Dig Deeply

A gardening project with peas engages second- and third-grade students in thinking, acting, and writing like scientists.

By Sharon Owings and Barbara Merino

Most children enjoy being in gardens. Our school garden is just outside the classroom, so students can go in during recesses under my supervision. Students had participated in several gardening projects, but I wanted them to dig deeply and cultivate more than just plants. Building on my second- and third-grade students' enthusiasm for gardening, I designed a pea project in which they would discover how plants grow under different conditions while also developing observation and nonfiction writing skills.

Though my students enjoyed writing fiction and dialogues, they were less capable nonfiction writers. To assess their expository writing skills, I gave them a purposely vague writing prompt: "Write about what you have been doing in your garden. You may have as much time as you need." I collected these writing samples for comparison with later writing. To develop their writing, I taught them to use data recording sheets and journals. Throughout the project, I emphasized scientific discourse using scientific terms.

From the exciting discovery of the first sprout until the last pod was harvested, I reiterated that botanists observe plants carefully to create accurate drawings and that labels make illustrations more informative. My young botanists confidently used thermometers and moisture meters to collect data and cared for their plants diligently, taking pride in recording their plants' progress and growth. Most important, the attention to detail showed in their writing.

Getting Started

Snow peas (*Pisum sativum*) are excellent subjects for student projects. Most children enjoy the mild taste and crunchy pods and are enthusiastic about growing them. Pea seeds are large enough for small hands to manage, germinate promptly even in cool weather, and will grow in all but the poorest soil. The parts of the plant are distinct and easily recognizable. Furthermore, peas' short life cycle permits students to experience all stages of the plant's growth in a few months.

I launched the project by telling students that they would become *botanists*, scientists who work with plants. I explained that each botanist would be responsible for planting and caring for six pea seeds. Two seeds would be planted outside. Two more would be planted beside the first two, but would be covered with a *cloche* (a bell-shaped covering used to protect plants). We used the top third of a clear plastic two-liter bottle. The last two seeds would be planted in containers (the bottom two-thirds of a two-liter bottle) and grown inside.

Because scientists need to keep careful records of their experiments, each botanist would maintain a binder that



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Observing a pea plant under the cloche.

contained plant growth records and documentations of plant care procedures. Each student received a new observation sheet each day. They used their observation sheets as journal pages, writing the notes, observations, questions, and comments in the margins or on the backs of their sheets. Binder paper was available if they needed more writing space.

I gathered a large collection of fiction and nonfiction books about plants and gardens and put them on display in the classroom. Throughout the project, I read aloud

from these books, using them to guide discussions and focus instruction. As scientific terms emerged in the reading, I highlighted them for the students. If the text did not provide adequate explanation of the term's meaning, we used dictionaries. We added the words to our gardening word wall, which remained in place throughout the project. Once a term had been added to the word wall, students were expected to incorporate it into their speaking vocabularies, use it appropriately, and spell it correctly in their journals.

Introduce Scientific Drawing

On the first day, I conducted a demonstration using dried lima beans. I first modeled making an accurately sized, labeled drawing of a dry bean and supervised students' efforts to make their own drawings. These lima beans were enormous, so it was possible for the children to trace around them for accurately sized and shaped drawings. Less conveniently sized or shaped seeds can be more accurately drawn if the students use graph paper. Then, we added two cups of water to one cup of dry beans and let them soak overnight.

The next day, the beans had absorbed most of the water and had doubled in size, making it easy for the botanists to understand that seeds need water to grow. I modeled drawing a soaked bean near the picture of the dried bean to show changes in size and appearance. The meaning of *dicot* was introduced when students split a soaked bean into two congruent parts and discovered the bean's embryonic root, stem, and leaf. I told them that *di* is a prefix that means *two*, and I showed them that the two parts of the bean are symmetrical. I contrasted *dicot* with *monocot* and gave them examples of monocots as (e.g., corn, other grasses). I explained that botanists can examine a plant's seed to help identify, classify, or group the plant. This reminded them that they had spent time earlier in the year comparing different leaves and talking about their various functions. I included the information that the first pair of leaves (seed leaves) that come from dicot seed emerge as a pair, whereas a blade emerges from a monocot seed. Emphasizing the importance of labels in scientific illustrations, I modeled drawing and labeling the bean's visible plant parts. I stressed the importance of learning scientific terms so that we could discuss and share information without any misunderstandings. Students drew the beans and added the pages to their binders.

