Garden-Based Learning: It’s Just the Berries!
Indoor and outdoor experiences engage students in plant science.

By James Rye, Sarah Rummel, Melissa Forinash, Alana Minor, and H.R. Scott

Would you like to engage your students in an authentic yearlong project that provides a rich context for science and mathematics? How about a chance to really “get moving” with the Next Generation Science Standards (NGSS Lead States 2013)? Do you want to make more community connections, such as involving parents and networking with professionals in science-related disciplines? A school garden program can help you realize these opportunities while “greening” the school curriculum and extending your classroom boundaries to include outdoor raised beds.

Research (e.g., Blair 2009) has presented a strong case for incorporating gardening into the elementary school curriculum. A review of the literature by Williams and Dixon (2013) documents the positive impact of garden-based learning (GBL) on science achievement. This article describes how we are “growing” GBL at North Elementary School and describes two projects—“Just the Berries” and “Oh, Gourds!”—that spanned the 2012–13 academic year.

Overview of North Elementary GBL

North Elementary created a GBL infrastructure in spring 2011 and has partnered with university faculty, extension services, parents, and other community organizations to initiate and expand our school garden program (Rye et al. 2012; also see Internet Resources: Garden-based Learning at North Elementary School). A university science education faculty member and a kindergarten teacher procured the grant funding and currently serves as an overseer of the garden project; the school was assigned a full-time AmeriCorps volunteer to assist with...
GBL beginning in fall 2013. Indoor components include facilities for germinating seeds and raising seedlings, container gardens, and vermicomposting units. In summer 2012, we launched a projects approach (see Internet Resources: Buck Institute for Education) to GBL where North Elementary teachers experienced in GBL helped 25 of their teacher-colleagues get started. A projects approach is driven by a robust open-ended question that engages students in a long-term investigation, which provides authentic experiences (in our case, gardening) and outcomes (a bountiful yield of produce). The project culminates in some type of capstone event (in our case, a project presentation) that includes audiences beyond the teachers and students (parents and other community members).

All projects developed by teachers had indoor and outdoor components. Like many of the projects, “Just the Berries” and “Oh, Gourds” integrated mathematics and an EarthBox container garden system. This system, coupled with indoor grow lights, provided a classroom learning environment for students to study the growth of plants, the focus of their project. The learning that ensued during fall and winter was applied to sowing seeds in or transplanting seedlings to their outdoor beds during spring and to developing guides for parents to follow during summer as garden caretakers. Note: Prior to starting any of these hands-on activities, make sure safety precautions are read, reviewed, and addressed through training with students and others involved (see “Safety Tips for Indoor and Outdoor Gardening” sidebar).

**Just the Berries**

Two second-grade teachers partnered to implement this interdisciplinary project on growing strawberries. The entry event in September included reading *The Little Mouse, the Big Red Strawberry, and The Hungry Bear* (Wood and Wood 1984), tasting strawberries, and asking the students if they would like to grow yummy fruit in the school garden. Students were excited and began brainstorming all the ways strawberries could be prepared. The driving question became, “How best do we produce and care for strawberries all year long?” The classrooms dedicated one of their outdoor raised beds

**Safety Tips for Indoor and Outdoor Gardening.**

Check with the school nurse to ascertain the presence of allergies among students and avoid growing any plants to which students are allergic. Check school district rules before allowing students to taste produce grown in the classroom or on school grounds. The teacher should network with the school nurse to check students’ health records to ensure none of the students are allergic to strawberries.

Students should wear garden gloves and wash their hands after working in the garden with soap and water. Also use good “sun sense” in clothing and eye protection to protect against excessive UV exposure. Be cautious of the presence of stinging insects like bees, which are attracted to plant flowers. Most indoor soil can be a site for harmful mold growth, especially during the winter months. Check for visual signs of mold growth and remediate immediately.

