The Living Classroom Manual

An Ecological Approach to School Garden-Based Education in Alaska

Correlated to Alaska Grade Level Expectations and Standards
Compiled by Calypso Farm and Ecology Center
Fall 2006

Welcome to *The Living Classroom Manual!*

Taking children out of doors and walls and into woods and gardens is the equivalent of breathing life into our education system. When young people have the opportunity to learn in the outdoors, education becomes applicable (and messy!) and engaging.

The garden, whose primary intention is to feed, is an ideal setting from which we can feed the minds of our students. Here, the core subjects grow senses. Language arts grows a taste, as the chomping of the spiciest mustard green or the sourest sorrel is translated into poetry and descriptive writing. Mathematics grows a smell - the potent, saccharine fragrance of sweet peas vines measured everyday for a month, as growth is charted on a student-constructed graph. Science grows a sound, the buzzing of pollinating insects in fall or the crunch of snow underfoot as a snow pit is laboriously dug and gleefully examined for evidence of winter animal activity in the garden.

Undoubtedly, teaching in the outdoors is full of unknowns. Taking young people outside is risky and messy and, often, full of inherent complications: foul (or extremely cold!) weather, the need for appropriate layers, behavior problems, sunflowers that don't grow at the rate expected (or insisted on by some book!). But the truth is, we see children visit Calypso Farm and Ecology Center everyday who are *lit up* from the inside with the possibilities of exploring their world outside of the confines of walls and ceilings. Often, it is the children with the most trouble learning in a traditional setting who are *most* engaged and *most* transformed by the opportunity to *live* their education. With a school garden, the potential for illuminating young minds and faces is only a few steps outside your classroom.

This manual seeks to inspire teachers and students to learn experientially in the school garden and natural world through the process of active participation and direct observation. In essence, *The Living Classroom Manual* seeks to provide teachers with the information and resources to take children outside and to be academically productive at the same time. Many of the activities in this manual could be done just as easily indoors as out. We encourage you to embrace the challenge and the potential in taking your students outside to dig, experiment, read, write, plant, and measure in the garden. Enjoy!

Calypso Farm and Ecology Center compiled *The Living Classroom Manual* to compliment The Schoolyard Garden Initiative in the Fairbanks North Star Borough School District. Please see pages 99-100 for more information on Calypso Farm and Ecology Center and the history of The Schoolyard Garden Initiative.

For more information or support, please contact:

Calypso Farm and Ecology Center
PO Box 106
Ester, Alaska 99725
(907) 451-0691
(907) 451-0697 (fax)
www.calypsofarm.org
info@calypsofarm.org

Resources for Garden-Based Education

The Living Classroom Manual contains a mere sampling of garden-based lessons and teaching ideas adapted for use in the Fairbanks area. In addition to the lessons in this manual, the following resources could prove invaluable in your use of the garden:

- **Calypso Farm and Ecology Center staff**: The Calypso staff is excited to support teachers in their use of the school garden. Staff members have a wide range of experience in ecological agriculture, soil science, and environmental education. Please contact us with questions!
- **Local Experts**: Throughout this manual, we suggest guest speakers or field trips that may strengthen your class' garden-based learning. For example, a local apple farmer would be an ideal guest speaker to teach about the physical adaptations of cultivated plants in interior Alaska. Calypso maintains a list of individuals and groups who may be willing to speak with your class on a given subject. If you are unsure about how to find local experts, please contact us for more details and resources!
- **Local Gardeners**: Fairbanks gardeners have a wealth of local knowledge that can support the integration of the school garden into your classroom. Contact gardening parents at your school, local garden clubs, the University of Alaska Fairbanks Cooperative Extension Services Master Gardeners, and local farmers for ideas, volunteers, and assistance.
- **Curriculum Resources**: The annotated bibliography on pages 93-97 contains a list of the Calypso staff's favorite garden-based education resources. All of the books listed can be borrowed from Calypso. Additionally, many high quality resources exist that are not yet on this list. If you find a favorite that you think we should reference in this manual, please tell us.
- **Children's Literature**: An astounding amount of literature exists for young people on the subjects of gardening and plants. Throughout *The Living Classroom Manual*, applicable, subject-specific books are referenced. For a complete list of books referenced in this manual, please see pages 47-49. ANY book can be obtained via inter-library loan through the Fairbanks North Star Borough library system, and many garden-themed books are already available at all branches of the public library system. Throughout *Living Classroom Manual*, books that are available locally are marked as follows:
  - ♥ = available at the University Park Elementary School library
  - ♣ = available at Noel Wien public library
  - ♦ = available at North Pole public library
  - ▲ = available at the University of Alaska Fairbanks library
  - • = available from one of the middle or high schools in the Fairbanks North Star Borough School District; please check with your school librarian for availability
- **You!**: Teachers are the greatest resource for information regarding the integration of the school garden into the classroom. Please speak with other teachers who are using the garden, and share your experiences and lessons with us for future printings of *The Living Classroom Manual*. For more information on submitting lesson ideas, please see pages 3-4.

A Call for Lesson Submissions!

Do you have garden-based lesson plans?
This manual is an ever-growing resource. Calypso will reprint the manual at regular intervals with additional lessons from teachers across the district and state. If you have lessons that you think other teachers might use with the schoolyard garden, please share them with us.

All lessons need to have an experiential component and should incorporate agriculture into science, math, and/or language arts curricula. When agriculture is viewed as a part of a larger natural system (ecological agriculture), then nearly any natural science topic can be made relevant to the schoolyard garden. Lessons need not be entirely experiential but all lessons should encourage discovery through active participation and direct observation. If your lesson fits these criteria we would love to see it.

In order for your lesson to fit into the format of this manual, please submit your lesson ideas in one of the following formats:

- A short (250 word) lesson prompt. Please see page 5 for the lesson prompt submission form. Please try to keep your submission to 250 words or less.
- A fully developed and outlined lesson. If you would like to submit a fully developed lesson, please include:
  - Your name and school
  - Lesson title
  - Subject area
  - GLE if applicable
  - Appropriate grade level
  - Ideal season for lesson
  - Time needed to facilitate lesson
  - Suggested materials
  - Goal and outcomes
  - Curricular connections/extension activities for other subjects (correlated to GLEs when appropriate)
  - Bibliography
  - A step-by-step guide to teaching your lesson

Thank you in advance for your helping us share the beautiful natural and agricultural world with students in our schools! We look forward to receiving your lesson plans.

Lesson Prompts for the Schoolyard Garden

Your name: _____

School name: _____

Subject area: _____

Grade level: _____

GLE (if applicable): _____

Lesson Prompts (<250 words): _____

The Living Classroom Manual
Table of Contents

Year-Round Garden Explorations

Gardening in winter?!? *The Living Classroom Manual* can support teachers in using the school garden as a dynamic outdoor classroom year-round!

Teaching Science
Through Gardening

Teaching Science through Gardening

Teaching Science through Gardening

The schoolyard garden is an ideal setting for experiencing science through experiments and discovery. Science is real life in the garden, poking out of the soil every spring, growing in every garden box, buzzing around the flowers. When visiting the garden with your class, set a goal for your time there, be it a garden maintenance task you hope to complete (like harvesting) or a concept or lesson you want to cover. Regardless of your objective, be open to the possibility of using your garden-based experience to connect to science lessons back in the classroom.

How This Chapter is Organized

For each grade level, short lesson prompts are provided for Concepts of Life Science, Physical Science, and Earth Science. Some lesson prompts are developed into "Featured Lessons," which include:

- Correlated GLEs and Standards
- Lesson Topic
- Materials List
- Resources
- Lesson Objectives
- Lesson Procedure

These "Featured Lessons" are compiled at the conclusion of the "Teaching Science through Gardening" chapter on pages 33-43.

Correlation to Local and State Education Standards

The "Teaching Science through Gardening" chapter is correlated to local and state educational standards. Lessons are correlated to standards in the following way:

- **Kindergarten through Second Grade**: All primary grade activities are based on the Fairbanks North Star Borough School District Science Concepts outlined in the *K-12 Science Curriculum* guide published by the school district.
- **Third through Sixth Grade**: Intermediate grade lessons are divided into subjects based on Alaska State Grade Level Expectations (GLEs) for each grade level. Correlation to specific GLEs is noted after lesson prompts, where appropriate.

According to the GLEs, some concepts should be addressed at every intermediate grade level, including

- Science as Inquiry and Process
- Science and Technology
- Cultural, Social, Personal perspectives, and Science
- History and Nature of Science

The garden can provides a unique context for teaching within each of the above concepts, especially for the science process skills – such as asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating. In this chapter, these concepts are integrated in to the larger GLEs for Life Science, Physical Science, and Earth Science.

For more information on resources for integrating gardening into the science curriculum, please see the Annotated Resources on pages 93-97.

Kindergarten

Kindergarten Science in the Garden

Kindergarten Concepts of Life Science

FNSBSD *Human Body* Concept: *The human body is made up of many parts, each with its own function. We are able to investigate the world around us with each of our five senses – sight, touch, smell, taste, and sound. With so much to see, feel, smell, taste, and hear, the garden provides many opportunities to heighten students' sensory awareness.*

- Take a Focused Look: Practice using descriptive words. Gather leaves from five different plants in the garden, two from each plant. Divide the class into two groups. Seat the groups back to back, each with one set of the leaves spread in front of them. One team will work to describe each of these leaves; the other team will seek to find the same object by listening to the spoken description. The teams work together in this way (one team describing, one team asking clarifying questions) as they attempt to put the objects in same order on the ground (also covers FNSBSD *Observation* Concept).
- Examine a flower and describe it using as many of the five senses as possible.
- Describe the body movements necessary to perform a given task in the garden (i.e., weeding beds, harvesting broccoli, planting seedlings) after completing the activity.

FNSBSD *Living Things* Concept: *Different types of living things inhabit the earth. Living things have life cycles, and plant offspring closely resemble their parent plant.*

- Study the life cycle of a flowering plant by raising seeds in the classroom to be planted in the garden.
- Plant edible pod pea seeds to take home. Provide each student with one container filled with soil. Each student may plant one or two pea seeds in the container. Use the masking tape and permanent marker to label containers with student's name, date, and type of seed planted. Each student should also get a Plant Care card like the one shown below.

Plant Care Card

1. Keep the soil moist but not wet.
2. Let newly germinated seeds grow in a warm, sunny spot by a window or in a greenhouse.
3. Plant in a warm spot in the garden after danger of frost is gone.
4. These edible-shell snap peas will grow 2-3 feet tall and do not need to be staked or supported.
5. Pick and eat when the pods begin to swell!

- If some plants (especially flowers) have been allowed to over-winter in the garden, search for seeds produced by last year's plants. What will these seeds need to grow into adults? Calendula flower seeds, which look like tiny scaled dragons, are especially fun to find!
- Play a matching game with seeds and pictures of the vegetables they produce.

Kindergarten Concepts of Physical Science

FNSBSD *Observation* Concept: *Properties of materials can be observed, measured, and predicted. Physical properties include size, shape, color, texture, weight, and flexibility. Water can be a liquid or a solid and commonly transforms between the two states.*

- Describe different plants in the garden according to their physical properties.
- Predict the time necessary for the snow to melt from the school garden site in spring. Graph the decreasing height of the accumulated snow as it melts. Note weather patterns and other factors that may affect this snow melt.
- Observe and identify the different colors found in the garden. Read *Planting a Rainbow* by Lois Ehlert (♥♣). Sort flower seeds based on the color they will grow using pictures on flower seed packets and in seed catalogs. Using a color wheel, put the sorted seeds in rainbow order. Plant seeds indoors in early spring and then transplant them outside into the garden after the thaw.

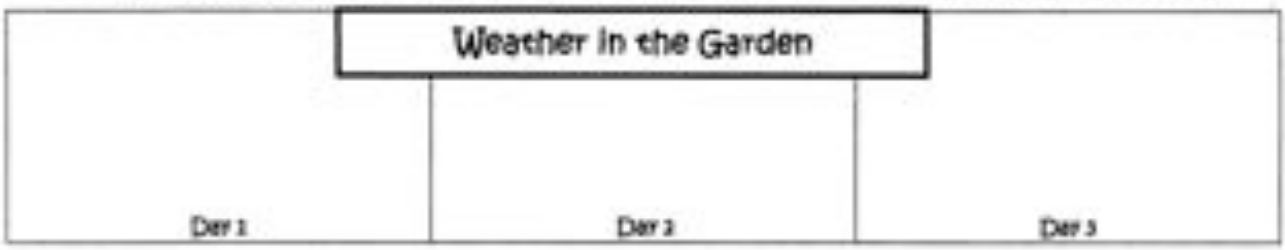
Kindergarten Concepts of Earth Science

FNSBSD *Our Earth* Concept: *Earth is composed of land, air, and water. Human activity can affect the Earth in many ways, both positive and negative.*

- Save classroom food wastes to be used as compost for the garden. Work with an older grade level (such as fourth or sixth grade) to learn about composting. See the composting unit on pages 67-91 for more background information.
- Identify the ways that nutrients are recycled in the school garden and ways that reusable and recyclable materials may be used in the garden. Have students make "garbage art" sculptures or birdhouses for display in the garden.

FNSBSD *Weather* Concept: *Weather changes both daily and with the seasons and affects Earth and its inhabitants.*

- Visit the garden every day for a week. Each day, record the weather in the garden in pictures.
- Visit the garden site throughout the school year. Have students draw the garden site in each different season and label their drawings.
- Identify how weather (rain, early frosts) affects the soil and plants in the garden.



First Grade

First Grade Science in the Garden

First Grade Concepts of Life Science

FNSBSD *Human Body* Concept: *The human body has systems that work together. These systems include the digestive system, the respiratory system, and the muscular system.*

- Follow a vegetable on its journey through the mouth and stomach. Enjoy tasting vegetables from the garden once you finish talking about, writing about, or acting out this journey.

FNSBSD *Origin of Plants* Concept: *Most plants come from seeds, though some plants reproduce asexually. The life cycle of a seed includes: germination, growth, and reproduction (the creation of new seeds). Seeds may be transported from their parent plant by air, water, and animals.*

- Take a Focused Look: Practice using descriptive words. Gather five different types of seeds that are easily discernable. Divide the class into pairs. Seat pairs back to back, each with one set of the seeds spread in front of them. One student will work to describe each of these seeds; the other student will seek to find the same object by listening to his/her partner's description. The partners work together in this way (one partner describing, one partner asking clarifying questions) as they attempt to put the objects in same order on the ground.
- Read "Frog and Toad in the Garden" (from *Frog and Toad Together* by Arnold Lobel) (♥♣). Determine what seeds require in order to germinate. Design an experiment with your class comparing Toad's methods of seed starting (shouting, playing music, etc.) to more traditional methods of starting seeds (from www.kidsgardening.com).
- Match pictures of seeds to their mode of travel. Start a class seed collection: Take a walk in the schoolyard and in the garden searching for seeds, and encourage students to bring in seeds from home and to save seeds from food that they eat. Categorize each seed based on its mode of travel.
- Review different ways that seeds are dispersed – by air, by water, by wind, as hitchhikers, by animals, as projectiles. Brainstorm characteristics of seeds that make them specialized and allow their dispersal (i.e., seeds dispersed by wind have helicopter wings or feathery parts, while seeds dispersed by water are hollow). As a class, use pictures or examples of seeds to create a pictograph like the one on the next page to show different methods of seed dispersal. After completing the bar graph, gather art materials, including scissors, glue, colored paper, markers, feathers, pipe cleaners, beads, string, and felt or fabric pieces. Give each student a lima bean seed (or some other large, manageable seed). Allow students to use the art materials to specialize their lima bean seed for one type of dispersion. After completing their seed, they can explain its method of dispersal in words and pictures. Add student creations to your class graph.

How Seeds Travel Pictograph

- Give each student a plastic bag with a bean seed and a moist paper towel inside. Explain that they will be watching this seed germinate over the next few days. Students should open and air out each bag every day and check to make sure that the paper towel stays moist. Students should draw/record how the seed changes over the next two weeks in their journal.
- Read *The Gumdrop Tree* by Elizabeth Spurr. Soak lima beans in water overnight. Split open the lima beans and identify the tiny plant (embryo) inside. Explain that this embryo will grow into an adult plant in the right conditions. All plants start as an embryo in a seed. Read the book and have students predict what would grow if they planted gumdrops in the ground. Have students draw a picture of their predictions. Plant gumdrops in soil in the classroom or outside in the garden. Monitor the progress of the gumdrops. After a few weeks, dig up the gumdrops "seeds." One teacher who did this activity said that "Some kids helped turn on the light for others by reminding them that because the gumdrops had no embryo like the beans and oats, they couldn't grow. The class then considered how the make-believe had inspired their imaginations and influenced predictions, but recognized that the experiment provided evidence that disproved their hopeful guesses" (from www.kidsgardening.com).
- Discuss the ways that plants usually start (with a seed). Read *The Plant Sitter* by Gene Zion (♥♣▲) about a boy who learns about taking cuttings from an overgrown plant that he is taking care of. Practice planting cuttings from mint, which will grow well in the school garden (from www.kidsgardening.com).
- *GrowLab: Activities for Growing Minds* includes a comprehensive unit on seeds and plant growth geared toward kindergarten through second graders.
- *Beyond the Bean Seed: Gardening Activities for K-6* recommends the following books to teach about seeds:
  - *Seeds: Pop, Stick, Glide* (Patricia Lauber) (▲♦)
  - *The Tiny Seed* (Eric Carle) (♥▲♦)
  - *The Magic School Bus Plants Seeds* (Joanna Cole)
  - *The Reason for a Flower* (Ruth Heller) (♦)
  - *How a Seed Grows* (Helene Jordan) (▲♦▲)
  - *The Carrot Seed* (Ruth Krauss) (♥▲♦)
  - *How Seeds Travel* (Cynthia Overbeck) (♥▲♦•)
  - *Seeds* (George Shannon)

FNSBSD *Plants* Concept: *Plants are producers, meaning they produce their own food through photosynthesis. Plants are the foundation for every food chain and food web.*

- Create a mobile depicting a simple food web in the garden.
- Brainstorm a set of food webs specific to Alaska. Trace each food web back to the plant(s) where they started.
- A root box is a thin planting box with a clear side. This clear side is covered with a wooden or opaque plastic flap that can be lifted up to reveal the roots of the plants growing inside the root box. Utilize the school root box to learn about the different parts of a plant. If your school does not have a root box, ask the school Garden Committee or parents in your class to build one. Identify the main parts of the plant (roots, stem, and leaves) and their functions.