Plant Pea Seeds

On day 3, we went into the garden and I modeled how to plant seeds correctly. I gathered the children around me and showed them how to use a trowel to loosen soil in an area about as large as their two hands spread out with thumbs touching. I showed them that the diameter of a pea seed is about half as long as the first joint of their index finger. I showed them how to poke a hole as deep as the first joint of their index finger in the cultivated soil for each pea. Then I showed them how to drop the seed into the hole, cover it with soil, pat the soil down firmly, and sprinkle water from the watering can to settle the soil around the seed. I then gave each botanist two pea seeds and a name label, telling them to choose a spot, plant the seeds, and indicate the location with the marker. I then explained the function of the cloche (to trap the Sun's heat to warm the air and soil) and demonstrated how to plant the second pair of seeds, covered with the cloche, near the first pair. The children then chose their own planting locations. Students always washed their hands after working with soil, and I reminded them that tools are to be used only for their intended purpose, and that it is important not to run on the garden pathways, especially while transporting tools.



Back in the classroom, I directed the botanists to fill their containers halfway with potting soil, plant two seeds on opposite sides of the container, add water, and place a marker. In the transparent containers, students could observe all aspects of plant growth.

During discussions about seeds and plant growth I reminded the children that not every seed will grow. Sometimes the gardener may not have provided adequate care for the seeds, but a few seeds are not viable. We talked about why seeds may or may not be viable.

Make Observations

I told students that scientists keep careful records of what they do with their subjects (in our case, plants) and how they develop. I gave them each a blank observation



Using instruments to measure climatic and soil conditions.



Using a plant as a model to produce accurate illustrations.

sheet and I demonstrated its use, stressing the importance of accurate recordings and illustrations. The sheets included a simple list of plant characteristics to check at each reading; drawing space; and space for information about indoor and outdoor climate conditions, temperature readings, and soil moisture levels (Figure 1).

To measure air temperature, we placed one thermometer in a central location in the garden and one in the classroom near the bottle gardens. To measure soil temperature, each child placed a thermometer in the soil between the two sets of pea seeds. These thermometers remained in place throughout the project. I showed students how to read the thermometers and how to use the moisture meter, a simple device that indicates whether soil is moist. Students also learned how to record the information on their recording sheets. I found the moisture meter in the gardening area of the hardware store. The children loved this simple-to-use device. (To use: stick the point in the soil and read the scale to see whether soil is dry or wet.)

As soon as the first sprout emerged from the soil, I taught the students to use their rulers to measure the plant's height in inches and centimeters to help them gain a clearer notion of how the two systems are related. As the plants continued to grow, students counted the number of leaves, blossoms, and pods on each plant. I hoped they would use these measurements to compare the different growing conditions.

Students completed a new recording sheet each day. This took less than 15 minutes. As the project proceeded, students became more proficient in all of the skills that the observation sheets required, including the drawing and labeling.

Virtually all of the seeds the students planted were viable. Seeds planted in the bottle gardens germinated quickly and grew rapidly into tall spindly plants that required supports to remain upright. A few developed

Figure 1.

Observation sheet.

Time AM/PM	Soil Temp. °F/°C	Air Temp. °F/°C	Moisture	Conditions
8:35	Inside 54°F 12°C Outside 40°F 10°C	42°F 2°C	7½	warm Warm
12:25pm	44°F 16°C	60°F 14°C	6	brezey
2:25pm	41°F 9°C	79°F 18°C	7½	cool

Observation	Yes	No	Comment
My inside plant is alive.	✓		It has germinated.
My outside plant is alive.			
My inside plant has leaves.	✓		It is growing correctly.
My outside plant has leaves.			
My inside plant is upright.	✓		It is very tall.
My outside plant is upright.			
My inside plant is the correct color.	✓		It is green.
My outside plant is the correct color.			

My inside plant looks like this:



My outside plant looks like this:



blossoms and fewer still produced pods. We found little difference between the peas grown with and without the cloches, though the results were almost certainly inaccurate due to the cloches that were repeatedly washed away by heavy rains and blown away by strong winds. Lessons learned for my little scientists. Almost all peas grown outdoors turned out to be tall sturdy plants that were in danger of overwhelming their trellises. Most produced many blossoms and peas. We ended our pea project in January with a party during which each student presented his or her special "Pea Project"—a book, poster, poem, song, or report.

Write About Plants

As I ended the project, I told the children that their plants would remain, but they would no longer be recording data, and that they should look back through their many pages of work to review what they had been doing and reflect on how their plants had grown and developed from those six seeds they had planted in the fall. That afternoon, I repeated November's writing prompt. ("Write about what you have been doing in your garden. You may have as much time as you need.")