Prior to constructing equipment, make certain students have been trained on hand tool safety. Also make sure students, teachers, and volunteers are wearing appropriate personal protective equipment (e.g., sanitized safety glasses or goggles meeting the ANSI Z87.1 standard) while setting up, working with, and putting away tools and construction materials. Use only ground-fault circuit interrupter or GFCI-protected electrical outlets for the indoor grow lights and any other apparatus (e.g., seedling heat mats). Check with custodial staff to ascertain if grow lights are allowed to be on overnight: A timer can be installed to shut the lights off at night and back on in morning as needed. Install tube protectors over fluorescent bulbs in grow light systems. Tell students to not stare directly into grow lights and, when outside, not look directly at the Sun. Pesticides should not be used in school gardening.

Check with maintenance if school soil is used to determine if pesticides or herbicides have been applied or if there has been a pesticide maintenance program in place. If soil is purchased, try to secure sanitized soil and search for pesticide/herbicide free seeds for planting. Be sure to review safety data sheets for any fertilizer used prior to application in case there are any safety hazards noted and that need to be addressed.
to strawberries; students measured for appropriate spacing and planted strawberry bare roots then winterized the bed with straw from a local organic farm. Students, parents, and teachers also installed, planted, and winterized a terraced strawberry bed one fall weekend.

**Indoor “Raised Bed” Gardening**

Students were eager to determine if they could produce strawberries in the classroom. The first step engaged students in preparing for planting a container garden (see Internet Resources: EarthBox). These containers are engineered to facilitate proper hydration of plants through capillary action (see Internet Resources: The Water Cycle) and contain multiple compartments: water reservoir, wicking stations, soil chamber separated from the reservoir by an aeration screen, and tube spanning the entire depth of the container. Figure 1, page 58, shows an EarthBox “in action” (see Internet Resources: EarthBox Instructions for a diagram of internal components and how to assemble). Students helped assemble the container, pack the wicking stations, and fill the upper chamber with potting soil. They watched their teacher mix dolomite and make a trench for fertilizer in the soil, then assisted in planting the bare roots. The water reservoir was filled and the grow lights turned on. Students hoped to put their observational and measurement skills as well as taste buds to work soon. They would not wait long! (Note: An alternative to the EarthBox is to work with your students and perhaps a “talented”
parent to design and/or construct a self-watering container system, following safety precautions such as wearing approved goggles surrounding the use of tools. See Internet Resources, “DYI…” and “Self-watering…” for sample designs and instructions, which may not include all safety precautions necessary.

Berries on the Run

Eight bare roots of strawberries were planted in two separate rows in the EarthBox. Students made a diagram to show the location of each plant: the front row contained June-bearing plants labeled A–D and the back row contained ever-bearing plants labeled E–H. Within two weeks, students were measuring growth. Although class research revealed it should take eight weeks, our first berries emerged in just four and were ripe 11 days later. In one of the classrooms, students completed OWL (observe, wonder, learned) charts in September and again in February that compared the plants in the two different classrooms. One student’s initial observations included “young plants, little, both have flowers, look similar.” Yet, the plants in one classroom began sending out runners at a much greater rate, which was puzzling given that students previously had learned that “we [both classrooms] did everything the same.” In February, students wondered (and were assessed on their reasons for) “Why are they different now?” (see Figure 2). Students learned that the growing environment differed across the two classrooms: “Mrs. Forinash’s lights are newer and brighter.” Mrs. Minor received her grow lights (T8 bulbs; see Figure 1) a year earlier, whereas Mrs. Forinash had the T5 higher output lights (see Figure 3).

Through caretaking, students observed the biological process by which one strawberry plant gives rise to another (runners/stolons from existing plants “root” in the soil) and eventually, blossoms and berries (see Internet Resources: EarthBox in Our Schools). Students also observed that when you prune the plant of its runners, it channels its energy into growing very large leaves as well as blossoms and berries. Additionally, students used mathematics in estimating, measuring, and comparing the length of strawberry runners and were assessed on related mathematics content (see Figures 4 and 5, p. 62).
good way to have students track runners for repeated measurement is to apply around the runner a label with a number or letter of the alphabet or a student’s name; labels also could be differentially colored to help students more quickly identify their runner. Students also decided to collect data on berry production from each plant. Surprise! Even though it was December, the June-bearing variety was more productive than the ever-bearing. The strawberries also fueled the students, who enjoyed strawberry shortcake in winter and in spring, smoothies from their own locally produced berries!