- Review the different parts of a plant and their function: the roots pick up water and nutrients from the soil, the stem supports the plant, the leaves collect sunlight to make food, and the flowers attract pollinators so that the plant can reproduce. Create a giant human model of a plant. Assign groups to be each of the following plant parts:
  - Roots: The root students will lay on the ground, with their legs and arms spread. They will make loud sucking noises and grab at the air with their hands, as if they are sucking up water and collecting nutrients from the soil.
  - Stem: The stem students will lay flat and stiff in a straight line chanting, "Strong support, strong support!"
  - Leaves: The leaf students will curl themselves into the shape of leaves branching off of the stem. They will yell, "I make food! I make food! I make food!" repeatedly.
  - Flowers: The flower students will sit cross-legged near the leaves, primping and yelling, "Here, pollinators! Here pollinators!"

First Grade Concepts of Physical Science

FNSBSD *Heat* Concept: *Heat can be produced and transferred in many ways, including conduction, convection, and radiation.*

- Build a hot compost pile as a class (for more information and directions, see pages 83-85). Monitor the heat that is produced by the decomposers in this compost pile using a 12 or 24-inch long compost thermometer (a thermometer with a long probe). Explain that, regardless of size, living things produce heat.
- Monitor the temperature of the garden soil and the air in the garden. Maintain a record of this information on a class graph. In addition, note the amount of daylight each day. What trends does your class notice about the soil and air temperature in relation to increased daylight in the spring or decreased daylight in the fall?

FNSBSD *Light* Concept: *Light travels in a straight line until it hits an object. Objects reflect, refract, and/or absorb light.*

- Create a prism mobile for the school garden.
- Build two terrariums in your classroom. In each, place the same types of plants and a thermometer. Place a piece of thick black paper across the lid of one of these terrariums. Top the other terrarium with a white piece of paper. Over the next few days, measure and record the temperature inside each of these terrariums. Does the different colored top affect the temperature inside? Explain that dark objects absorb light and heat better than light objects. How would this knowledge be useful in choosing the colors of clothing we wear in the summer or winter?
- Have students chart the shadow of a stationary object in the garden throughout one day. They may mark the borders of the shadow with stakes and string or with masking tape. They should label each outline with the time at which the observation was made. How does the shadow of a stationary object change throughout the day? Why?

First Grade Concepts of Earth Science

FNSBSD *Weather* Concept: *Many types of weather exist. Observable factors – such the position of the Earth and resulting season changes – affect the weather.*

- Graph the amount of snowfall in the garden throughout the winter.
- At different parts of the day (or a few times each week), visit the garden as a class. Give each student the opportunity to sketch the clouds in the sky. What different types of clouds can be observed?
- Set aside a corner of the school garden for weather instruments. Go outside daily to measure the amount of precipitation that has fallen, the air temperature, and other weather factors. Maintain a class weather graph of the data collected.
- Write a comic strip that describes what happens to the garden in various weather conditions.
- Read *Cloudy with a Chance of Meatballs* by Judi Barrett (♣). Compile a class book based on *Cloudy with a Chance of Meatballs* that utilizes vegetables from the garden. Enjoy snacking on those vegetables as you read the story aloud.

FNSBSD *Elements* Concept: *Air, land, and water have weight and take up space. All of these are forces that shape the earth.*

- Construct pinwheels or wind socks to display in the garden.
- Look for places where erosion has occurred in the garden.

Second Grade

Second Grade Science in the Garden

Second Grade Concepts of Life Science

FNSBSD *Food Groups* Concept: *Healthy diets include foods from all the food groups. Many of the foods we eat come from plants grown in gardens or on farms!*

- Design and serve a well-balanced meal that includes food from the garden. Designate each part of the meal as being a plant or an animal.
- In the spring, harvest and eat a meal that includes wild grown plants from the schoolyard, like fireweed, dandelion roots, and bluebells. In the late summer and fall, wild berries may be harvested. Be sure that no harvested plants have been sprayed at any point with herbicide or insecticides. Janice J. Schofield's *Discovering Wild Plants: Alaska, Western Canada, the Northwest* (♣♦•) is an excellent resource on edible native plants.
- Trace the journey of the food in your meal from its origin. Plot on a map where each part of your meal originated. Ask: *What types of food do we eat and where do they come from? Is everything we eat grown right here in Fairbanks?* Using a box of vegetables that includes citrus, peas, corn, greens, and broccoli and a U.S. map, discuss with the class the origins of some of the foods that they eat:

  Citrus: from California or Florida
  Peas: from the Pacific Northwest (in summer) or Mexico (in winter)
  Corn: from the Midwest or California (in summer), from Mexico or further south (in winter)
  Greens: from Alaska or the West Coast (in summer), from California (in winter)
  Broccoli: from California

  A lot of energy is used to transport food to Alaska from the Lower 48. One of the beneficial things about buying Alaskan-grown food is that we use less energy and our food is much fresher!

FNSBSD *Habitats* Concept: *Plants and animals are generally found in a particular habitat to which they have adapted. Gardeners work to create ideal habitats for the plants they grow.*

- Create a favorable habitat for a given species in the garden. For example, research plants that native butterfly species use for food. Plant these species in one corner of the garden. See Chapter 10 (pages 135-146) in *Beyond the Bean Seed: Gardening Activities for Grades K-6* for ideas on building habitat gardens based on the following books:
  - *The Butterfly Garden* (Jerry Sedenko)
  - *Feathers for Lunch* (Lois Ehlert) (♣)
  - *The Clover and the Bee: A Book of Pollination* (Anne Ophelia Dowden) (♣♦•)
  - *Alejandro's Gift* (Richard E. Albert)
  - *Growing Wild* (Constance Pereny)

- Play "Down and Dirty" in the garden: Have each student find a comfortable position away from other students. Using their hands, have them frame out a small area that they can observe closely. You may also provide a string for each student, about two feet in length. Have them lay out this string in a circle; the inside area is their small area to observe. Ask them questions about their area: Can they count all the plants in their area? What would it feel like to shrink and suddenly live in that environment? Look for living things in amongst the growing plants. This also works well if students have hand lenses, which help them to see the detail in the soil.
- Create a vermiculture (composting worm) box. For more information on vermiculture, see pages 77-81. Specify what must be present in order to create a successful worm habitat.
- Identify what your school property looked like before it was developed. What animals might have had their habitat there? How has that changed?
- Gather and create a nature museum in your classroom. Open the world of nature study by encouraging children to explore their yards and garden beds, the countryside or a vacant lot, sidewalk cracks and parking lot fences. Encourage them to gather specimens such as flowers, seed pods, leaves, stems, branches, or weeds. Organize and display specimens according to the microenvironments in which they were found (from *Beyond the Bean Seed*, page 5).

Second Grade Concepts of Physical Science

FNSBSD *Sound* Concept: *Sound is produced by vibrating objects. Sound travels in waves. Pitch is determined by a sound's rate of vibrations.*

- Play "Sound Count": Have students find a comfortable position in the garden. Ask them to listen for a minute and to count the number of sounds that they can hear. After a minute, ask them to repeat some of the sounds that they heard. Which ones were natural? Unnatural? Can students mimic sounds heard in the garden? Identify sounds as having a high pitch or a low pitch.

FNSBSD *Force and Motion* Concept: *Motion is created by force and the transfer of energy.*

- Work in the garden on a given task, such as weeding, harvesting, or watering. Identify what force and energy was needed to complete the work. Write up a description of what you did in the garden using appropriate vocabulary words, such as "force," "motion," and "gravity." Each student can draw pictures to accompany his/her writing.

Second Grade Concepts of Earth Science

FNSBSD *Earth* Concept: *Earth's seasons are determined by its constant tilt and position in orbit.*

- Keep a season journal. Visit the garden once a month. Draw and describe what it looks like. Throughout the winter when the garden may look pretty unchanging (covered in snow), have students measure snow depths, look at layers in the snow, or describe how the snow pack feels (is it hard packed or fluffy?).
- Compare and contrast the seasons in Alaska to different parts of the country. How does this affect the growing season here? You may want to explain that our growing season is similar in length to that of New England (with a similar number of frost free days, though our average temperature is much colder). Increased daylight allows plants to mature quickly in Alaska.

FNSBSD *Rotation* Concept: *Day and night are caused by the rotation of Earth. As the Earth rotates, the sun shines directly and indirectly on different parts of the Earth. The Earth's rotation makes the sun appear to move through the sky throughout the day. The sun is always shining somewhere.*

- Go to the garden to investigate the place of the sun in the sky at different parts of the day and seasons.

Third Grade Science in the Garden

Third Grade Concepts of Life Science

The Human Body: *The human digestive system consists of a number of parts, each with its own function.*

- Harvest vegetables, flowers, and herbs from the garden that have a strong flavor, like sorrel, lovage, onions, rhubarb, radishes, and nasturtiums. Cut up vegetables, flowers, and herbs so that each student can have one equal-sized portion. Have blindfolded students attempt to identify plants as they taste them or use the variety of tastes as inspiration for poetry writing. For more information on garden-based poetry activities, please see pages 51-55.
- Using the book *What Happens to a Hamburger* by Paul Showers (♥♣♦) as a model, write a class story that details the journey of a piece of broccoli as it travels through the digestive system. Harvest broccoli to eat and enjoy once the story is complete. Illustrate your class book with pictures or design a three-dimensional model to accompany your story.
- Create a class "Digestion Play" that explains how food moves through the digestive system. Perform the play for another class. Provide snacks from the garden.

Plant Parts We Eat

Edible Roots: carrot, turnip, beet, sweet potato, yam, sugar beet, horse radish, rutabaga, cassava, spices such as licorice, sarsaparilla and sassafras

Edible Flowers: cauliflower, artichoke, broccoli, squash, daylily, violet, nasturtium, brussel sprout, saffron (spice from dried stigmas of flower), cattail, capers (pickled flower buds), cloves (spice), honeysuckle (can sip sweet nectar), chamomile, pansies, marigold

Edible Seeds: bean, corn, wheat, rice, barley, oat, peanut, coffee, chocolate, pine, walnut, sunflower, pecan, almond, cashew, pea, cola nut (for cola drinks), several spices such as nutmeg, mustard seed, anise seed, poppy seed, carraway seed, cumin seed, dill seed, fennel seed and celery seed; oil seeds such as safflower, sesame, and canola

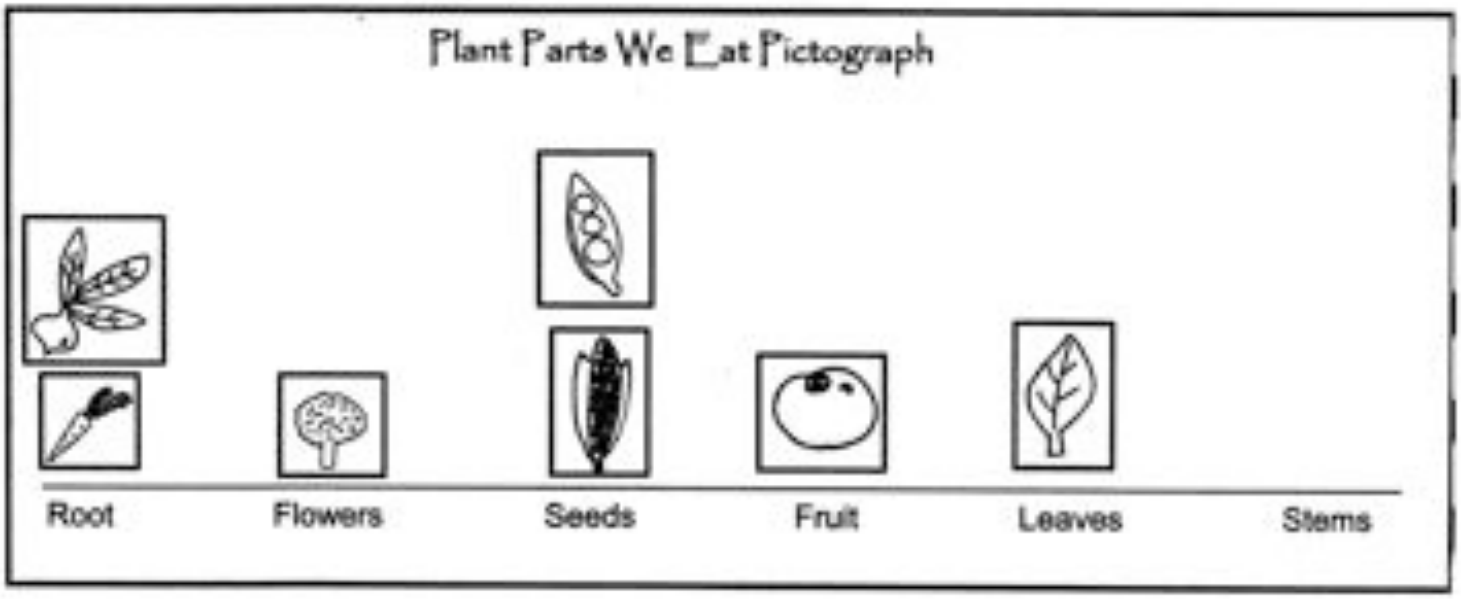
Edible Fruit: apple, pear, peach, orange, lemon, lime, persimmon, banana, pineapple, mango, papaya, strawberry, tomato, olive, plum, date, pomegranite, jujube, vanilla, coconut, paprika, pumpkin, vanilla, snap pea, green bean, avocado

Edible Leaves: lettuce, cabbage, tea leaves, spinach, mustard greens, turnip greens, celery, onion, garlic, chives, parsley, many herbs and spices such as parsley, basil, chives, rosemary, thyme, peppermint, sage, marjorum, oregano, tarragon, watercress, mint, and bayleaf

Edible Stems: potato (a tuber, which is a modified stem), asparagus, sugar cane, ginger "root" (actually a rhizome or underground stem), Jerusalem artichoke, water chestnut, cinnamon (spice from bark), bamboo shoot, radish

Plant Functions: *Plants are made up of roots, stems, flowers, and leaves with each part having its own unique function. Plants can be classified according to their physical characteristics and edible parts. Physical adaptations of plants allow them to survive and thrive in certain habitats.*

- Collect edible flowers such as nasturtiums, borage, calendula, chives, mint, and pansies for a special treat!
- Read the book *Tops and Bottoms* by Janet Stevens. In this book, two animals discover which parts of different plants are edible. Cut out pictures of different vegetables from magazines, or draw pictures of favorite vegetables. Create a class pictograph that shows which parts of the plants are edible (see the example below). Walk through the garden and classify plants in the garden according to their edible parts (see the box on the previous page for more information about edible plant parts). Enjoy taste testing some roots, flowers, seeds, fruit, leaves, and stems. (GLE[3]SB1.1)



- *Beyond the Bean Seed* recommends the following books for learning about plant life cycles and plant parts:
  - *A Flower Grows* by Ken Robbins
  - *Morning Glory* by Sylvia Johnson
- Use seed catalogues to search for plants that are "cold-tolerant" or write letters to seed companies or local gardeners to determine what garden plants are well-adapted to life in Alaska. (GLE [3]SC1.2)
- Read *The Giant Cabbage* by Cherie Stihler (♣♦), an Alaskan folktale. This book is a traditional story centered on the impressive growth of cabbages in Alaska. Discuss: *What natural factors contribute to plant growth and survival?* Make a list of conditions that affect and limit plant growth in a Fairbanks school garden (such as water, sunlight, soil health, space, nutrients, and attention). (GLE[3]SF.1 – SF.3, GLE[3]SA3.1)
- *Beyond the Bean Seed* suggests: "Salvage kitchen or cafeteria scraps such as potato eyes or sprouts, carrot and pineapple tops, and citrus, apple, pumpkin, squash and avocado seeds to plant and grow in your own garbage garden"

(Jurenka, 7). Use this garbage garden to observe and compare the external features of these plants that allow for reproduction, by focusing on what scraps of the plant result in the germination of a new plant (adapted from *Beyond the Bean Seed*, page 7). (GLE[3]SC2.2)

