process, and record student responses (such as, Plants need water, but how much is too much? too little? Plants need soil, but how do soils differ? Plants need light, but how much? What kind of light?). Throughout the unit, come back to the K-W-L chart before and after each activity, and add new information. Use the gauging student needs assessment as an example.

Investigating and Learning about Plants

Conduct the following experiments and activities to answer the following Content and Unit Questions:

- *Why are plants important to us?*
- *Could humans and animals live without plants?*
- *What are the parts of a plant?*
- *What does a plant need to live?*
- *What are the functions of different plant structures?*
- *What is photosynthesis?*

Investigating Light

Referring to the K-W-L chart, discuss the effect of light on plant growth. Use the following questions to help guide students in their learning:

- If light is what makes a plant grow, what is the ideal amount of light to optimize growth?
- Outdoor plants are exposed to the amount of sunlight available during the day. If they are exposed to more light, will they grow more?
- Is indoor or outdoor light better? Are they the same?

Have students record their hypotheses and predictions in their journals along with their rationales. Present to the class the plants that have been growing the past three weeks with 12, 18, and 24 hours of light. Have students record and evaluate results.

Investigating Phototropism

Present this simple demonstration: Place a 4-inch bean plant in a curtained box, and move a small lamp to a different side of the box every half hour. Have students illustrate the plant and its position as it changes with the change of the light source in their science journals. Have students share in a Pair and Share grouping what they discovered and the results of the investigation. Encourage students

to draw conclusions about light and plants.

Investigating Plant Parts and Photosynthesis

In small groups, have students visit The Great Plant Escape* Web site. Have them become detectives in Case One to learn about plant parts and photosynthesis. When students finish the case, have them write what they learned in their science journals. While small groups are investigating at the Web site, have learning stations set up around the room where students can observe and investigate roots, leaves, and stems of real plants. Have students draw diagrams with labels in their science journals. After students have visited the Web site and participated in all of the learning stations, have a class discussion about what students learned. Clarify and expand on the content, and answer any questions focusing on the importance of plants as givers of oxygen and takers of carbon dioxide.

Investigating Soil Porosity and Absorption

Using background information, explain that soil serves plants in different ways. The soil study will evaluate the porosity and moisture-holding nature of soil. If soil absorbs too much water, the plant "smothers," because no air pockets can form around the roots. If the water drains completely, the plant will die of thirst.

Set out six buckets of soil (loam, clay, sand, humus, potting soil, and native soil). Have students look at and feel the samples, and write journal entries predicting and supporting their reasons for choosing which soil is best for both holding water AND allowing air pockets to remain around the roots. Working in groups of six, tell students to set up a funnel and filter over a plastic soda bottle for each soil sample. Place 250 ml (loosely packed) of soil in the funnel. Pour 250 ml of water (all at once) onto the sample, and record how long it takes water to begin draining from the funnel. Measure the amount of water that drained through the sample. Subtract this quantity from the original 250 ml to find the amount of water held in the soil. Have students record the data in the soil spreadsheet and continue with the remaining soil samples.

If students are not familiar with using spreadsheets, introduce them to the spreadsheet as a tool for recording data. Using a projector, provide students with a spreadsheet tour—show students how to create a new worksheet, type a title, enter headings and data, and create charts.

Instead of giving students the soil spreadsheet, which only needs to be filled in with their data, students can create their own spreadsheets. If so, provide them with the spreadsheet instructions to aid them in creating their spreadsheets or refer them to the Intel® Education Help Guide for further support for using spreadsheets. Either way, make sure students give their spreadsheet documents a name and save them. Have students write comparisons of their predictions versus their observations. Discuss student findings with the whole class.

Investigating Soil pH and Other Properties

Referring to the K-W-L chart, ask, Are all soils equal? Use simple soil-test kits to determine the pH of the six types of soil. Construct charts in science journals, and record the results. Lead the class in a discussion about the other properties of soil they think are important. Soil is composed of organic and inorganic matter. Components include sand, silt, clay, and humus. None is perfect in its own right, but each has properties that promote plant growth. In proper combination, these components contribute to a good soil that does the following:

- Holds the right amount of moisture
- Is porous enough for air circulation around roots
- "Anchors" the rooted plant
- Has a proper pH
- Provides nutrients, including nitrogen and minerals

Have students list the properties of each component in their science journals to refer to when conducting their bean plant experiments. This information will help students decide which soil combination they want to use in The Great Bean Race.