My formal assessment of their writing was both quantitative and qualitative. I used four objective

Figure 2.

Pre- and postproject writing samples.

"Gloria"

November:

"My friend and I are growing lettuce. We named it Sunshine. [She] and I are naming lots of things. [She] and I are having so much fun. We love working in the garden. It's fun. We named the other one Sunny."

January:

"My outside peas are very small and my inside ones are very tall. This is how I plant pea seeds. I dig a hole twice as big as the pea and put the pea inside the hole and put some soil over the pea. You have to water it. It has to have sunshine. It needs lots of air too. My inside peas have lots of tendrils. My inside pea plant has forty two leaves. My outside plant has five. My outside plant is about two-and-a-half inches long."

In November, Gloria wrote about her social interactions in the garden. She wrote her narrative in a personal voice, focusing on having fun with her friends. In January, Gloria was writing with the voice of a scientist. Her explanation of how to plant seeds was accurate and thorough: a "thick" description. Anyone following her directions would be able to plant a seed properly.

"Gabriel"

November:

"Today I tried lettuce with a carrot and Ritz-bit. The Ritz-bit made the lettuce a lot slipperier. And the carrot made it a little too crunchy. The lettuce alone was just too bitter."

January:

"My peas have germinated at last! I just measured my plants and my inside one is a foot tall and 30 centimeters tall. My outside one is two and a half inches tall and five centimeters tall. Right now, on 1/22/08, I can't find out anything about my outside pea plant because it is raining. I have noticed that the leaves on my inside plant have grown over the weekend. I've been trying to find a blossom lately. I'm surprised one of my peas died. My root system is so big it will probably reach to the other side of the bottle. I bet I'll need a tall trellis."

In November, Gabriel's personal narrative described a personal, physical experience and focused on irrelevant detail. In January, he used a scientific voice to provide thorough, accurate descriptions of physical characteristics and life cycle of his plants.



Student pea plot showing cloche, moisture meter, and thermometers.

measures to compare the samples, tabulating numbers of (1) words, (2) focus words, (3) illustrations, and (4) labeled illustrations. Focus words were words from the gardening word wall. All students wrote longer pieces and used more focus words in January than in November. I analyzed their writing to determine whether they understood gardening procedures and how carefully and completely they were able to write about those procedures (Owings 2008).

It was clear that the content of the students' writing changed after their gardening experiences. Preproject writing had relied heavily on subjective narratives, but postproject writing focused more on objective presentation of scientific facts. In January, the children were writing like scientists, providing expository text meant to be informative rather than the personal narratives of earlier samples. To support their statements, students included quantitative details and technical words. Samples of pre- and postproject writing by two mid-level students show changes typical of the class (Figure 2). Content learning was ongoing throughout the project. A main purpose of the writing assignment was to assess students' understanding of the relevant science concepts.

A New Understanding

I designed this project to give students opportunities to learn about plants and plant growth so they could write authentically. I was pleasantly surprised by the change from narrative to objective voice in their writing. Their

explanations were more comprehensive and complex. They wrote with accuracy and enthusiasm. They showed new understandings of statistics, measurement, and problem solving.

This kind of inquiry-based learning that begins with scaffolding via modeling has been called *sheltered constructivism* and can be an effective way to teach the discourse of scientific argument (Merino and Scarcella 2005). This approach worked effectively for all students. My botanists included special needs, full inclusion, and English learner students, all of whom successfully completed the project and demonstrated growth in literacy and scientific discourse. This approach places additional responsibilities on teachers who need to know when and how to provide the kinds of scaffolding their students need. The binders and observation sheets, especially the initial modeling and ongoing monitoring, can be considered one kind of scaffolding. Other examples would include the reading and discussion that went on in the class throughout the project.

Teachers must also know when and how to remove that support so that students can develop independence. In our next project, I gave my entomologists silkworms and helped them build on their experiences to design their own experiments. In our most recent project, my students chose their own subjects and designed their own experiments! ■

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The roots of the plant are visible through the clear plastic container.

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades K–8

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Grades K–4

Standard C: Life Science

- Characteristics of organisms
- Life cycles of organisms

Teaching Standards

Standard A:

Teachers of science plan an inquiry-based science program for their students.

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academies Press.

References

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Owings, S. 2008. *Gardening is the most fun time of day!* MA thesis, University of California at Davis.

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