- Review the parts of a plant and the function of each part. Take students out to the garden. Have each student sketch three different plants in the garden, labeling the root, stem, leaves, and flower parts. (GLE[3]SB1.1, GLE[3]SC1.1)
- Over the course of two to three weeks, have students make observations of a single flower in the garden, recording the stages of its life cycle. Dissect flowers to identify the major reproductive parts of flowers. Please see the Featured Lesson, *Observing Flowers and Their Parts*, on pages 34-35 for a detailed lesson on flower observation and dissection (GLE[3]SC1.2, GLE[3]SC2.2, GLE[3]SA1.1, GLE[3]SA1.2)
- Save seeds from the garden with your class in the fall. These seeds can be planted the following spring indoors and transferred to the garden after break-up. For information on how to save pea, zucchini, flower, and garlic seed, please see the Featured Lesson, *The Great Seed Rescue*, on pages 36-37. (GLE[3]SC2.2)
- Create a Plant of the Week (or Plant of the Month) Journal with your class. Bring in a different plant to observe and describe each week or month. For ideas about plants to include in your journal and guiding questions for writing, please see the Featured Lesson, *Plant of the Week Journal*, on page 38. (GLE[3]SA1.1, GLE[3]SA1.2, GLE[3]SA2.1, GLE[3]SC1.1, GLE[3]SC2.1)
- *GrowLab: Activities for Growing Minds* features many lessons on the external features of plants that help them to grow, survive, and reproduce. (GLE[3]SC2.2) These lessons could be easily used in the late summer/early fall school garden or inside the classroom for winter exploration. Lessons include:
  - "Root Watch" (Topic: Root structure and growth, page 56)
  - "Why Root for Roots?" (Topic: Roots' role in water intake, page 59)
  - "Root Loops" (Topic: Geotropism, page 63)
  - "What a Sys-Stem!" (Topic: Stem functions, page 70)
  - "Look Out for Leaves" (Topic: Leaf structure, page 78)
  - "What's in a Name?" (Topic: Plant part structure and Function, page 97)
  - "Plant Cycles" (Topic: Life Cycles, page 123)
  - "Flowers Up Close" (Topic: Flower structure, page 125)
  - "Petal Attraction" (Topic: Pollination/Seed production, page 132)
  - "Fruit for Thought" (Topic: Fruit structure/function, page 136)
  - "Plantenstein" (Topic: Propagation from plant parts, page 141)
  - "Slips, Snips, and Growing Tips" (Topic: Propagation investigations, page 144)

Third Grade Concepts of Earth Science

The Water Cycle: *The water in the biosphere is constantly being recycled through evaporation and condensation. Recorded weather patterns (such as temperature, cloud cover, and precipitation) can be used to make reasonable weather predictions.*

- Study different forms of water catchment systems. Design a water catchment system for your school to utilize the water that runs off the roof. Please consider the material that the school roof is made of; do not store and use rainwater or snow runoff from the roof on the school garden if pollutants could have contaminated it. Contact Calypso for resources on water catchment.
- Use the school garden as an observation site for recording weather every day for one week. Use these recorded weather patterns (including temperature, cloud cover, or precipitation) to make reasonable predictions about upcoming weather. (GLE[3]SD3.1)

Third Grade Concepts of Physical Science

Simple and Complex Machines: *The lever, pulley, wedge, wheel and axle, screw, and incline plane are simple machines that help us do work. Complex machines are made from many simple machines.*

- Identify simple machines used in the garden. For example, the wheelbarrow is a wheel and axle and/or a lever (depending on how it is being used), and the each tong on a garden fork has a sharp wedge on the end. Have students draw and identify one example of each type of simple machine that could be useful in the garden. List the costs and benefits of each tool/technology. For example, students could construct a simple incline plane from the ground into a raised garden box. This incline plane could be used to push a wheelbarrow of compost into the garden bed; however, one disadvantage is that the incline plane requires a significant amount of space in order to be gradual enough to be practical. Utilize these simple machines to do some garden maintenance! (GLE[3]SE2.1, GLE[3]SE3.1)
- Design a complex machine that would aid in working in the school garden. Have each student identify the simple machines that are a part of his/her creation. List the positive and negative effects of each invention. (GLE[3]SE3.1)

Electricity: *Electricity can be used to produce light, heat, and motion. Materials can be classified as either conductors or insulators according to their ability to conduct electricity; both conductors and insulators have important functions in the study and application of electricity.*

- Design a simple experiment to determine what materials (wood, aluminum, steel, copper, etc.) should be used as the posts and electric wires in an electric moose fence. Please see the Featured Lesson, *Moose Fence Design*, on page 39 for more information on electric moose fences and experimental design. (GLE[3]SB2.1)

Fourth Grade

Fourth Grade Science in the Garden

Fourth Grade Concepts of Physical Science

States of Matter: *The common states of matter are solids, liquids, and gases. These states have unique physical properties. Temperature changes cause changes in the phases of substances. For example, heat causes ice to change to water and water to change to water vapor. Decreasing temperatures reverse this process.*

- Identify the effects that water in its different states has on the garden. For example, plants require water to grow, but plant cells freeze and burst when the water in the cells is frozen. (GLE[4]SB1.1)
- Study the various ways that energy (heat) can be conserved in a garden. Look at examples of greenhouses, hoop houses, or plastic covering for plants that hold in both heat and moisture (GLE[4]SB3.1). Research the adaptations that allow or prevent energy transfer in certain plants. (GLE[4]SB2.1)
- Present the class with an orange (in skin), orange slices, cucumber slices, scored grapes, kale leaves, and thick potato slices. Explain that they will be exploring the water content in different fruits and vegetables. Can they make some guesses about whether the weight of the fruits and vegetables will decrease or increase each day? Ask the class to weigh the fruits and vegetables today and record their weights on the piece of butcher paper (making a graph with the days listed horizontally and the weights listed vertically with color coded vegetable and fruit names). Then, they should leave the fruits and vegetables out on the windowsill. Weigh the fruits every day and record their weights on the butcher paper graph. This activity also works well with leftover Halloween pumpkins.

Fourth Grade Concepts of Life Science

Insects: *Insects have observable characteristics and behaviors. Insects can be classified according to their physical characteristics. In the garden, some insects are pests, while many insects are beneficial to plants.*

- Identify and classify common insects in the garden. Using insect identification guides, diagram the life cycle of these garden-dwelling insects.
- Invite a local gardener to speak about helpful and harmful insects in the garden and ways to attract beneficial insects to the garden.
- Invite an entomologist from UAF to speak about common insects in Alaska. Look for examples of these common insects in the garden. Draw and describe the distinguishing features of the insects found in the garden. The UAF Entomology website has contact information for local entomologists and links to insect species information specific to the Fairbanks area.

Life Forms: Alaskan Organisms: *Alaskan plants have developed unique physical adaptations to accommodate their ecological niche in the habitat. Matter and energy flow through organisms and their environments through food webs. The school garden can be an approachable, accessible mini-ecosystem to study the interactions of living things!*

- Invite an Alaskan farmer to speak about the specific challenges of growing food in Alaska.
- Plant one section of the garden with plants native to Alaska; plants that will flourish into the fall school year include columbines, poppies, and forget-me-nots. Review the basic requirement of living things and create a plan to ensure that these native plants' needs will be met in the school garden (GLE[4]SC2.1). Identify the limiting factors that exist for native plants in Alaska and identify the physical adaptations of these plants that allow each one to survive in the Interior. The University of Alaska Fairbanks Cooperative Extension Services has excellent resources on Alaska native plants (GLE[4]SA3.1, GLE[4]SC1.1).
- Within the garden ecosystem, have groups go on a scavenger hunt to find examples or evidence of the following:

A producer	Signs of a consumer	Symbiosis	Humans
Photosynthesis	Parasitism	An insect	Moss
A decomposer	An herbivore	Mutualism	A bird
An omnivore	An animal	A fungus	Oxygen
A plant	Microscopic organisms	A nonliving thing	Water
An invertebrate	A mammal	Interdependence	Erosion
A consumer	A tree	Recycling of minerals	

  Before beginning, review the list of objects. Define any unfamiliar terms. During the scavenger hunt, students should leave things where they find them. They may write down the name of the thing they find or descriptive words about what it is and its location. Can students find one thing that is an example of at least three of the things listed above (i.e., an insect is an animal and an invertebrate)? Which group can find the most things? (adapted from *Alaska's Ecology: Alaska Wildlife Curriculum Teacher's Guide*) (GLE[4]SC3.1)
- Collect native Alaskan plants to study in the classroom. Have students choose appropriate tools (such as a hand lens, microscope, ruler, or balance) to examine and measure the structural components of these plants (GLE[4]SC2.1).
- Encourage students to collect Alaskan wildflowers and wildflower seeds. Be sure to tell students to only collect flowers where they are abundant and where collection is allowed; also, students should always leave plenty of flowers for other people to find and enjoy. Press the flowers and plant the wildflower seeds in the school garden (adapted from *Beyond the Bean Seed*). Read *Miss Rumphius* by Barbara Cooney (♥♣♦) about a girl who nods when her grandfather tells her that in order to live a good life, she must make the world a more beautiful place. It's not until she's an old woman that she understands. She spends the rest of her days blanketing the countryside with lupines. Research traditional uses for Alaska's wildflowers; for example, fireweed shoots are a delicious spring treat! See *Discovering Wild Plants* by Janice Schofield (♣♦•) for more examples.

- Invite a local farmer who cultivates apple trees to speak about the specific adaptations apple trees have for survival in Alaska. Many apple trees in this area are grafted onto Siberian apple tree roots (which can survive the cold but do not produce preferable fruit). Read *An Apple a Day: From Orchard to You* by Dorothy Hinshaw Patent (♣♦) to learn more about apple growing (GLE[4]SC1.1).
- Collect soil samples from the garden and use a Berlyse funnel to filter out the organisms in each sample. Draw and describe the animals found. Please see the Featured Lesson, *Investigating Animals in Soil*, on page 40-41 for more ideas and for instructions on building a Berlyse funnel from common classroom materials (GLE[4]SC1.1).
- Classify things in the garden as either living or non-living. Identify the relationship between these living and non-living things (GLE[4]SC3.1)

Fourth Grade Concepts of Earth Science

Geochemical Cycles: Rocks and Minerals: *Rocks and their minerals are classified by their observable characteristics. Through the rock cycle, the breaking and weathering of landforms and larger rocks causes smaller rocks and particles to form.*

- Provide a student volunteer with safety glasses and a rock hammer. Have the student break a large rock with the rock hammer. Make observations about how the rock broke: *Did it break into two pieces or into fragments? What are we creating by breaking the rock?* (This is one form of weathering which, in the end, results in the making of soil. Other forms are wind, water, chemical weathering (like acid rain), and the grinding together of rocks. As the rock breaks down, the different particles make up soil.) Discuss how the properties of water relate to the rock cycle (GLE[4]SD1.2). Discuss the components of soil (sand, silt, clay and organic matter). Display and pass around soil components individually in small clear containers for the class to observe and touch while you discuss them. Discuss the way they look and how they are formed (Rock breaks down into sand, sand breaks down into silt. Clay isn't solely made from the physical breaking down of silt, but it is the smallest particle in soil.). *Why is each one important in a good growing soil?* (sand and silt have a lighter soil texture for root penetration, clay holds nutrients and water, organic matter contains nutrients). Loam is a mixed proportion of all of these components. A good loam has a nice, light texture and good water and nutrient holding capacity. *What is the importance of soil?* (Soil provides a foundation for roots, holds water, provides nutrients for plants, and gives a home to many organisms). Plant seeds in various environs, such as bare rock, sand, poor soil, and rich soil. Design an experiment to compare the growth of seeds in these different conditions (GLE[4]SD1.1).

Erosion: *Waves, wind, water, and ice shape and reshape the Earth's surface by eroding rock and soil.*

- Look for signs of erosion in the garden. What structures are in place to prevent erosion? Create an invention that could prevent further erosion in the garden. (GLE[4]SD2.1)
- Build an erosion demonstration box, a long shallow box divided into four long compartments. Fill each compartment with a different soil: clay, sand, silt, and

organic matter. Pack each of these in tightly. One week before you begin your class experiment, plant a line of grass seeds thickly midway down each of the compartments. With the box lying flat, pour an equal amount of water into one end of each of the compartments. Have students sketch and describe what happens in each compartment. Is the water absorbed or does it stay mostly on top of the soil? Is a depression created as soil is displaced by the falling water? After making observations individually and as a class, prop the box up at an angle. Pour an equal amount of water into the upper portion of each compartment. What happens as you increase the amount of water or repeat the experiment over a number of days? Have students sketch and record in words the effect of the water on the different types of soil. Pay attention to the grass planted in each type of soil. Does the grass stay rooted in place or it is washed away? Does the soil move and pile up at the lower end of the box? Compare the different types of soils. (GLE[4]SD2.1)

Fifth Grade

Fifth Grade Science in the Garden

Fifth Grade Concepts of Life Science

Living Organisms: *All organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy. Matter and energy are transferred through food webs; the source of energy in every food web is sunlight.*

- Pick plants from the garden to look at under a microscope. Using a razor blade, cut plants into thin slices; mosses (which are single celled) and stems work particularly well. Place slices on slides and cover with a slide cover. View these plants under a microscope. Diagram or make a model of the plant cells.
- Trace the path of a broccoli through the body. How does one piece of food interact with the various body systems?
- Build a "Bioburger" in your classroom: Place a picture of a hamburger in the middle of the board or on a large, blank piece of paper. Identify the major components of a good burger (meat, cheese, tomato, lettuce, ketchup, mustard, etc.). Create a flow chart with the burger in the center that identifies each of these components. Trace each of these components back to its source "ingredients," adding to the flowchart. For example, meat comes from a cow, a cow eats grass, grass is grown using water, soil, sun, and air. Each of the ingredients should lead back the same Big Four source ingredients of water, soil, sun, and air. Have students choose their favorite meal that includes at least three separate ingredients. Each student should create a flowchart of his/her own, tracing the ingredients back to these same Big Four. How many of the ingredients in students' favorite meals could be grown in the school garden? (Adapted from *The Growing Classroom: Teaching Science through Gardening*.) (GLE[5]SC3.2).
- Play "Predator and Prey" outside: Appoint two students to be producers. The producers should stand at the end of a rectangular playing area. Give the producers a large handful of rubber bands that represent energy. Assign five students to be carnivores. All other students are designated herbivores. Give herbivores four rubber bands to wear on their wrists. Herbivores move around the designated playing area and try not to get tagged by the carnivores. If an herbivore is tagged by a carnivore, the herbivore must surrender two rubber bands to the carnivore. Herbivores can restock their supply of rubber bands by running to the producers, who must remain stationary. To add another twist, two students can represent death and decay. If an herbivore or carnivore is tagged by death and decay, they must surrender all of their rubber bands. Back in the classroom, diagram the transfer of energy and matter in this game. Discuss: How is this cycle seen on a small scale in the school garden? (GLE[5]SC3.1)

Fifth Grade Concepts of Earth Science

Geochemical Cycles: Soils: *Smaller rocks come from the breaking and weathering of larger rocks. Soils have both a mineral and organic component: weathered rocks and minerals combine with plant materials to form soils.*

- Bring in soil from the schoolyard. Identify the different components of the soil (silt, sand, clay, crushed rock, crumpled leaves, twigs). Pass out these components to small groups and challenge them to construct their own soil from raw materials. Compare student-made soil to earth-made soil. Explain that each inch of topsoil take over 100 years to create. Soils have both a mineral and organic component: rocks and minerals combine with organic matter to make up soil. Given that decomposition (of organic matter) and chemical weathering (or rocks and minerals) halts in subfreezing temperatures, soil creation takes even longer in interior Alaska than it does in other parts of the world; interior Alaska has a relatively young, shallow topsoil in our forests compared to more temperate regions. However, peat (considered by some to be living plant matter and others to be slowly decomposing moss) could be considered a soil that accumulates more quickly. Bacteria, fungi, and other living things work together to recycle the nutrients of dead material into the organic component of soil. Over 100 billion microorganisms live in one pound of soil. (Adapted from *The Growing Classroom: Garden-Based Science*) (GLE[5]SD1.1)
- See fourth and sixth grade "Concepts of Earth Science" sections for more activities related to geochemical cycles and the formation of soils.

Fifth Grade Concepts of Physical Science

Properties of Matter: *All matter has mass, weight, volume, and density which can be measured and compared. Using the school garden harvest as a point of inquiry, students can learn to choose appropriate tools to measure the physical properties of matter.*

- Choose a large vegetable from the garden (i.e., kohlrabi, turnip, cabbage, cauliflower, beets, rutabaga etc.). As a class, determine all of the ways that this vegetable could be measured. How would you determine its mass, weight, and volume? What other parts of this vegetable can be measured or described? (GLE[5]SA1.1

Sixth Grade

Sixth Grade Science in the Garden

Sixth Grade Concepts of Life Science

Plant Reproduction: *Life forms change over time. Some life forms reproduce sexually (by producing seeds); some reproduce asexually (through cloning, cutting, and grafting).*

- Explore the ways that flowers in the garden reproduce. Some flowers (including many beans) are self-pollinating, though many flowers must attract pollinators in order to sexually reproduce. Identify the ways that flowers attract pollinators, including:
    - *Colors*: Different pollinators can see the same colors differently; for example, bees can see yellows, blues, and purples, so bees commonly pollinate flowers that are these colors. Once pollinated, some flowers stop maintaining the colorful petals which attracted bees.
    - *Patterns*: Some flowers have lines or concentric rings that "point" pollinators toward food.
    - *Scents*: The smell of flowers attracts pollinators. From www.kidsgardening.com: "Some flowers, like skunk cabbages, smell like rotting flesh to attract insects such as carrion-eating flies or certain beetles looking to lay eggs. Flowers that appeal to a wide range of pollinators often have light aromas, which accommodate a variety of taste buds. Others, such as those that bloom at night, have strong, distinct scents that attract moths and bats in the dark. Many flowers typically pollinated by hummingbirds, such as nasturtiums, don't need to be fragrant because their pollination partners have little sense of smell."
    - *Shapes*: Butterflies prefer flat, open surfaces, while some bees prefer flowers with special patterns that are used like landing platforms. Flowers that have a drooping bell shape protect their pollen from weather elements.
    - *Numbers*: Some "flowers" are actually groups of tens or hundreds of tiny blooms. These small flowers often attract different pollinators.