Students concluded in May that their bare roots in the outdoor beds did not overwinter, so they transplanted their classroom strawberry plants to these outdoor gardens. With scaffolding from their teacher, students developed a recruitment letter to parents to attend their capstone presentation and take care of their outdoor garden, and they developed a caretaker’s guide (see Figure 6). Summer arrived and the plants were blossoming!

**Oh, Gourds**

To prepare for this project, the fourth-grade students completed a unit that included plant parts and their function, necessity for plants to adapt to their environment for survival, and impact of climate change on plant growth. Students realized that they could not grow gourds outdoors in a West Virginia winter, and they began discussing ways that the classroom could be adapted to grow them inside. “How can we grow gourds in our classroom?” was the overarching problem. Four types of gourd seeds were procured that would yield fruit—botanically what gourds are—with potential for different uses, such as a serving utensil. An infrastructure (EarthBoxes, grow lights, trellis supports) to support plant growth was set up in the classroom. Students employed measurement to properly sow seeds of each gourd type.
Oh, My!

Students learned that all gourd seeds are not easy to germinate, despite their carefully following the package instructions. Students realized a germination rate of four out of four seeds for only the ornamental variety; three-fourths germinated from the speckled swan, one-fourth germinated from the dipper gourd, and none of the wooly bear. The class sowed wooly bear and dipper seeds again and employed trouble-shooting strategies from a state extension service (see Internet Resources: Growing Gourds): Seeds were pre-soaked several hours in water and clipped slightly at their pointed ends. Germination rates were greatly improved.

Many additional problems surfaced over the next few months, which fueled the use of science and engineering practices and the opportunity to try out solutions (see Table 1, p. 65). Students researched the best way to make a trellis, created their own, and improved the design of a commercial product (see Figure 7, p. 64). Additionally, students continued their learning about structure and function relative to reproduction: Gourds produce imperfect flowers in which the male and female reproductive parts are not in the same flower. Mrs. Rummel also discussed with students how their container garden was a “system.” The students learned how the soil wicks up the water from the reservoir underneath. They learned how the lights affect the flowers and the best time to pollinate: when both the male and female flowers are open. They also discussed the differences between growing inside and outside and what they were doing to the plants to simulate the outdoors (e.g., the use of different lights to stimulate production of both male and female flowers).

Throughout the indoor duration of this project, plants produced many blossoms—even several females—but only one small fruit. Nevertheless, students harnessed what they learned from this experience to make decisions (e.g., types of seeds to sow) about “what and how” to grow the gourds outdoors. But…

Student: We are going to have to worry about animals.
Teacher: Why?
Student: Animals might hurt the plants or eat them.
Teacher: What other pest might be a problem?
Student: Bugs.
Teacher: Yes, in fact there are two different types of bugs (squash vine borer, squash bug) that can be a problem for the gourd plants.
Student: How will we know what they look like?
Teacher: Great questions! Dr. Rye has a book (see Internet Resources: Good Bug, Bad Bug) that we can use that will show us what the bugs look like.

Throughout this project, students’ thinking and understanding was assessed through journaling:

FIGURE 6.
Caretakers guide next to strawberries transplanted from indoors.
daily observations about gourd plant growth and answers to teacher-created prompts. Students moved from simply writing about what they saw to providing meaning for their observations. Students were also learning to become more precise in their measurements and drawing conclusions based on the information they have collected about their plants.

Students were successful in recruiting many parents to attend their capstone presentation and to take care of their gourd garden every week during summer. Parents helped to build the outdoor raised bed into which gourd seeds were sown and seedlings transplanted as well as a low tunnel to protect the gourds from insect pests until they begin flowering (see Figure 8).