Reflecting on Learning and Getting Started

Re-form groups. Have students share journal entries about light, water absorption, and soil. Then have the students submit a group plan for growing the tallest bean plant. Have students predict how tall they think their plants will grow. Any changes made in growing conditions during the challenge should be documented and explained using this form. Have students gather materials and prepare for The Great Bean Race. (Lima bean seeds were pre-germinated, and each group should select two seeds to use in the challenge.) Have students use the project rubric to self-assess the design of their experiments.

The Great Bean Race Begins

Have students complete individual project plans to help them direct their own learning. If necessary, hold conferences with individuals and groups to facilitate completing this task.

On an agreed-upon date, begin the challenge. Plant the seeds, and record daily growth and temperature in a plant log or on the plant spreadsheet. Monitor students' data collection by checking their logs periodically. Ask students to take digital pictures of growth or make observational drawings, and measure (in inches and centimeters) weekly. At the end of each week, have students compare plants. Tell students to describe the differences and similarities between the plants and the group bean plans in their plant logs and journals. Instruct students to use the plant description section of the project rubric to guide their work. E-mail messages sent between classes can keep students informed of how other plants are growing. Encourage students to create charts of their plant's growth within the spreadsheet program and to e-mail their charts to help communicate their findings. Any changes to the growing conditions should be recorded on the group bean plan.

Creating Student Newsletters

Have student groups create newsletters to address and answer the Unit and Content Questions, *Could humans and animals live without plants?* and *What does a plant need to live?* Newsletters should include information about the following:

- The Great Bean Race
- Importance of plants
- ePALS partners
- Bean plan
- Bean poem
- Lima bean facts
- Graph and survey results (may include growth of one plant over time [line graph], comparison of growth of all plants [bar graph], or results of a survey* of students' favorite beans [bar graph or pie chart]; see directions on how to create a favorite beans graph)

Show students the newsletter example and discuss the requirements. Hand out the newsletter checklist and discuss the project requirements with students. After students see the checklist, model using the checklist with a sample newsletter to show students what quality work looks like and how they can use the checklist to ensure they are meeting project requirements. The newsletters will be shared with ePALS partners' classrooms and the groups' family members as a way to keep others up-to-date and informed about what is being learned in class. Students showcase some of the highlights from the unit so far and tie in the science content across the curriculum. Make sure students create their newsletters before the race is over and after the students have learned about plants and created their group plans.

The graphs and poetry could be created during math and language arts. Include mini-lessons about citing resources, writing poems (cinquain, acrostic, free verse, and so forth), using spreadsheet programs to make charts and graphs, and inserting charts and graphs into newsletters to ensure student understanding and success. Alternatively, teach skills prior to beginning the unit. After newsletters are complete, have students fill out the collaborative assessment to assess group participation.

Analyzing Results

At the end of three weeks, present the Unit Question, *What are the perfect conditions for growing a bean plant?* Have students analyze results of growth investigations. Allow students to compare and contrast their experimental designs and subsequent results with those of the other participants. Tell students to synthesize information and develop conclusions about the best methods for growing bean plants in their science journals. Ask them to use the project rubric to self-assess their conclusions. Using spreadsheet software, have students graph the results and draw conclusions about why the plants grew as high as they did.

Drawing Conclusions

Now that students have participated in the experiment and seen the conclusions firsthand, have students begin to reflect on their initial prediction and what they have learned. Place students in small groups to discuss the following Essential and Unit Questions:

- *Is conquering the impossible possible?*
- *What are the perfect conditions for growing a bean plant?*
- *Why are plants important to us?*

Remind students to use results and examples from the bean plant experiment to support their opinions and ideas. Bring the discussion back to the whole group, and chart student responses to the Essential Question next to the original responses from the beginning of the unit. Ask students to reflect about what they have learned using the Essential, Unit, and Content Questions (post on chart paper or on the board) as a guide to help with their responses. In addition, have students write a reflective paragraph on the Essential Question giving real-world examples supporting their opinions.

Read *Jack and the Beanstalk* again to students. Take some time to discuss the possibilities of growing a beanstalk that tall and how students' own bean growing experiences tie into the story.

Wrapping Up

Have students choose their favorite activity from the unit and write a reflection about why they liked the experiment and what they learned. Then ask them to use the project management section of the project rubric and their project plans to reflect on their self-management during the project. Digital pictures of the students participating in the bean plant experiment would be a great addition to the portfolio pages. Add students' reflections to their portfolios that showcase the year's units.