  Challenge students to find flowers in the school garden with different characteristics that increase their chances of reproductive success! (information adapted from www.kidsgardening.com) (GLE[6]SC1.1)
- Identify and experiment with plants in the school garden that reproduce asexually. For example:
    - Students can take cuttings from mint.
    - New plants will sprout from garlic cloves and potato eyes.
    - Apple trees sold in Alaska are often grafted onto hearty roots systems of Siberian apple trees, whose fruit is not tasty.

Classification of Living Organisms: *All organisms are scientifically classified by their structure. Dichotomous keys are one method of organizing and classifying animals and plants.*

- *Beyond the Bean Seed* recommends Carol Lerner's *Plant Families* (♥♣•) as an effective reference for classes learning about the classification of plants: "Twelve of the largest plant families are introduced to young readers. Lerner sorts out the *Compositae* from the *Umbelliferae*; the *Rosaceae* from the *Labiatae*. Each plant has particular characteristics that botanists use to place it in one category but not another. Lerner tells how this identification is done. Before this book is introduced to readers, it is recommended that they have read a more basic botany book so that they have the background to identify plant parts. Lerner's lovely and colorful illustration, detailed and accurate, provide the reader with aesthetic botany lessons" (Jurenka, 28).
- Invite an Alaskan farmer to come speak about the types of plants that can grow in Alaskan gardens compared to plants in other parts of the world. (GLE[6]SC1.2)
- Introduce the concept of a dichotomous key by encouraging students to create a dichotomous key for familiar objects, such as individuals in the class or common fruit. The National Gardening Association suggests that teachers should challenge students to make dichotomous keys for leaves: "Have students collect a variety of leaf types, then describe different characteristics: color, shape, size, margins, texture, vein pattern, and so on, or create a scavenger hunt for leaves with particular characteristics. Consider inviting students to divide a variety of leaves into two piles based on a comparable observable characteristic (for example, hairy versus smooth). You might have young students practice this a number of times using different qualities. This is the first step in creating a dichotomous key in which only two descriptive alternatives are available at each step. Once students have divided leaves by one characteristic, they should take each pile and choose two new alternatives. (For instance, the "hairy leaf" pile might then be divided by type of leaf margin (lead margin serrated/leaf margin smooth). If students select subjective qualities, such as small/large, encourage them to quantify their choices (leaves less than ten centimeters and leaves greater than ten centimeters). Students should continue in this fashion until there is only one leaf left in each category. Once your young taxonomists have create their unique keys, consider using some published guides to identify trees" (from www.kidsgardening.com). (GLE[6]SC2.1)

Photosynthesis: *Energy is transferred within and between organisms through physical and chemical changes, including digestion, growth, respiration, and photosynthesis. Photosynthesis is the process by which plants make their own food (fructose), creating oxygen as a byproduct.*

- In the garden, read *The Magic School Bus Gets Planted: A book about photosynthesis* by Joanna Cole (♣). Have students write an addition to the story based in the school garden.
- Dramatize the process of photosynthesis with "Photosynthesis Theatre" in the school garden: Appoint one student to be a tree; this student stands up straight with outstretched arms. Another student is the sun and stands near the tree and will produce the light that the tree needs. The sun will show this light by yelling "Beam, beam, beam." The tree also needs water to live and several children can represent rain by standing near the tree, hitting their legs loudly and saying

"Pssh, pssh, pssh." Trees need a medium in which to grow and several students can act out the role of the soil by chanting, "Soil, soil, soil, soil, soil, soil, soil." Two students work together to be chlorophyll. One student is designated Chloro while the other is Phyll. Together they chant:

"Chloro-PHYLL! Chloro-PHYLL!
We need carbon! We need carbon!"

Finally, three children represent carbon dioxide. One child is a molecule of carbon while the other two are molecules of oxygen. They sing "C-O-2" repeatedly to the tune of "Hot Crossed Buns." The stage is now set for photosynthesis to occur. Chlorophyll runs over and grabs a carbon from carbon dioxide. The oxygen molecules run around shouting, "We're free! We're free!" which demonstrated the oxygen being released into the atmosphere. The chlorophyll has gained one carbon molecule. This can be repeated four more times in order to obtain the five carbon molecules required to make the fructose sugar molecule. (GLE[6]SC3.1)

Food Webs: *All organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy. Matter and energy are transferred through food webs; the source of energy in every food web is sunlight.*

- Identify the non-human consumers of the plants in the garden. Create a garden food web that includes both human and non-human consumers, including voles, root maggots, moose, and more! (GLE[6]SC3.2)

Sixth Grade Concepts of Earth Science

Geochemical Cycles and the Earth's Forces: Soil: *Soils are formed and composed by forces that shape Earth. Smaller rocks come from the breaking and weathering of larger rocks. Soils have both a mineral and organic component: weathered rocks and minerals combine with plant materials to form soils.*

- Create a class compost container or project. See the composting unit on pages 67-91 for more ideas. (GLE[6]SD2.1)
- Invite a guest speaker from a local landscaping company to speak about the components of soil. (GLE[6]SD2.1)
- Have students bring in a small container of soil from home, a local garden, the forest, etc. Allow students who do not bring in soil to collect soil from the garden. Study these samples and have students answer the following questions (adapted from *Beyond the Bean Seed*):
  - What color is the soil?
  - How does it feel when it is squeezed?
  - What does the soil do when it is squeezed? Does it clump up? Fall apart?
  - Is it mostly clay, sand, or humus? Does it include all three?
  - Is it acid, alkaline, or neutral? Test it with litmus paper. (GLE[6]SD2.1)
- Plant seeds in various soils (i.e., sand, clay, and organic matter). Measure the growth of the plant over one month and graph the results. (GLE[6]SD2.1)

- Listen to "Dirt Made My Lunch" by the Banana Slug Band, written by Steve Van Zandt, 1979. How is dirt responsible for making each of the things – salad, sandwich, and milk – claimed in the song?
- Invite a soil scientist to your class to complete a soil test with your class to identify the minerals found in the schoolyard garden soil. The macronutrients essential to plant growth include: nitrogen, phosphorous, potassium, sulfur, calcium and magnesium. In addition, a trace amount of the following micronutrients is necessary: iron, boron, manganese, copper, zinc, and molybdenum (GLE[6]SD2.1).
- Have students bring in soil samples from home. Add soil samples to a jar of water. Shake the soil and water mixture for one to two minutes and then let the mixture settle overnight. After 24 hours, identify the layers of soil that have settled. For more information, see the Featured Lesson, *Soil Shakes*, on page 42-43 (GLE[6]SD2.1)

Featured Science Lessons

Featured Science Lessons

The following section includes fully developed science-based lessons to compliment lesson prompts presented earlier in the "Teaching Science through Gardening" chapter. Lessons in this section include:

- Correlated GLEs and Standards
- Resources
- Lesson Topic
- Lesson Objectives
- Materials List
- Lesson Procedure

Featured Lesson: *Observing Flowers and Their Parts*

(adapted from *Beyond the Bean Seed*, page 19, and *GrowLab*, pages 125-127)
(GLE[3]SC1.2, GLE[3]SC2.2, GLE[3]SA1.1, GLE[3]SA1.2)

Topic: Flower Parts
Grade Level: Third Grade
Season: Late summer/early fall
Time: *Section A*: 15 – 20 minutes, every day (or every other day) for 2-3 weeks; *Section B*: 30 – 45 minute periods for 2 days
Objective: Students will closely observe and record the life cycle of a single flower in the garden. Students will dissect flowers to identify the major reproductive structures.
Materials: *Section A*: Popsicle sticks or garden markers (one per student or small group); flowers planted in garden (one per student or small group – should be a flower whose flower parts and seeds are easy to see, such as sunflowers, sweet peas, nasturtiums, poppies, zinnias, squash, or pumpkin flowers), journals; *Section B*: One flower in full bloom (one for each student or small group of students), hand lenses, journals, *The Magic School Bus Plants Seeds* by Joanna Cole, diagrams of flower parts

Procedure:

Section A:

1. Though all students have seen a flower in bloom, most have not observed the whole of the process from bud to seed dispersal. Have each student or small group of students choose a single flower bud in the garden. Designate this bud with a popsicle stick or other marker.
2. Have each student visit the flower each day or every other day to sketch and record observations in their journals about the flower. Pay close attention to the area of the flower where seeds are forming.

Section B:

3. After two or three weeks of observation, have students work in small groups to make observations about the changes their flower went through during its development. Play music such as "Waltz of the Flowers" from *The Nutcracker Suite* or "Honeysuckle Rose" by Fats Waller while students are working.
4. Share small group observations with the whole class. Consider these questions with your class: *Can you differentiate different stages in the development of the flower? What is the purpose of a flower? What seems to be happening to the plant? Why do you think flowers smell and look pretty? What did you observe about your flower that might help you to answer these questions?* (Students may be able to conclude that the flower serves some purpose in the formation of seeds, which develop in the ovary of the plant.)
5. At this point, share the basic life cycle of a flowering plant with students. Build on student observations to introduce the correct terminology for flower parts. Explain that pollen must move from the stamen of one flower to the pistil of another in order for seeds to form in the second flower. Read *The Magic School Bus Plants Seeds* by Joanna Cole and/or act out the act of pollination and the role of the flower in attracting pollinators with your student (different students may act – and even dress up – as flower and insects).
6. Have students pick a flower (in full bloom) from a designated area of the garden. Be sure that students choose a flower whose parts are easy to distinguish, such as the types recommended in the "Materials" section of this lesson; the lesson will work well if different students/groups

have different varieties of flowers to observe.

7. Using hand lenses, encourage students to look closely at the flower, to dissect and draw the flower they find, and to label reproductive parts.
8. Discuss:
   - *Which parts were hardest to identify on your flower?*
   - *Which parts were easy to identify?*
   - *Did the same parts look the same on different flowers?*
   - *Why are the petals of many flowers bright and why do flowers often smell sweet?* (Bright colors and sweet smells attract pollinators to visit flowers for nectar, which they eat. In the process of visiting, pollen sticks to their bodies and is transferred to the next flower they visit. The bright color of certain flowers determines what pollinator will visit; for example, bees can see yellows, blues, and purples best, so flowers that are usually pollinated by bees have adapted to be these colors.)
   - *Why might the stigmas of some flowers be sticky?* (The sticky stigma ensures that transferred pollen will stick, so that the flower will be fertilized.)
   - *What might have pollinated your flower?* (Insects, birds, wind; some flowers can self-pollinate!)
   - *How could a person pollinate a flower?* (Some farmers hoping to save seed will transfer pollen from one flower to another in order to ensure that the flower is pollinated by a flower of the same variety. Sometimes they transfer the pollen on a cotton swab!)
   - *What happens when something interferes with the process of a plant moving from flowering stage to seed stage?* (It may not produce seeds.)
9. Extensions (from *GrowLab*):
   - Soak a few whole cloves in water overnight. Try to identify the parts of these dried flower buds.
   - Have an outdoor "flower hunt." Give pairs of students cards with directions such as "Find a flower that: has pistils and stamens that are hard to find; smells sweet; has loose pollen; has no petals; is on its way to becoming fruit."
   - Have pairs of students group flowers in different categories, e.g., by color, smell, or shape. Challenge other students to guess what factor was used to distinguish each group.
   - Compare some flowers that are wind pollinated with those pollinated by birds or insects.
   - Make models of flowers using classroom materials (such as clay, tissue paper, and pipe cleaners) to simulate different parts.
   - Have a snack of flowers including cauliflower, nasturtiums, and chive flowers.
   - Collect poetry and music that refer to flowers. Identify which attributes are being described. Discuss how these flower characteristics please us and how they help the flower.
   - Play flower charades, acting out flower part names.
   - Press different types of flowers or parts between newspapers weighted with books. Mount on paper, tagboard, or index cards with clear contact paper. Use as wall hangings, placemats, or cards.

Featured Lesson: *The Great Seed Rescue*
(adapted from *Digging Deeper*, pages 72 – 73 and
Calypso's Ecological Gardening Workshop "Seed Saving")
(GLE[3]SC2.2)

Topic: Seed Saving
Grade Level: Third Grade
Season: Fall
Time: One class period
Objective: Students will identify the external reproductive features of plants in collecting seeds from several types of plants.
Materials: garden vegetables, jars or envelopes, labels, markers
Procedure:

1. Observe plants throughout the season. Select the strongest, healthiest, and most prolific plants. Mark them with a brightly colored ribbon or tag. You must use plants from open-pollinated (rather than hybrid) seed to yield "true" varieties. Please see "A Note for Teachers" on the next page for more information regarding the distinction between hybrid and open-pollinated seeds.
2. Allow several fruits from your chosen plants to ripen fully on the vine, stalk, or in the ground to enable the seeds to mature. Harvest when ripe.
   a. *Saving Pea Seed*: Select good quality, large pods. Do not pick the pods; allow them to dry on the vine. Once dried, harvest and crack open the pods. Inside, you will find round little balls. These are the seeds. Place seeds on newspaper in a warm (not hot), dry, dark place, and allow to dry. Store in an airtight container (like a film canister or a seed packet in a jar with silica) in a cool, dark place. Label the jars with the name of the plant, the variety, and date.
   b. *Saving Zucchini Seed*: Wait until the zucchini is fully ripened. Smash open ripe fruit with an ax or shovel; be careful that the squash does not roll out from under the squashing implement. Gather seeds and separate from the flesh of the zucchini. Rinse the seeds in a colander under water. Rub the seeds on a wire strainer to remove any flesh. Place the seeds on newspaper in a warm (not hot), dry, dark place, and allow to dry. Store in an airtight container (like a film canister or a seed packet in a jar with silica) in a cool, dark place. Label the jars with the name of the plant, the variety, and date.
   c. *Saving Calendula, Poppies, and Nasturtium Seed*: After a flower is pollinated, seeds will develop in the ovary, at the base of the flower. Given relatively dry weather, these seeds will dry almost to the point of falling off. Poppy seeds will dry inside of the seed pod, which is ready for harvest when the seeds dryly rattle around inside of the pod. Shake poppy seeds out of the pod and into a container. Harvest calendula and nasturtium seeds by picking the dried seeds off of the flower base; both of these seeds have a strange appearance (calendula seeds resemble dragons and nasturtiums look like caterpillars) and are fun to draw or write about. Store in an airtight container (like a film canister or a seed packet in a jar with silica) in a cool, dark place. Label the jars with the name of the plant, the variety, and date.
   d. *Saving Garlic Cloves*: Harvest garlic cloves when most of the leaf has turned brown (usually in late August). Separate the cloves from

the bulb (there is no need to peel). Save cloves in a paper bag until planting. Do not save in an airtight container. A few weeks after the first frost in the fall, plant the cloves about two inches deep in loose soil (with a light layer of compost) with the pointed end up.

3. Extensions
   a. *Create a Seed Bank*: Create a school seed bank, whereby students save seed each year to be planted in the school garden during the next growing season.
   b. *Seeds for Sale*: Package seeds to sell to local gardeners and families as a fundraiser for the school garden.
   c. Please see page 61 for mathematics activities related to seed saving and for a list of seed saving resources available at Calypso.
   d. Watch the video *The Magic School Bus Goes to Seed* (•). Can students add to the story based on their own experiences in the school garden?

A Note for Teachers: Open-Pollinated and Hybrid Seeds

A **hybrid** plant is a cross between two different varieties of the same species. The seeds produced by hybrid plants will not produce viable offspring true to the parent (hybrid) plant. For example, a grower for a seed company might pollinate a large-headed broccoli with the pollen from a long-season broccoli. The seeds produced by the pollinated broccoli would be hybrid seeds. Their offspring would (hopefully!) grow into large-headed, long-season broccoli. The seeds of these large-headed, long-season broccoli *would not* reliably produce large-headed, long-season broccoli.

An **open-pollinated** plant is a non-hybrid variety, one whose seed will produce a plant of the same variety as the parent.

Seed catalogues and seed packets list information about whether the seeds are hybrid or open-pollinated. Only save seed from open-pollinated plants for reliable outcomes!