**Future Growth**

The GBL project, “Just the Berries,” really was! Mrs. Forinash and Mrs. Minor will treat their incoming second-grade students to a revised version that includes an investigation about the growth needs of plants and an explicit focus on engineering design. Mrs. Rummel and her fourth-grade students concluded that “Oh, Gourds” lived up to their reputation as being one of the more difficult crops to produce. Other North Elementary School classrooms that attempted to realize, indoors, fruits from other cucurbits (squash and cucumbers) also experienced difficulties being successful in pollinating, although some cucumbers were produced. An important lesson learned: It’s not easy to replicate nature’s ecosystem services that we often take for granted. Future attempts to grow cucurbits in the

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**FIGURE 7.**

Students constructing net for trellis.

**FIGURE 8.**

A parent volunteer prepares garden beds with mulch and row cover.
classroom may utilize varieties that do not need pollination (see Internet Resources: Parthenocarpy).

Reading/language arts is a robust interdisciplinary connection that we will continue to pursue through next year’s projects. We are considering how the caretaker guides developed by students could also serve as an impetus to garden at home, which would provide an informal science learning opportunity during the summer and further engage parents in their children’s education.

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References


<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
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<tbody>
<tr>
<td>The plant is higher than the trellis and the lights cannot be raised further</td>
<td>Install trellis extensions; raise light stands by placing (safely) on spare classroom desks</td>
</tr>
<tr>
<td>The high climbing ornamental gourds are shading new seedlings</td>
<td>Reposition containers or lights to get light to new seedlings</td>
</tr>
<tr>
<td>There are too many plants in each container</td>
<td>Remove some plants (the least healthy ones)</td>
</tr>
<tr>
<td>The trellis netting is not always “grabbed” by the vine tendrils</td>
<td>Gently insert tendrils into netting, “train” the plant</td>
</tr>
<tr>
<td>There are fungus gnats flying around the gourd plants (and are a nuisance to us)</td>
<td>Reduce moisture level in soil; affix yellow “sticky” tape near soil surface</td>
</tr>
<tr>
<td>The gourd plants are producing only male flowers</td>
<td>Add fertilizer rich in phosphorus; set timer to provide only 10–12 hours of light</td>
</tr>
<tr>
<td>There are no insects, birds, or wind to transfer pollen from male to female flowers</td>
<td>Hand pollinate using paintbrush to transfer the pollen from the male to the female</td>
</tr>
<tr>
<td>The fruit from the female flower is not growing even though we pollinated it</td>
<td>Pollinate the flower more than one time: each day during a week if possible</td>
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Connecting to the Next Generation Science Standards (NGSS Lead States 2013)

K-2-ETS1 Engineering Design

www.nextgenscience.org/k-2ets1-engineering-design

<table>
<thead>
<tr>
<th>Performance Expectation</th>
<th>Connections to Classroom Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>The materials/lessons/activities outlined in this article are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.</td>
<td>Students engage in an extended investigation about how strawberries can be raised all year long.</td>
</tr>
<tr>
<td>K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.</td>
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Science and Engineering Practice

| Asking Questions and Defining Problems | Ask questions about the growth of strawberries from bare roots and identify problems based on the variables involved in the process. |

Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>ETS1.A. Defining and Delimiting Engineering Problems</th>
<th>Students learn about artificial lighting and assist in constructing an environment for raising strawberries indoors in the winter.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A situation that people want to change or create can be approached as a problem to be solved through engineering.</td>
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<tr>
<td>LS2.A: Interdependent Relationships in Ecosystems</td>
<td></td>
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<tr>
<td>• Plants depend on water and light to grow.</td>
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Crosscutting Concept

| Structure and Function | Students learn how natural and designed objects work together to provide an ideal watering system for plants. |

Resources


Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013)

### 4-LS1 From Molecules to Organisms: Structures and Processes


<table>
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<td>Students grow gourds in their classroom and observe/journal about plant structures and functions.</td>
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#### Engaging in Argument From Evidence

Students construct an argument that female flowers require hand pollination when grown indoors.

#### Disciplinary Core Idea

**LS1.A: Structure and Function**

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Students modify seeds (soak, cut tip) to enhance germination. Students use tendrils to “train” plant. Students observe differences between male and female “imperfect” flowers and hand pollinate.

#### Crosscutting Concept

**Systems and System Models**

Students help construct an indoor system to support the growth of gourds. Students observe and journal about how water moves throughout the system.