Accommodations for Differentiated Instruction

Special Needs Student	• Enlist support from resource personnel to help the student study vocabulary and concepts, and complete work that may take more time or revision than science-class time permits • Allow written tasks to be completed orally, or allow the student to dictate responses • Develop a daily "to do" schedule of tasks to help focus the student's effort during project work • Recognize the student's strengths and put those strengths to use when assigning group tasks • Assign the student to groups in a thoughtful manner • Reduce assignments or allow more time as needed

Nonnative Speaker	• Work with the ELL teacher to make a dictionary of terms in the student's first language and English language to aid vocabulary development • Have the student dictate journal entries to the ELL teacher, and clarify science concepts (invite the ELL teacher to help assess student learning as well) • During class, pair the student with another student when the language load indicates a need for this (for example, during journal writing time) • Accept assignments written in the student's first language for later translation • Enlist the help of similar first-language speakers in the school who have greater English proficiency to help the novice • Shorten assignments or allow more time as needed
Gifted/Talented Student	• Encourage the student to investigate and report to the class on related topics, such as pollination, vegetative propagation, seed dispersal, or how plant varieties develop • If the student has special technical abilities, have the student apply them to the development of the class Web page • If the student has special writing abilities, allow the student to take the lead on e-mail correspondence between classes

Materials and Resources Required For Unit

Technology – Hardware (Click boxes of all equipment needed)

☐ Camera	☐ Laser Disk	☐ VCR
☒ Computer(s)	☐ Printer	☐ Video Camera
☒ Digital Camera	☐ Projection System	☐ Video Conferencing Equip.
☐ DVD Player	☐ Scanner	☐ Other
☒ Internet Connection	☐ Television	

Technology – Software (Click boxes of all software needed.)

☒ Database/Spreadsheet	☐ Image Processing	☐ Web Page Development
☐ Desktop Publishing	☒ Internet Web Browser	☒ Word Processing
☐ E-mail Software	☒ Multimedia	☐ Other
☐ Encyclopedia on CD-ROM		

Printed Materials

Kits and Charts

- *The Life Cycle of a Bean,* FOSS Structures of Life Module, grades 3 and 4.
- *Beyond the Bean Seed*, Gardening Activities for Grades K to 6, Jurenka, Blass.
- *Bean Seed Chart* (96cm x 127cm), 10 stages of bean growth, Sargent-Welch publisher.

Books

- Cooney, B. (1982). *Miss rumphius*. New York: Penguin Group.
- Gibbons, G. (1991). *From seed to plant*. New York: Holiday House.
- Jordan, H. (1992). *How a seed grows*. New York: HarperCollins Children's Books.
- Kellogg, S. (1991). *Jack and the beanstalk*. New York: William Morrow and Company.

Supplies

- Lima bean seeds (100)
- Six soil types: loam, clay, sand, composted humus, potting mix, and native soil (not amended); the bean seeds and first five soils can be purchased from Carolina Biological Supply Company for continuity across classrooms
- Small incandescent lamp
- Large paper or polystyrene cups with lids (for saucers)
- Paper towels
- Metric measuring cups and graduated cylinders
- Metric rulers
- Outdoor thermometer
- Soil-test kits to determine pH
- One two-pocket, three-hole pronged folder for each student (this can be pre-stuffed with binder paper for the journal, drawing paper for observational drawings, bean plan, and plant log)
- Two class folders placed in a location that is accessible to everyone, one labeled *Web Page* and the other labeled *Newsletters*
- Parent helper

Internet Resources	**For Teachers:** • ePALS www.epals.com* Locate other classes for participation in The Great Bean Race • Kids Gardening www.kidsgardening.com* Locate other classes for participation in The Great Bean Race • Plant Nutrients www.agr.state.nc.us/cyber/kidswrld/plant/nutrient.htm* Read about photosynthesis and mineral nutrients in plants **For Students:** • The Great Plant Escape www.urbanext.uiuc.edu/gpe/gpe.html* Presents an interactive game that takes visitors through the life cycle of a plant and provides other interesting plant information • Education World www.educationworld.com/a_curr/TM/WS_citation_educators.shtml* Gives examples of how to cite resources **For Teachers and Students:** • Green Bean's Staff: The Bean's Page www.greenbeans.com/bean.htm* Offers facts about green beans • Weather.com www.weather.com* Provides information about weather around the world
Other Resources	• Invite a master gardener to talk about growing plants for food • Invite a farmer to talk about agriculture