Featured Lesson: *Plant of the Week Journal*

(adapted from *Beyond the Bean Seed*, page 3)
(GLE[3]SA1.1, GLE[3]SA1.2, GLE[3]SA2.1, GLE[3]SC1.1, GLE[3]SC2.1)

Topic: Physical characteristics of plants
Grade Level: Third Grade
Season: Year-Round
Time: 15 – 30 minutes every week/month
Objective: Students will observe and compare the external features of unusual garden and potted plants.
Materials: One plant each week, Plant of the Week journals, plant resources
Procedure:

1. Create a Plant of the Week (or Plant of the Month) journal with your class. Each student could have their own journal or the class could maintain one journal together; in the latter case, a different student or small group could be in charge of entering the information about the featured plant each week.
2. Throughout the school year, focus on studying one plant each week, using unusual or rare plants to increase students interest in the project. Consider using plants such as broccoli romanesco, desert cacti, carnivorous plants, and plants with a strong taste or unusual color (like purple cauliflower); if the plant is edible, be sure to allow all students an opportunity to taste test the featured plant. Start the school year by featuring a plant from the school garden to study. Continue the project throughout the year with indoor plants. Feature seedlings planted in the classroom in spring. Plants can be borrowed from parents, community members, garden centers, garden clubs, horticultural organizations, florists, or local gardeners.
3. Develop a list of questions with your class that you will discuss and enter in the Plant of the Week journal each week. Questions might include the following:
    a. What do we already know about this plant?
    b. What do we want to know?
    c. What is the geographic origin of this plant?
    d. What traits does this plant possess that help it survive as a species?
    e. How could this plant be classified?
    f. What features of this plant help it to grow, survive, and reproduce?
    g. What type of animals eat this plant?
    h. What is its native habitat?
    i. Are stories, legends, or folklore associated with this plant?
    j. Are there literary references or allusions to this plant?
    k. Are poems, music, or dances associated with this plant?

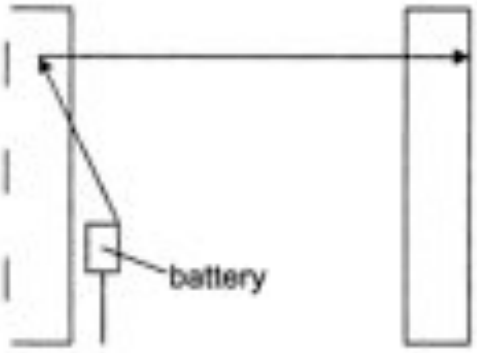
    Discuss these and other questions about the featured plant each week, utilizing reference materials when necessary.
4. Record information, pictures of students with the plants, and illustrations in the Plant of the Week journal. The librarian or media specialist at your school, UAF Botanical Gardens, Calypso Farm and Ecology Center, and local garden centers and gardeners may be able to provide reference materials to your class.
5. For inspiration and information, *Beyond the Bean Seed* recommends the book *Flowers for You: Blooms for Every Month* by Anita Holmes (♣), which features one potted plant for each month of the year and relates "plant parts, environmental needs, and instructions for caring for the plants . . . [including] a chart [that] shows plants, blooming seasons, such environmental needs as lights, temperature, and humidity, and finally comments regarding care" (Jurenka, 3).

Featured Lesson: *Moose Fence Design*

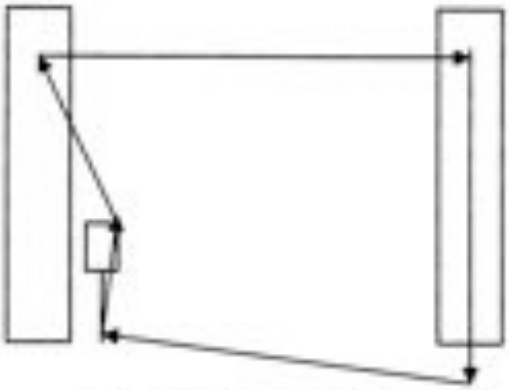
(GLE[3]SB2.1)

Topic: Electricity, conductors and insulators
Grade Level: Third Grade
Season: Fall, Winter, Spring, or Summer
Time: 45 minutes
Objective: Students will create a simple circuit and assess the conductive properties of various materials in order to make a recommendation for a moose fence design.
Materials: For each group: light bulb, wire, battery, switch, test materials (wood, plastic, aluminum, steel, copper, paper), paper and pencil
Procedure:

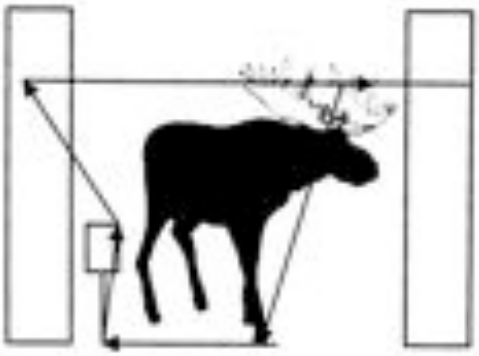
1. Present the following scenario to your class: A moose has repeatedly broken into the school garden by tearing down the fence. Studies have shown that if a moose receives a slight electric shock as it attempts to walk through a fence, it will back off and leave the fenced area alone. The shock startles the moose, but does not hurt it substantially. Your school has decided to install a single electric line above the garden fence that will act to startle the invading moose. See the diagram below of the circuit created by the fence. The moose acts as a switch, making the circuit complete. In order for the electric fence to function, the circuit must be open until the moose's touch creates a complete circuit. In small groups, your students will work to decide what materials the fence poles should be made of. If the fence poles are a material that conducts electricity, the circuit will be complete and electricity will be constantly flowing through it. Thus, students will recommend an insulating material for the fence posts.
2. Design an experiment for your class to be completed in small groups. Groups will create a circuit with a switch. A light bulb will light up if the circuit is complete. Provide a variety of materials (wood, plastic, aluminum, steel, copper, paper) and allow groups to test these materials to determine if they are conductors or insulators.
3. Have groups write a recommendation of the material they believe would be best for fence posts. Share recommendations with the class.



Electric line between two poles: No electricity is running because the circuit (shown with arrows) is incomplete. The poles are insulated with plastic or ceramic, which do not conduct electricity.



Electric line between two poles: Electricity is flowing because the circuit (shown with arrows) is complete. The poles are made from a material that conducts electricity.



Electric line with moose acting as switch: By touching the electric line, the moose completes the circuit, allowing electricity to run down to the ground and back to the battery pole. Shocking!

A Note for the Teacher: Moose Fences

One of the peskiest of garden pests in Alaska is the moose, which can eat an entire garden in very little time. Moose have been known to jump over the seven foot electrified moose fence at Calypso Farm and Ecology Center in order to munch a few broccoli heads or brussel sprouts!

Featured Lesson: *Investigating Animals in Soil*
(adapted from *Alaska's Ecology: Alaska Wildlife Curriculum Teacher's Guide*)
(GLE[4]SC1.1)

Topic: Physical characteristics of soil-dwelling animals
Grade Level: Fourth grade
Season: Spring or Fall
Time: One to two class periods
Objectives: Students will describe signs of animal activity in the soil and will describe some of the animals found in soil.
Materials: For each group: one coffee can with holes in the bottom, plastic bag, paper and pencil, tray, and microscope/hands lens (if available), funnel, collection container
Procedure:

1. In advance, mark one square foot areas of the garden with a small flag or other marker that are appropriate for digging. Avoid areas where digging would disturb plant roots. Mark enough areas so that each group of four students will have their own place to dig.
2. While in the classroom, list the name of animals that are very small and not often seen by humans. (*voles, shrews, insects, earthworms, etc.*)
3. Discuss why some animals would be well adapted to spend most of their time underground, living on other animals and nutrients in the soil. Explain that this underground environment serves as a safe place for smaller animals to live.
4. Explain that students are going to become scientists and search for animals living underground in the garden. A healthy soil is full of many living organisms, so we hope to find many living things in our soil.
5. Divide students into groups of four students. Assign a Head Scientist, Mapmaker, Recorder, and Materials Manager for each group. Distribute materials.
6. Explain the procedure. Go outside and direct groups to their designated area.
7. The Head Scientist will oversee the procedure, making sure that all scientists are on task with their work.
8. The Materials Manager is in charge of all materials for the project. He/she will check out materials from the teacher, clean up any materials left in the experiment area outside, and be responsible for returning all materials to the classroom.
9. The Mapmaker will draw a map of the group's designated area, noting any special features, identifying nearby plants, and sketching any structures (like garden box walls).
10. On this map, the Recorder will write down any surface evidence of animals.
11. One member of each group will press the open end of the coffee can into the ground until the can is at least half buried. After turning the can right side up, the group will dig out the soil marked by where the can was, filling the can half full.
12. The group should place their half-filled can into a plastic bag (because the can has holes in the bottom) and carry it back to the classroom.
13. Back in the classroom, each group will spread their soil on their tray and sort through it, looking for animals, larva, or other evidence of life in the soil. Use microscopes and hand lenses (if available). All members of the group should draw pictures of any living things they can find. Can students identify any of these organisms? With a fresh soil sample, create a Berlyse funnel like the one pictured here,

which is simply a funnel of soil sitting in a collection container. Leave the funnel under a bright light for the entire night. What do students think will happen? By the morning, many of the organisms within the soil will have moved away from the light and fallen into the collection bottle. Do any of these organisms look similar to those observed in the previous day's experiment?

14. Evaluation: Complete drawings and identification of animals found in local soil. Have students write a story that describes the life of an underground-dwelling organism.
15. Wrap-up discussion: What adaptations might a small organism living underground have? (*antennae to feel way underground, specialized body parts for digging*)

Featured Lesson: *Soil Shakes*
(adapted from *Project Seasons*)
(GLE[6]SD2.1)

Topic: Components of Soil
Grade Level: Sixth Grade
Season: Fall, Winter, Spring, or Summer
Time: 30 minutes for initial activity, 15 minutes for later observation
Objective: Students will learn that soil is composed of different sized particles and how these particles influence water drainage and retention.
Materials: student soil samples; sample bags of sand, silt, and clay; paper bags; large piece of paper for particle size chart; paper cut-outs the size of basketballs, baseballs, and small confetti dots (one each per student); clear quart jars with tight fitting lids; coffee filters; funnels
Procedure:

1. Ask students to bring in soil samples (approximately two cups) from home. Collect soil from the school garden or schoolyard. Have students compare the different soils based on physical appearance and texture. Explain to the class that soil is a composition of organic materials and mineral soils of three main particle sizes.
2. Set up the sample bag of sand, silt, and clay in a central location in the room, with an empty paper bag next to each sample. Explain to the students that in three of the bags are soil samples of the three main particle sizes. Show the students a chart listing only the particle sizes (you will add more information as the activity progresses). Pass out one of each of the circular cut-outs to each student. Explain that these represent the three particle sizes and show the relative different in sizes between the particles. Ask the students to feel to soil samples without looking in the bags and to place the cut-out that matches its relative size in the paper bag next to that sample.
3. Review the cut-outs placed in each bag, and then reveal the sample, from largest to smallest. Ask students to identify the first sample with the largest particles by name (Sand). Review the particle size chart and add the name next to the size listing. Use the paper cut-outs as a visual aid to show how the different particles would fit together. Note the amount of large air space between the sand particles indicating rapid drainage and the inability to hold much water or nutrients. How do the silt particles differ? (They have medium air spaces, moderate to poor drainage, and can hold some water). Last, look at the clay. The particles are so fine that often water is unable to penetrate into the clay; clay soils are known for their poor drainage.
4. Explain that most soils are a combination of these particle sizes. *Why is each component important to growing plants?*
   - Sand has a lighter soil texture for root penetration. However, it does not provide adequate water-holding capacity for most growing plants.
   - Silt has a lighter soil texture for root penetration, but lacks adequate drainage.
   - Clay holds nutrients and water, but is difficult to work with and, alone, does not provide for adequate drainage.
   - None of these mineral components alone contains adequate nutrients for growing plants.
5. *Besides small pieces of rock, what is soil made up of?* (decaying sticks, leaves, logs, animal waste, etc.) Write student answers on the board. *All the small pieces of living things are called organic matter. Why would organic*

matter be important in soil? (Organic matter contains important recycled nutrients)

6. Introduce the term **loam**, which is a mixed proportion of all of these components. A good loam has a nice, light texture and good water and nutrient holding capacity.
7. Review: *What is the importance of soil?* (root foundation, water holding, nutrients-plant food, home to many organisms, etc.)
8. Different types of soil are classified based on their percentages of the three mineral components (sand, silt, and clay). Some soils are better than others for gardening. Over time, the texture and composition of all soils can be altered by adding differing amounts of sand, silt, or clay, plus compost and other organic materials.
9. Explain that they will determine the composition of their soil sample from home by using the "soil shake" method. Soil is added to a container of water. Then the mixture is shaken to disperse the particles. How would they predict the three particles to settle? (The particles separate by size and weight, and distinct layers can be observed when the soil completely settles). Which particle type would settle first? Second? Last? (Sand settles first, then silt, and lastly clay).
10. Divide the class into pairs and have each pair fill a quart jar 2/3 full with water. Have them add their soil to the jar until it is almost full and screw the lid on tightly. Student should shake their soil for 1-2 minutes until the soil is well dispersed and the solution looks like a rich chocolate soil shake. Have them set the jar in a level place and not disturb it for 24 hours. Ask the students to predict which component will make up the greatest percentage of their soil sample.
11. After 24 hours, have the students observe and measure the layers. Can they determine which layer is sand, which is silt, and which is clay? Which layer is largest? In the Fairbanks area, students may find that soil are primarily composed of silt and (depending on where it was collected from) organic matter. We have little to no clay in the Fairbanks area, though loess (a glacier and wind-sifted silt) is abundant. Students can draw a scaled representation of their soil sample, labeling each layer.

SOIL PARTICLE SIZE CHART
In millimeters diameter

Clay	**<.002**
Sand	**.05-2.0**
Silt	**.005 - .05**
Gravel	**>2.0**

Source: U.S. Department of Agriculture, 1984

Teaching English/ Language Arts through Gardening

Teaching English/Language Arts through Gardening

As a unique outdoor classroom, the school garden may be used to augment and encourage reading and writing studies. While many of the activities in this chapter could be done just as easily indoors and out, the garden has the potential to greatly enhance and inspire your students' reading and writing, as the natural world comes out to join in the stories. For example, the garden may be used:

- For individual or small group reading time
- For writing time
- As a setting for performances and group presentations
- For class discussions
- As a source of inspiration for creative and descriptive writing
- As a topic around which to focus many kinds of Language Arts lessons

How This Chapter Is Organized

The "Teaching English/Language Arts through Gardening" chapter is divided into three sections:

1. *Children's Literature in the Garden*: Many children's literature books include gardens and growing as themes. These books can serve to both introduce language arts and gardening concepts. The natural setting of the garden is ideal for reading and exploring themes introduced in these books.
2. *Poetry in the Garden*: Because time in the garden often ignites the imaginations of students, these activities encourage exploration and observation through creative writing.
3. *Growing Readers and Writers in the Garden*: Additional garden-based language arts activities from a variety of resources are compiled in this section.

Activities in this chapter are not divided by grade level because activities may be adapted to a class or student's individual level.

When using the garden for English/Language Arts, ensure that students are comfortable in the garden setting. Consider including the following materials in your planning, especially if students will be sitting in the garden for a period of time:

- Journal
- Extra layers
- Seats, towels, or tarps
- A hard surface to write on
- Bug and sun protection

Look for opportunities to publish student work related to the garden. Articles, poetry, and stories may be published in the following places:

- The school newsletter
- The *Fairbanks Daily News-Miner*
- The school website
- The *Ester Republic*
- A class book kept in the school library
- The Calypso Farm and Ecology Center bi-annual newsletter
- University of Alaska Fairbanks Cooperative Extension publications
- The Calypso Farm and Ecology Center website

One of the most well-developed collections of garden-based children's literature and language arts activities is the teacher's guide *Beyond the Bean Seed: Gardening Activities for Grades K-6*. This book contains a gardening activity, language arts activity, creative activity, poem, treat recipe, and word play for each children's book featured. The book also contains a comprehensive annotated bibliography of garden-based children's literature. Some of the books and activities introduced in this resource are included within *The Living Classroom Manual*; however, the complete book would be an invaluable resource for any school.

Children's Literature
in the Garden

Children's Literature in the Garden

A Note on Book Availability

All of the books mentioned in *The Living Classroom Manual* can be obtained via inter-library loan through the Fairbanks North Star Borough library system. Additional garden-themed books are available at all branches of the public library system. Throughout *Living Classroom Manual*, books that are available locally are marked as follows:

♥ = available at the University Park Elementary School library
♣ = available at Noel Wien public library
♦ = available at North Pole public library
▲ = available at the University of Alaska Fairbanks library
• = available from one of the middle or high schools in the Fairbanks North Star Borough School District; please check with your school librarian for availability

The following collection of book titles and literature-based activities is adapted from the National Gardening Association's website (www.kidsgardening.com).

Primary Grades (Kindergarten – 3)

City Green (Anne DiSalvo-Ryan) ♣♦

Marcy watches as an abandoned building is torn down. She is saddened by the empty space, and by her neighbor's bitterness over the loss of his old home. In the spring, Marcy begins a quest to transform the ugly, littered lot. By summertime both the sunflowers and a new friendship are flourishing. The last page explains how to start a neighborhood community garden.

Cucumber Song (Vickie Leigh Krudwig)

All the insects in the garden, from ten little black ants down to one tiny flea, get involved in moving a fallen cucumber. Don't miss the delicious recipe for cucumber soup and factual information about insects.

Jack and the Beanstalk ♥♣♦▲ - available in video and book form in multiple versions

The traditional tale of Jack climbing the magical beanstalk in his backyard can provide inspiration for classroom explorations. Connecting Activities include:

- Researching the nitrogen-fixing ability of beans.
- Sorting different types of beans.
- Planting beans, inside and outside. Keep a journal of plant growth, including anecdotal information and measurements.
- Researching cultures where beans are a staple food. Study traditional foods in other cultures; learn additional information about these cultures such as food preparation practices, home lives, and geography. Have groups of students rewrite *Jack and the Beanstalk* to be about a different

culture, maintaining the story concept (the relationship between the boy and the giant) but replacing the details of the story to reflect another culture. Create a class book with these revised stories and present them to parents or other students.

Sunflower Sal (Janet S. Anderson)

Sal longs to make a quilt but she feels clumsy, and her hands just can't sew those tiny stitches. She finds solace -- and success -- in growing sunflowers, hundreds of them throughout her village, lining roads and fields.

- Connecting Activity: Plant sunflowers in the school garden in spring. In the fall, harvest the seeds from the sunflowers to plant next year.

The Maybe Garden (Kimberly Burke-Weiner)

A charming story in which a little girl envisions a garden of her dreams. It is nothing like the immaculate garden her mother enjoys. It offers a gentle treatment of important themes about individual identity and the creative aspect of planning a garden.

- Connecting Activity: Read this book before beginning the garden planning process to encourage students to envision their own idea of a perfect garden.

Intermediate Grades (4-6)

Seedfolks (Paul Fleischman) ♥♣♦•

One by one, 13 people of varying ages and ethnic backgrounds transform a trash-filled inner-city lot into a productive and beautiful garden. In doing so, the gardeners are themselves transformed.

Where the Lilies Bloom (Vera and Bill Cleaver) ♣♦•

This is a story of a family of children who, after their father's death, take up gathering and selling medicinal herbs to pharmacies. They meet many challenges in the harshness of the Smoky Mountains.

My Side of the Mountain (Jean Craighead George) ♥♣♦♣•

A young boy runs away to the mountains where he spends a year living on wild plants and learning about wilderness, and himself. A coming-of-age novel that can inspire an appreciation of nature and even an interest in edible plants.

The National Gardening Association also recommends:

- *A Child's Book of Flowers* (Janet Marsh)
- *Allison's Zinnia* (Anita Lobel)
- *Eating the Alphabet* (Lois Ehlert) ♣
- *Garden Wizardry for Kids* (Patricia Kite)
- *Growing Vegetable Soup* (Lois Ehlert)♣•
- *Lore and Legends of Flowers* (Anne Ophelia Dowden) ♣♦
- *Linnea in Monet's Garden* (♥♣♣•) and *Linnea's Windowsill Garden* (♥♣♦♣) (Christina Bjork, Lena Anderson)
- *Play with Your Food* (Joose Eiffers)
- *Pumpkin, Pumpkin* (Jean Titherington) ♥♣
- *Rosy's Garden: A Child's Keepsake of Flowers* (Elizabeth Laird) ♣♦
- *The Butterfly* (Judith Levicoff)
- *The Lotus Seed* (Sherry Garland)♥♣♦
- *The Tale of Peter Rabbit* (Beatrix Potter) ♥♣♦♣•

Books referenced in other sections of *The Living Classroom Manual* include:

- *A Flower Grows* (Ken Robbins)
- *An Apple a Day: From Orchard to You* (Dorothy Hinshaw) ♣♦
- *Andy Goldsworthy: A Collaboration with Nature* (Andy Goldsworthy) •
- *Alejandro's Gift* (Richard E. Albert)
- *Cloudy with a Chance of Meatballs* (Judi Barrett) ♣
- *Compost, By Gosh!* (Michelle Eva Portman)
- *Discovering Wild Plants: Alaska, Western Canada, the Northwest* (Janice J. Schofield) ♣♦•
- *Feathers for Lunch* (Lois Ehlert) ♣
- *Flowers for You: Blooms for Every Month* (Anita Holmes) ♣
- *Frog and Toad Together* (Arnold Lobel) ♥ ♣
- *Growing Wild* (Constance Perenyi)
- *Hand to Earth: Andy Goldsworthy Sculpture, 1976-1990* •
- *How a Seed Grows* (Helene Jordan)♣♦♣
- *How Seeds Travel* (Cynthia Overbeck) ♥♣♦•
- *Life in the Cold* (Peter Marchand) ♣
- *Miss Rumphius* (Barbara Cooney)♥♣♦
- *Morning Glory* (Sylvia Johnson)
- *Plant Families* (Carol Lerner) ♥♣•
- *Planting a Rainbow* (Lois Ehlert) ♥♣
- *Rivers and Tides: Andy Goldsworthy Working with Time* (DVD) ♣
- *Seeds* (George Shannon)
- *Seeds: Pop, Stick, Glide* (Patricia Lauber) ♣♦
- *Terrariums* (Alice Parker)
- *The Butterfly Garden* (Jerry Sendenko)
- *The Carrot Seed* (Ruth Krauss) ♥♣♦
- *The Clover and the Bee: A Book of Pollination* (Anne Ophelia Dowden)♣♦ •
- *The Giant Cabbage* (Cherie Stihler)♣♦
- *The Gumdrop Tree* (Elizabeth Spurr)
- *The Magic School Bus Gets Planted: A book about photosynthesis* (Joanna Cole)♣
- *The Magic School Bus Goes to Seed* (video)♦
- *The Magic School Bus Meets the Rot Squad: A book about decomposition* (Joanna Cole)♣
- *The Magic School Bus Plants Seeds* (Joanna Cole)
- *The Plant Sitter* (Gene Zion) ♥♣♣
- *The Reason for a Flower* (Ruth Heller)♦
- *The Tenth Good Thing About Barney* (Judith Viorst) ♥♣♦♣•
- *The Tiny Seed* (Eric Carle) ♥♣♦
- *Tops and Bottoms* (Janet Stevens)
- *What Happens to a Hamburger* (Paul Showers) ♥♣♦
- *Where the Sidewalk Ends* (Shel Silverstein) ♥♣♦•

Poetry in the Garden

Poetry in the Garden

Many of the following poetry ideas were borrowed and adapted from a workshop presented by two U.S. Fish and Wildlife Service employees, Mary Timm (Tok) and Laurel Devaney (Fairbanks) at the 2006 Alaska Natural Resources and Outdoor Education Association (ANROE) conference. These garden-based poetry ideas are most suitable for third graders and above, though many can be adapted to younger grades, particularly if the poem is written collaboratively by the class.

General Guidelines to Keep in Mind When Writing Poetry:

- Take risks! Something that may sound odd in prose may be exactly right in a poem.
- Read your poetry out loud through all stages of your writing and editing.
- Ask people to give you critical comments in the form of questions rather than suggestions. Suggestions often sound like negative criticism.
- When composing a poem, write down all your thoughts, rather than pre-editing them.
- Remember, the sound of the poem is integral to the content. It is generally far easier to hear a poem aloud than to hear poetry held in your mind.
- Scan your poem for the strongest opening line. Your best opening verse may be half or three-quarters of the way down the page. Then order and rewrite your other verses.
- Read your poem both silently and aloud. Watch for "Glitches," or feeling inside you that something is wrong. Check these words and phrases. That feeling or hunch may signal that you have made mechanical errors or that you are not completely satisfied with your wording. Go back and pay attention to these verses.
- Poetry does not have to rhyme! Many wonderful poems do rhyme, but do not feel limited to rhyming in writing poetry.

Metaphor- and Simile-Based Poetry

Metaphor: the comparison of two unrelated nouns (persons, places, or things)
Simile: the comparison of two unrelated nouns (persons, places, or things) using "like" or "as" to bridge the connection.

1. First, write a metaphor or simile by comparing one noun to another unrelated noun. For example, "The rows of zucchini sat like students in a classroom." Write the metaphor or simile about one of the following topics or brainstorm your own.
   - The garden
   - Garden beds
   - Tools
   - The sun
   - The water cycle
   - Rows of vegetables

2. Then, answer these questions about your comparison: Who? What? Where? When? Why? How? Sometimes, this short brainstorm may be enough to inspire a loose poem like the following:

> The row of zucchini sat like students in a classroom
> Staring at an impossible math problem as confounding as the sun.
> Some were blinded by the difficulty of the multiplication
> And hid behind hands like prickly zucchini leaves.
> Others rolled out slowly from the shade,
> Raising their hands to answer the problem,
> Amazed at their own brilliance.

3. You may also extend your comparison for additional inspiration. For example, using the metaphor "Friendships are nasturtiums," list characteristics of the second noun: nasturtiums are bright, spicy, and cheerful. Extend this metaphor into a poem:

> Friendships are nasturtiums
> Bright and cheerful, they make me smile.
> Surprisingly spicy, one experience makes my whole day better.

4. Use the following poem structure for more simile practice. Fill in the blank lines by completing the phrase about something in the garden. For example: "The flower bud expands like a balloon being inflated." Expand these similes to create a poem.
   - _____ feels like _____.
   - _____ expands like _____.
   - _____ whispers like _____.
   - _____ dreams like _____.
   - _____ scatters like _____.
   - _____ turns like _____.
   - _____ yells like _____.
   - _____ moves like _____.
   - _____ opens like _____.
   - _____ waits like _____.
   - _____ streams like _____.
   - _____ rolls like _____.
   - _____ blooms like _____.
   - _____ dashes like _____.
   - _____ dances like _____.

Personification Poetry

Personification is the assigning of human traits to things, colors, qualities, and ideas. Personification allows you to add a human dimension to any object, color, quality, or idea. Ways to write personification include:

1. Using verbs that name human actions. Write a human action next to each object below. Then expand some by answering one of the following questions: Who? What? When? Where? Why? How? For example: "The sun blinked (why?) in surprise at the sight of the garden's new growth."

- The stream _____.
- The chickadee _____.
- The earthworms _____.
- The soil _____.
- The garden hose _____.
- The peas _____.

2. Writing with adjectives that generally are used to describe people. Write the name of an object next to the adjectives listed below. Then expand the expression by answering one of the following questions: Who? What? When? Where? Why? How? For example: "Loving leaves (what?) shade growing zucchini from the harsh rays of the sun."
   - Thoughtful _____.
   - Mean_____.
   - Caring _____.
   - Honest _____.
   - Sulky _____.

3. Referring to objects, ideas, qualities, and color using personal pronouns. For example, "When I passed by the apple tree, *she* kindly whispered "Good day!"

4. Giving things human body parts, such as: "The sunflowers raised their proud *faces* in the air, displaying golden *hair* and freckled *noses*."

5. Constructing a complete personality for an object by discussing its friends, home, or job. To do this, choose a thing to personify, such as the soil. Now, give the thing you chose a personality by providing some more information about it. Describe, for example:
   - Where it lives
   - Its favorite colors, clothes, food, and holidays
   - Its job and hobbies
   - Its friends and relatives
   - Where it goes on vacation
   - Its memories and emotions
   - Its dreams and desires
   - Problems it has
   - The way it moves

   A finished poem might look like this:

Spring
The garden sleeps through the winter,
Dreaming of sunny autumn days, of harvests, and children.
It misses its little friends:
Little decomposers
Little pollinators
Little kindergarteners.
The garden moves slowly upon waking,
Stretching its tired muscles free of the weight of so much snow.
And it smiles.

The "I Am" Poem

Fill in the following blanks to describe an animal, plant, thing, place, or quality.

I AM _____.

I am . . . (same line as title)
I wonder . . .
I hear . . .
I see . . .
I want . . .
I am . . . (same line as title)
I pretend . . .
I feel . . .
I touch . . .
I worry . . .
I cry . . .
I am . . . (same line as title)
I understand . . .
I say . . .
I dream . . .
I try . . .
I hope . . .
I am . . . (same line as title)

The Biopoem

Line 1 First name of person (or vegetable, insect, etc!)
Line 2 Four traits which describe the character
Line 3 Relative (brother, sister, wife, husband, etc.) of _____
Line 4 Lover of _____ (three things or people)
Line 5 Who feels _____ (three items/qualities)
Line 6 Who needs _____ (three items/qualities)
Line 7 Who fears _____ (three items/qualities)
Line 8 Who gives _____ (three items/qualities)
Line 9 Who would like to see _____ (three items)
Line 10 Resident of _____ (place)
Line 11 Last name of person or renaming of person

For example:

Cabbage
Leafy, lovely, hearty, healthy
Relative of broccoli and kohlrabi
Lover of full sun, moist soil, and happy farmers
Who feels quiet, round, and full
Who needs TLC, regular watering, and respect
Who fears root maggots, early frosts, and drought
Who gives goodness to soup, stir fries, and sauerkraut
Who would like to see more compost, gardens, and flowers
Resident of Calypso Farm and Ecology Center's upper field
Cabbage

Haiku

A haiku is a Japanese form of poetry with three lines. The first and third lines have five syllables and the middle line has seven. For example:

> Moose jump six feet high
> Over garden fences to
> A feast of veggies

Cinquain

The cinquain is five lines long and followings this form:

A noun
Two verbs
Three adjectives
A phrase
Renaming noun

> Kohlrabi
> Growing, stretching
> Green, fleshy, sweet
> Looks like an alien aircraft
> Kohlrabi

5-4-3-2-1

Each student should find a quiet spot in the garden and write down:
Five things she sees
Four things she hears
Three things she smells
Two things she feels
One things she is
Read aloud, these observations and thoughts have the potential to be breathtaking poetry!

Other things to try in your poems:

- **Alliteration** is the same beginning consonant sound in two or more words close together. The rhythmic quality of alliteration engages the ear and often shows us the humor in language. For example: "The garden greets the green of returning lovage leaves, blooming broccoli, and delicious dill."
- **Onomatopoeia** is the formation of words that sound like or suggest the objects or actions being names. They often engage the ear and stress the important of expressive sounds. For example: "Water *hisses* from the garden hose and ripened peas *pop* from their pods."
- **Repetition** in poetry works in a similar way. Poets often repeat words or phrases to establish rhythms and structure in their poetry.
- **Inquiry** can be the foundation for a poem. For example: "I asked the sun, "Why do you shine so brightly in summer? And she said . . ."

Growing Readers and
Writers in the Garden

Growing Readers and Writers in the Garden

This section includes additional garden-based language arts activities from a variety of resources.

- Research the history and use of specific vegetables. Students can write research papers or create brightly illustrated identification signs for the crops in the garden that include fun facts about the vegetables. Calypso Farm and Ecology Center has a few excellent resources for researching the history of specific vegetables including:
    - *The Visual Food Encyclopedia: The Definitive Practical Guide to Food and Cooking* (published by Macmillan)
    - *World Vegetables: Principles, Production, and Nutritive Values*, Second Edition (by Vincent E. Rubatzky and Mas Yumaguchi)
- Tell "circle stories" with your class in the garden. Gather students in a circle. Explain the concept of a circle story: the teacher will begin the story and then say, "Pop!" The student to the teacher's right will continue creating the story where the facilitator left off, adding a phrase or sentence to the story and then saying, "Pop!" The story will continue to develop as it is passed from one person to another, each individual in the circle adding to the narrative. Begin the story with a garden-related prompt, such as: "Once upon a time, there were three sister seeds in the forest. One of these seeds floated away down a forest stream, one blew far away on the wind, and one dropped right to the feet of its mother plant . . . Pop!" After the story, students may scatter in the garden or return to the classroom to record their class story and make revisions, or to write their own story from the prompt used in the circle story.
- The garden is an ideal natural setting to inspire rough drafts of creative writing stories. When writing in the garden, be sure to provide a hard surface for students to write on and to allow students the opportunity to find their own position of comfort in the garden area. Creative writing topics could include:
    - Stories from the perspective of vegetables: "Being a carrot is hard work. It is dark and moist here in soil, and pushing my roots through all this dirt is exhausting!"
    - Stories from the perspectives of different senses: "Morning in the garden smells like rain, all musty and sweet. As the sun heats up the day, the smell of sweet peas is a perfume strong enough to make me sneeze."
    - Progressive stories: Divide students into pairs. Each student will make observations about a single plant in the garden and incorporate these observations into the introduction to a story. The following day, the pair will trade stories and each will add to the story he/she is given. Each day, students will trade stories with their partner and spend time in the garden

adding a segment to their stories. By the end of the week, the pair will have co-authored two books together.

- As a class, create a list of descriptive words and similes that might help students in making observations about plants in the garden. For example, instead of "big," a cabbage may be gigantic, humongous, breath-taking, awe-inspiring, as big as a moose, and heavy as the school building.
- By maintaining a "Garden Journal," students can have a single record of plant and garden observations and creative writing inspired by the garden.
- Have students uncover plant stories by becoming ethnobotanical interviewers. They can question parents, grandparents, and community elders about changes in foods eaten or plants grown over their lifetimes, plant or food folklore, or memories of plants used for celebrations. Students can then share these stories through writings, drawings, and presentations (from www.kidsgardening.com)
- Explore wildflower folklore and the secrets behind their Latin and common names. Have students make creative guesses, then research to discover what the common and Latin names of wildflowers tell us about their structures, uses, or cultural/historical significance. Have students choose wildflowers and develop their own legends based on the names (from www.kidsgardening.com).
- Invite students to write descriptive paragraphs by thinking of plant-rich places they've been, then imagining and describing how they might look during different seasons of the year (from www.kidsgardening.org).
- Have students find a comfortable position in the garden. They should close their eyes as you read aloud the following story. You may stop in the middle of the story and allow students to write an ending to the adventure in their journals or you can simply allow the story to be an encouragement to write their own garden-based story (from *Earth Child 2000*):

In a garden, under the broad green leaves, little creatures crawl or fly from plant to plant looking for food. Imagine you are someone very small clinging to a vine in a pumpkin patch. The sun has come up and you begin to search for something to eat. You crawl under leaves, over the vines, and finally spy a tender new pumpkin forming under a withering flower.

The excitement of seeing food makes you unaware of the danger looming above. You head straight for the tiny green pumpkin and as you dart out into the sunlight, a large animal pecks at the vine with its beak. You scramble away as quickly as you can and hide on the underside of a leaf. The animal pokes and searches, brushing against the leaf several times. You hold on tight, hoping you won't be found. After awhile, he loses interest or finds another tasty morsel and it is safe for you to move about once more.

Cautiously, you look around. All is clear! Again, you make a path toward the delicious pumpkin. It's been a long morning and you are hungry. All of a sudden, whoosh! You are washed off the vine by a stream of water. You are dazed by the suddenness of the rain when only minutes ago the sun was high and bright in the sky. Whoosh! You are splashed with water again and find yourself struggling in a midday puddle. Whoosh! You realize that if you don't find shelter soon, you could drown. So, with much effort, you pull yourself out of the sticky mud and climb under some broad, strong leaves to sit out the downpour, never losing sight of the scrumptious meal waiting for you at the end of the vine.

Finally, at dusk the large puddles have dried enough for you to venture safely across the vine. Even without interference, it takes you a long time to reach the juicy pumpkin. You dig into its skin with your many legs and carve out delicious chunks to satisfy your hunger. As the sun sets, your body and legs get stiff. The breezes of the night are too cool for your tiny body, so you crawl into the flower bud that still holds the warmth of the mid-day sun. The petals close behind you, tucking you into a cozy bed until the sun returns to bring another day.

Teaching Mathematics
through Gardening

Teaching Mathematics through Gardening

Teaching Mathematics through Gardening

Mathematical connections abound in the school garden. From computing the number of broccoli seeds needed for planting to weighing the amount of broccoli harvested, the garden can be used to introduce, apply, or compliment many mathematical concepts. The following activities are a mere sampling of the possibilities. Please note that activities marked with a (*) are from www.kidsgardening.com.

How This Chapter Is Organized

Seed planting in the spring and seed saving in the fall are two especially rich opportunities to connect the school garden with mathematics studies. Math-based activities are listed specifically for each of these topics.

Additional activities are divided into the content strands designated by the Alaska Performance Standards and may be adapted for a range of grade levels. Activities are presented for the following content strands:

- Numeration
- Measurement
- Function and Relationships
- Geometry
- Statistics and Probability
- Estimation, Computation, and Process Skills

Seed Saving:
In the late summer and early fall, students can harvest seed from fully mature plants to be used for future plantings. Seed saving provides a wealth of mathematics connections; for example, students could:

- Estimate and count the number of seeds collected from different plants (Numeration, Estimation and Computation).
- Estimate and compare the weight and volume of seeds from different plants (Measurement).
- Perform germination tests on harvested seeds. Place ten seeds in a moist paper towel in a plastic bag. Monitor these "seed burritos" for one to two weeks and count the number of seeds that have germinated. Determine the probability of germination for each type of seed and label harvested seeds with this germination rate (Statistics and Probability).
- Create graphs, tables, and charts displaying data on number, weight, volume, or germination rates of seeds and compare and analyze this data (Statistics and Probability).
- Measure and compare the weight or volume of harvested seeds to the weight or volume of the plant that produced the seeds (Measurement, Statistics and Probability).

For information on how to save seeds from the school garden, please the Featured Science Lesson "The Great Seed Rescue" on page 36-37. Additional information can be found in the following books, which can be checked out from the Calypso Farm and Ecology Center Resource Library:

- *Seed to Seed* (by Suzanne Ashworth, published by Seed Savers Exchange, Inc. in 1991)
- *Back Garden Seed Saving – Keeping Our Vegetable Heritage Alive* (by Sue Stickland, published by Eco-logic Books in 2001)
- *Saving Seeds – The Gardener's Guide to Growing and Storing Vegetable and Flower Seeds* (by Marc Rogers, published by Storey Communications, Inc. in 1990)
- *Breed Your Own Vegetable Varieties – The Gardeners' and Farmers' Guide to Plant Breeding and Seed Saving* (by Carol Deppe, published by Chelsea Green Publishing in 2000)

Planting Seeds:
When planting seedlings in the classroom, students can:

- Use counting, addition, or multiplication to determine the number of seeds that can be planted in a flat of soil (Numeration).
- Graph the growth of seedlings and analyze the data to compare the growth rate. Students may also set up experiments to compare the growth rate of seeds planted in different conditions (no water, no air, no soil, no sunlight, etc.) (Statistics and Probability).
- Estimate the number of seeds that will germinate or the growth rate of the plants (Estimation and Computation).

When planting in the garden, students can:

- Graph the growth rate of plants and analyze the data to compare plants (Statistics and Probability).
- Measure out the correct amount of space needed between seeds or seedlings (following the recommendations found on the seed packet) and determine the most space-efficient arrangement for seedlings (Measurement).
- Determine a garden plan for where vegetables should be planted. Use graph paper to map out this plan (Geometry). Determine the number of seeds that should be ordered for a given crop (Numeration).

Numeration Activities:

- Practice counting in the garden with younger students. Everything can be counted: seeds, vegetables, tools, colors, and more!
- Use vegetables harvested from the garden to create fractions: Challenge students to harvest ¾ of the broccoli crop or to divide a zucchini into eighths!

Measurement Activities:

- Measure the accumulation of snow in the garden throughout the winter. Dig a snow pit and measure the height and temperature of each layer in the snow. Calculate the differences in temperature between the topmost and bottommost layers. Peter Marchand's *Life in the Cold* (♣) has a great description of how and why to measure variable in the snow pack.
- Compute the amount of soil in one garden box.
- Measure the water or air temperature in a certain part of the garden throughout one day. Create a graph to display this information.
- Measure the height of a plant over the course of its growth.
- Compare the weight of two cabbage, kohlrabi, turnips, cauliflower, beets, rutabagas, or broccoli heads from the garden.
- Measure the yields from the school garden after a harvest. How many ways can students find to communicate these yields? For example: "Today we harvested 10 zucchini. When lined up end to end, these zucchini measured 75 inches long. Together, these zucchini weighed 23.6 pounds."
- Measure and compare areas, lengths, and circumferences of different plant parts under different growing conditions.*
- Compare and graph growth rates of a fast-growing plant (e.g., beans) with a slow-growing plant (e.g., carrot).*
- Determine the volume of soil mix necessary for X pots.*
- Estimate the weight of each ingredient in your classroom salad garden, then weigh and graph the percentage of the total that each ingredient occupies.*
- Compare different plant roots by measuring and trying to estimate the total root length.*
- Use string to measure the lengths and circumferences of non-straight roots, fruits, leaves and other plant parts.*
- Calculate and compare the surface area of different leaves by drawing outlines on graph paper.*
- Calculate serving sizes of common fruits and vegetables using measuring cups.*

- Make a recipe using vegetables harvested from the garden requiring different measuring techniques.*
- Measure the height of garden plants using standard (inches and centimeters) and nonstandard (such as pencil lengths or hand widths) measuring techniques. Chart, compare, and discuss your results.*
- Plant bean seeds and let them grow for a few weeks. Remove from the soil and carefully wash soil away from the roots. Measure part of the root system. Estimate the percentage of total roots you measured and then estimate the length of the entire root system on that plant. After estimating, measure the rest of the roots and compare to your length estimate.*
- Plant a classroom window box. Determine the volume of soil you will need to fill your box. As you prepare the potting soil, first determine the weight and volume of potting mix when it is dry, then recalculate the weight and volume of moistened mix.*

Function and Relationships Activities:

- Use algebraic formulas to compute a variable, such as the amount of fertilizer to add per quart or liter of water. (Most fertilizer packages indicate how much to add per gallon of water.) Collect various dry bean seeds or plant leaves, and ask students to sort them by size, shape, color, and number. *
- Plant lima bean seeds in small pots. Place half the pots in a bright window and half in a dark closet. Measure growth daily. After two weeks, compile information into a chart and determine the average growth rate of plants grown in the light versus the dark. Discuss and calculate the effect of the variable of light on the variable of plant growth. *

Geometry Activities:

- Go for a shape search in the garden. Have students identify what shapes (or angles or solid figures) they can find on a walk through the school garden.
- Challenge students to create mathematical descriptions of flowers in the garden. For example, a flower seven-inch long, cone-shaped stem and fourteen triangular petals.
- Determine the lines of symmetry on different types or varieties of vegetables.
- Have students create and trade garden treasure maps. For example: "Walk north 14 feet. Turn to the west. Walk 4 feet forward. What crop is in front of you?"
- Use the sun or a compass to determine which direction is north in the garden. Discuss the importance of orienting the garden to the south for sun exposure.
- Estimate the number of pots that will fit on your windowsill or under your grow lights. Calculate using different sizes and shapes of pots.*

Statistics and Probability Activities:

- Seed packets include a germination rate for the seeds inside. For example, broccoli generally has a germination rate of 90%, which means that 90% of the seeds, when planted in conditions conducive for growing, should germinate. Using the published germination rate on a seed packet, test the seeds with your

class. Compute the actual germination rate (as a percentage) and compare this rate to the one published.

- Classify and organize data collected in the garden throughout a given period. Data can be collected on growth of plants, yields, temperature, or weather.
- Have students sort and classify leaves into different types, then calculate the percentage of the collection each category represents.*
- Predict, then count, compare, and graph the number of seeds inside different fruits.*
- Complete a market survey of students and parents regarding garden products you might want to sell. Summarize and interpret data to help you set the foundations for a school garden business.*
- Draw Venn diagrams, showing intersecting sets, to categorize fruits and vegetables. One set should show fruits; the other, vegetables. The intersection should show those fruits we commonly consider vegetables.*
- Sort a small amount of birdseed; glue seeds on paper to make a graph showing the numbers of different types of seeds in the mixture.*
- Collect five to ten flowers from the same plant in your garden. Count the number of petals on each flower and create a chart to display your results. Repeat with other types of flowers in the garden. What do the results say about the characteristics of plants? *
- Count the total number of flower buds on cucumber plant. Gently attach a piece of tape around the stem near the flower to mark those you counted (be careful not to damage the stems). A few weeks later, examine your marked flower buds and look for signs of baby fruit. Figure out what percentage or fraction of the total flowers produced fruit (number of fruit divided by the number of flowers). Discuss the probability of a cucumber flower producing a fruit.*
- Host a bean race. Plant a number of beans at the base of a trellis and track their growth on a chart. Determine the rate of growth. Award the fastest growing plant a blue ribbon.*
- Measure the height of a group of plants and determine the mean, median, and mode.*

Estimation, Computation and Process Skills Activities:

- Encourage students to create story problems based on the garden. For example, "There are two rows of cabbages in the garden bed closest to the school. Each row contains seven cabbages. How many cabbages are in the bed?" Students can exchange these story problems with classmates to edit and solve.
- Determine how many seeds per row or container will be needed if a packet says to plant X seeds every X centimeters.*
- If you have X plants, what are several ways you can group them when transplanting them outdoors (e.g., 4 rows of 4 each or 2 rows of 8 each)?*
- Estimate and verify the number of seeds in a fruit. Predict how many fruits you'd have if they all germinated and each plant produced X more fruits. Discuss what prevents this from happening in nature.*

- Try some root growth rate problems. For instance, roots of young seedlings can grow at .2 mm per hour. At that rate, how long would it take a carrot root to reach the bottom of a 10-cm pot? Discuss and investigate whether plant parts grow at the same rate throughout their lives.*
- Identify plant parts in different foods, using school lunches as a springboard (e.g., bread from seeds, pizza sauce from fruit, etc.). Calculate and graph the percentages of different plant parts represented in a typical school lunch.*
- Determine when to start seedlings indoors for spring plantings based on the days to maturity and recommended dates for transplanting out in your area.*
- Challenge teams of students to grow the biggest, longest, or heaviest of a particular vegetable. Keep daily records, develop criteria for determining winners, graph results, and conclude with a feast!*
- Create a planting schedule for your garden. First, determine the desired harvest date for each crop. Next, find the days-to-maturity for each, and count backwards from the harvest date to decide when each crop should be planted.*
- Track the cost of garden supplies against the amount of produce you harvest. Figure out the cost per unit (weight, volume, piece) of fruit or vegetable. Compare your cost to the cost of similar produce at the supermarket. *
- Plant a variety of seeds. Find out the number of days it should take for them to germinate (often this is listed on the seed packet). Chart the researched data, then track the actual time for germination and compare the results. Discuss the accuracy of the researched information and how seed producers may have arrived at those numbers. Discuss variables that may have affected your results.*

An Introduction to Composting in Alaska:

A Thematic Unit

for Grades 4-6

An Introduction to Composting in Alaska: A Thematic Unit

This comprehensive composting unit includes focused activities around the themes of decomposition, vermiculture (worm composting), and hot composting. For each fully developed activity within these themes, curricular connections are provided for Mathematics, Science, English/Language Arts, Social Studies, and Fine Arts. These curricular connections are correlated, where appropriate, to Grade Level Expectations (GLEs) and to Fairbanks North Star Borough School District Science Concepts.

This unit, intended for fourth through sixth grade classes, could be used in its entirety to introduce or review key topics in each of the core subjects or teachers can pick and choose activities to use for a shorter introduction to the concepts of decomposition and composting.

How This Thematic Unit Is Organized
This thematic unit includes the following sections:

The Basics of Decomposition: These activities focus on decomposition, serving to introduce biodegradation and decomposition in the natural world. Activities lay a foundation for the building and utilization of compost in the garden, outlined later in this unit.

- ***Activity*: "The Role of Decomposers in Nutrient Cycling**:" Students search for biodegrading waste in the schoolyard and garden, observe decomposition in the natural world, and create a food web specific to Alaska to show the flow of nutrients through a food chain.
- ***Activity*: "Discover Composting Organisms**:" Students observe and record characteristics of decomposing organisms found in a compost pile with the help of a hand lens or microscope.
- ***Activity*: "What is Biodegradable?**:" Students conduct an experiment with different materials to determine the biodegradability of each one. Students also note conditions that encourage decomposition.

Vermiculture: Composting with Worms: The activity, "**Building and Maintaining a Worm Bin**," and curricular connections provides a general overview of vermicomposting, including instructions for determining the proper size worm bin for your class.

Hot Composting: Building a hot compost pile with your class provides rich learning opportunities in every subject. This section outlines the hot composting method ideal for the Fairbanks area and provides activities to use and experiment with finished compost.

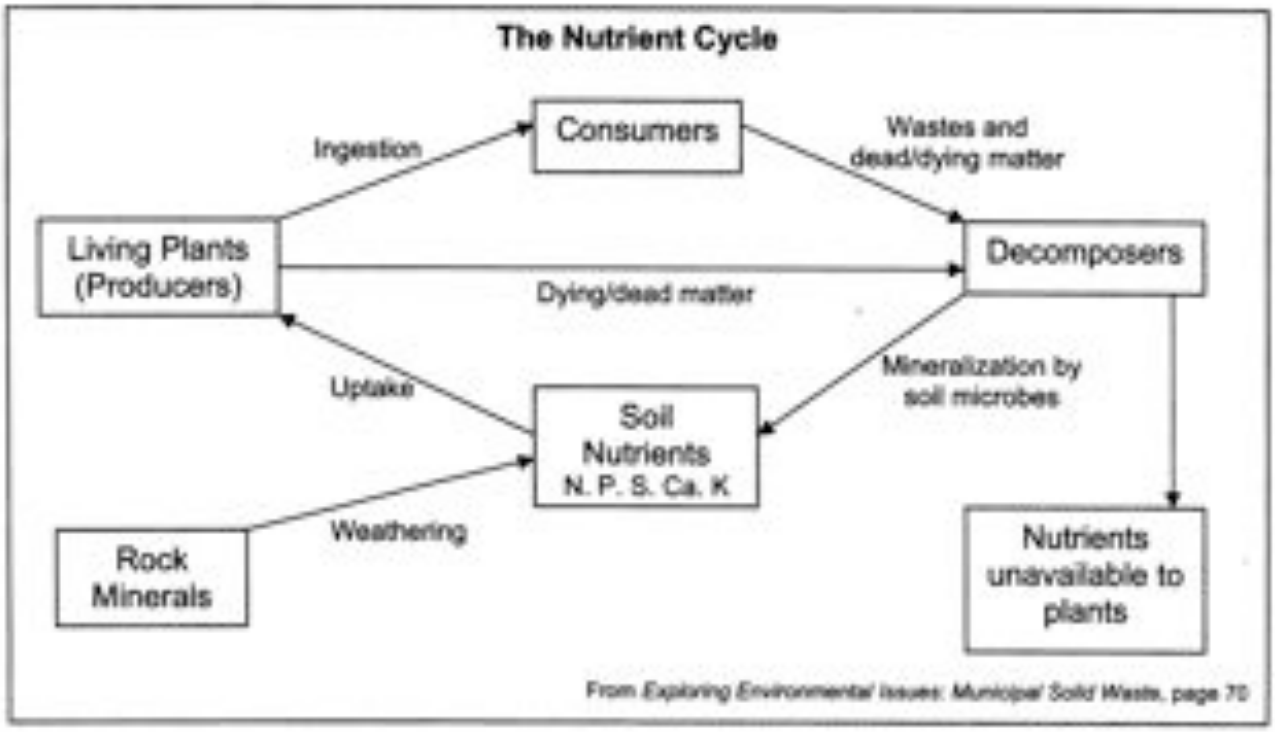
- ***Activity*: "Building a Hot Compost Pile**:" The introduction to the "Hot Composting" section introduces the method for building a hot compost pile; curricular connections that follow encourage exploration around the topic of providing an ideal setting for decomposition to create rich garden soil.
- ***Activity*: "Family Compost Feud**:" Students team up to apply their understanding of decomposition and composting in this competition to build the hottest compost pile.
- **Activity: What Good is Compost?**: Students design and test the effectiveness of their finished compost.

The Basics of Decomposition

Introduction

The fungus that grows on forgotten, leftover food can be pretty disgusting, but it is nature's way of releasing nutrients to be reused by other living things. Decomposition is the natural process of organic matter breaking down. Through the process of decomposing, nutrients are made available for use by other living things. Decomposition happens everywhere, from the natural world (i.e., the forest floor) to human-made environments, like the compost pile.

Freezing halts the process of decomposition, so the amount of time that it takes things to decompose in the natural world is longer in Alaska than in warmer environments. Because the organisms responsible for decomposition are inactive in subfreezing weather, organic matter (i.e., leaves and fallen logs) are preserved nearly unchanged from late fall to early spring. Thus, students in interior Alaska can readily observe remnants of last year's fallen leaves and logs in spring.



From *Exploring Environmental Issues: Municipal Solid Waste*, page 70

Activity: The Role of Decomposers in Nutrient Cycling

(adapted from *Exploring Environmental Issues: Municipal Solid Waste*)

Learner Outcome:

1. Students will identify organic items that can potentially be composted.
2. Students will learn about the chemical processes involved in composting.

Materials: paper and pencil (one per student), "The Nutrient Cycle" map (see previous page)

Procedure:

1. In small groups, have students agree on a definition for the terms "decomposition" and "biodegradable."
2. Have groups share their definition with the class. The whole class should come to a consensus on a working definition for these terms.
3. Take a walk in your schoolyard garden and near your school; this activity will work best if you can walk in an area that is not regularly groomed (like a forest or unkempt corner of the schoolyard). Point out signs of decomposition; note which types of objects are biodegradable and which types of objects will not break down. Pay attention to trash, fence posts, playground equipment, leaves, etc. See "What is Biodegradable?" for an activity that further explores what types of materials are biodegradable.
4. Have the students lay down on the ground on their stomachs. Using their hands, have students frame out a small area that they can observe closely. Ask students questions about their area: *Are there any insects? Can you count all the plants in your area? What would it feel like to shrink and suddenly live in that environment?* Have students search for signs of decomposition in their area. *Do you see any seeds in your area?* Remind students to leave things as they are found and to bring people to the area to view exciting findings (do not take things from the area!). If in a forest, have students look for layers of decomposing matter. Explain that leaves that are still recognizable would only be a year old or so, while smaller pieces may have fallen a few years earlier. Once students find layers that are unrecognizable as leaves, they are probably handling matter that is older than they are! Introduce the term "humus," explaining that these top organic layers of soil are most recently decomposed and serve as the primary nutrient holders in the soil.
5. Back in the classroom, have groups share things they saw that are biodegradable. *What stage of decomposition were these objects in? What would happen if decomposition did not occur in nature?* (Garbage would begin to pile up and nutrients would not be recycled and made available for growing plants. This could have a catastrophic effect on an ecosystem, all of which relies on the nutrients available in plants.)
6. Share these biodegradation facts with the group:
   - A banana peel takes six months to one year to break down in a landfill.
   - A hot dog takes one year to break down in a landfill.
   - A magazine takes 40 years to break down in a landfill.
   - A tin can takes 100 years to break down in a landfill.
   - An aluminum soda can takes 500 years to break down in a landfill.
   - A milk jug takes 500 years to break down in a landfill.
   - Glass will never break down, only fragment.
7. Ask: *How are nutrients recycled through decomposition?* Explain that nutrients are recycled through organic materials. Living materials take in nutrients, die, decompose, and release nutrients into the soil and water for other organisms to use.
8. Ask: *What is making this decomposition happen?* Explain that organisms break down living matter. Heat and moisture are essential for those organisms to function. See "Discovering Composting Organisms" on page 72 for another activity that introduces decomposers.
9. Share the "The Nutrient Cycle" map on the previous page with students. Follow the arrows to observe how nutrients move through the food chain. Have students create a food web specific to Alaska that includes: two producers, four consumers, and decomposers.

Curricular Connections: The Role of Decomposers in Nutrient Cycling

Mathematics Connections:

- Create a chart or table that represents the observations made about decomposition in the natural world. (GLE [4,5,6] S&P-1)
- Dig up a soil cross section from the forest. Have students create a scaled drawing of this cross section, representing the different layers of organic matter and soil in proportion to each other. (GLE [4,5,6] S&P-1)
- Create a timeline, chart, or graph that visually represents the amount of time that it takes different materials to decompose. (GLE [4,5,6] S&P-1)

Science Connections:

- Have students relate their food web to a specific Alaskan habitat. Utilize field guides and books specific to different ecosystems within Alaska. (GLE[4,5,6]SC3.2)
- Determine ways that non-biodegradable waste found in the schoolyard could be reused or recycled. (FNSBSD *Ecology* Concept – Grade 4)
- Connect the process of biodegradation through composting to effective ecological practices. For example, decomposition in your compost pile recycles nutrients for use by growing plants in the same way that a recycled plastic jug is broken down and made into a recycled plastic picnic bench. Research how recycled materials are transformed into new materials. (FNSBSD *Ecology* Concept – Grade 4)
- In addition to classifying materials found in the schoolyard as biodegradable or non-biodegradable, compare the physical properties of materials found. (GLE[4]SB1.1)
- Research the unique cycle of decomposition in the oceans. (FNSBSD Oceans Concept – Grade 5)
- Compare and contrast macro and micro decomposers. (GLE[6]SD2.1)
- Study decomposers in different biomes. Do the same organisms serve as decomposers in interior Alaska that decompose matter in the desert? (GLE[4]SC1.1)
- Research how seasonal changes in temperature affects the rate of decomposition in the garden. (FNSBSD *Weather/Climate* Concept – Grade 6)

English/Language Arts Connections:

- Break students into partners. Allow students to share their food webs with each other. Have students create a "story chain" of linked paper strips that follows nutrients through the food web their partner has created. (Reading GLE [4,5,6] 2.4.1, Reading GLE [4] 2.4.2)
- To encourage groups in creating working definitions for "decomposition" and "biodegradable," provide students with stories or paragraphs that use those terms. Students can work with context clues to determine what these words mean. (Reading GLE [4,5,6] 2.1.2)
- To introduce the concept of decomposition, read *The Tenth Good Thing About Barney* by Judith Viorst (♥▲●▲•), the story of a young boy delivering a funeral oration for his pet cat who has died. He lists ten good things about his cat Barney. The tenth thing on his list is that Barney will nourish the garden where he is buried.
- Write a story that follows nutrients through a food web. (Writing GLE [4,5,6] 2.2.2)
- Read aloud *The Magic School Bus Meets the Rot Squad: A book about decomposition* by Joanna Cole (▲). Write an addition to the story using the school garden as inspiration. (Writing GLE [4,5,6] 2.2.2)
- Read aloud the following poem. Work through the meaning of each line. Write a poem or a song about decomposition, using the following as a model. (Reading GLE [4,5,6] 2.5.1, Writing GLE [4,5,6] 2.2.3)

Where would we be
With no Fungus Among Us,
But buried in waste to our waist?
Then why do some folks just think of the fungus
As "yucky" and of most poor taste?
Now is it because they see only death
And fear the cycle of life?
Or is it perhaps that they haven't yet learned
Decomposers prevent much strife?
(from GrowLab, page 210)

Fine Arts Connections:

- Study examples of sculpture constructed of leaves, twigs, pebbles, and other natural objects in *Andy Goldsworthy: A Collaboration with Nature* (•) and *Hand to Earth: Andy Goldsworthy Sculpture, 1976-1990* (•). Also, you may want to watch the excellent documentary *Rivers and Tides: Andy Goldsworthy Working with Time* (▲). Have students bring in natural objects from their own yards and create Andy Goldsworthy-type sculptures. Display photos of the student's art work or create a class book of photographs. Have students discuss and predict how long it would take for the various sculptures to decompose. Does art have to be permanent to have value?

Activity: Discover Composting Organisms

(adapted from *Composting: Waste to Resources, Cornell Waste Management Institute*)

Learner Outcome:

Students will sketch decomposers observed under a hand lens or microscope.

Materials: fresh sample of compost, glass slide or petri dish (one per pair), hand lens or microscope (one per pair), paper and pencil (one per student)

Procedure:

1. Put a small compost sample from the garden on a glass slide with a drop of water.
2. Observe the sample under a hand lens or microscope. Look for both macro and microorganisms or signs of either. For example, students may be able to find snails and earthworms or simply snail shells or earthworm castings. Common large decomposers in Alaska include snails, slugs, and millipedes.
3. Draw pictures of what you see.
4. As a class, discuss: What would happen if there were no decomposers?

Curricular Connections: Discover Composting Organisms

Mathematics Connections:

- If utilizing a microscope, determine the scale of magnification and discuss what this number means. (GLE [5,6] N-1)
- Find patterns in the types of decomposers observed in the compost sample. Create a class graph that represents the number and frequency of different decomposers observed. (GLE [4,5,6] S&P-1)
- Given the number of decomposers observed the compost sample (i.e., one teaspoon of compost contained 200 decomposers), determine how many decomposers would be found in a five-gallon bucket of compost or in a whole compost pile. (GLE [4,5] PS-1, GLE [4,5,6] PS-3, GLE [4,5,6] PS-5)

Science Connections:

- Research the life cycle of insects that act as decomposers. (GLE[4]SC3.1)
- Compare the physical properties of different decomposing organisms. (GLE[5]SC2.1)
- Research the process of recycling non-biodegradable materials. Compare and contrast the forces that work to recycle materials with the decomposers that work to commercially recycle nutrient in the natural world. (FNSBSD *Ecology* Concept – Grade 4)
- Compare and contrast macro and micro decomposers. Determine the classification of different decomposers (fungi, bacteria, arthropods, etc.). Organize the identified organisms into a dichotomous key. (GLE[6]SC2.3)

English/Language Arts Connections:

- Write a story called "The Garden Where Nothing Decomposed" (Writing GLE [4,5,6] 2.2.2)
- Have students write a physical description of one of the decomposers they have drawn. Collect the writings and the correlated drawings. Read aloud one of the descriptions and have students attempt to determine which drawing it describes. (Writing GLE [4,5,6] 2.2.2, Reading GLE [4,5,6] 2.2.4)

Activity: What is Biodegradable?

(adapted from *Recycle Alaska Activities Handbook* and *GrowLab*)

Objective:

1. Students will determine what types of materials are biodegradable.
2. Students will analyze decomposiums to determine what conditions are most conducive to encouraging decomposition.

Materials: two of each of the following: glass, paper, steel or other metal, plastic bag, apple and lettuce (or other fruit and vegetable); ten clear sealed containers (plastic bags, jars, or plastic food containers); soil; masking tape or labels; water; hand lenses, "Watching Rotting Wastes Record" worksheet (see next page)

Procedure:

1. Place pieces of old food in a gallon plastic bag. Ask: *What do you see in this bag?* Have students predict what the contents of the bag will look like in one week, one month, and six months. Record predictions.
2. Hang the bag prominently in the classroom with the question: *What do you think is happening in this bag?* Throughout the next week, have students record their observations of the changes occurring in the bag.
3. After a week of general observation, ask: *What changes have you observed in the bag? What might be causing this change to happen?* Introduce the term "biodegradable." Are the food materials in this bag biodegradable (capable of rotting or decomposing)?
4. Display materials (glass, paper, metal, plastic bag, and food). Ask the class to predict which of these substances are biodegradable. Conduct the following experiment to determine whether their predictions were correct.
5. Fill five of the containers half full with soil from the school garden. Place a piece of each type of waste into each container. Continue filling the containers with soil. Place one piece of waste in the other five empty containers. Add enough water to all pots so that the soil or waste is damp but not wet to the touch. Cover the containers. Label the containers to indicate the type of waste and whether it contains soil (i.e., "Lettuce in soil" or "Lettuce"). Remoisten these materials every few days as necessary to maintain dampness. Explain that students have created "decomposiums," contained spaces where decomposition can take place and be observed.
6. After one week, examine the waste in each container. *Which wastes are decomposing?* (Food and paper waste will readily decompose in the presence of moisture, though glass, metal, and plastic will not break down easily. Use hand lenses to observe small changes. Students should record observations on the "Watching Rotting Wastes Record." Warn students not to inhale or ingest contents of the bags while examining. Some types of mold can be harmful.
7. Cover the wastes again, and continue to check them once a week for as long as you want, using a new "Watching Rotting Wastes Record" sheet each time.
8. At the conclusion of each observation period, check the original predictions and draw conclusions about which substances are biodegradable and under what conditions. Discuss or write about the following: *How did the materials in each of the decomposiums change? Why do you think there might have been differences between the two? Did some materials seem to decompose more quickly than others? Which? Did some materials show no signs of decomposition? Which?*

Watching Rotting Wastes Record

Name: _____

Date experiment started: _____ Today's Date: _____

Fill in the following table each time you check your decomposiums. Under "Waste," write the name of the item that you buried in the pot. Under "Moistened Compost," describe the condition of the item buried in compost each time you check it. Include such things as how decomposed the item looks, what color it is, and whether or not you see fungi (spots or thin strands) on it. Under "Moistened Waste," describe the condition of the item that was moistened but otherwise placed in an empty container.

Waste	Moistened Compost	Moistened Waste
1.		
2.		
3.		
4.		
5.		

Curricular Connections: What is Biodegradable?

Mathematics Connections:

- Besides the "Watching Rotting Wastes Record," determine alternate ways to compare decomposing matter. (GLE [4,5,6] PS-5)
- Maintain a record of the percent of a given food product (i.e., a slice of bread) that is covered with fungus by tracing the product onto graph paper, shading in the portion that is affected by decomposition each week, and converting this area into a percentage of the total area of bread. (GLE [5,6] N-4)

Science Connections:

- Design and conduct an experiment with different types of soils found in Alaskan ecosystems to determine which type of soil is most conducive to encouraging decomposition. (GLE[4]SC3.1)
- Design and conduct an experiment that measures changes in weight or volume of decomposing matter. (GLE[4]SB1.1)
- Experiment with bread to identify conditions that favor mold growth. Begin with eight pieces of bread. Seal one moist piece of bread in plastic wrap; expose another to the air. Place one piece of bread in bright light; another in the dark. Let one piece dry out while you keep another piece moist. Place one piece of bread in a warm dark place such as an oven. Place another in a cold dark place such as a refrigerator. Use a magnifying glass or jeweler's loupe to examine the bread daily. Record changes that you see (from *Beyond the Bean Seed*, page 77). (GLE[6]SC3.1)
- Extend the results of your composting experiment to make inferences about what a well-functioning ecosystem must include in order to encourage decomposition. Write about or discuss the importance of decomposition within a food web and ecosystem. (GLE[4]SC3.1, GLE[6]SC3.2).

English/Language Arts Connections:

- Summarize and write a report of the findings in this experiment. (Writing GLE [4,5,6] 2.2.2)
- Teach another class about the important role that decomposers play in the natural world. (Reading GLE [4,5,6] 2.4.1)

Fine Arts Connections:

- Listen to the "Decomposition Rap" on the Banana Slug Band's *Dirt Made My Lunch*. Have students create their own song or rap about the decomposition process.

Vermiculture:
Composting with Worms

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Introduction

Vermicomposting is the scientific term for utilizing worms to compost food wastes. Composting worms (also known as red wigglers or redworms) are a specific type of worm that turn leftover food wastes into a rich compost suitable for growing. Given a proper living environment that includes air, moisture, and food, worms will quickly break down food waste. Thus, you may begin the vermicomposting process with a simple container of bedding, soil, and food wastes. The bedding (strips of newspaper) holds an appropriate amount of moisture, which provides a proper medium in which worms can live. In addition, this bedding makes air available to the worms in the bin and provides a cover for the buried food wastes. The final product of the worms' work is called vermicompost. Vermicompost includes: worm castings (excrement), decomposing bedding, and organic matter.

Most of the following information was taken from *Worms Eat Our Garbage: Classroom Activities for a Better Environment*, published by Flower Press. Without a doubt, *Worms Eat Our Garbage* is a superb reference for classroom vermicomposting projects. This section includes a few activities from *Worms Eat Our Garbage* that are specifically correlated to Alaska Grade Level Expectations and Fairbanks North Star Borough School District Science Concepts. However, *Worms Eat Our Garbage: Classroom Activities for a Better Environment* includes even more information and reproducible handouts on:

- Physical and behavioral characteristics of worms
- Worm habitats and worm needs
- Building and maintaining a worm bin
- Soil
- Experiments with worms and finished vermicompost
- Recycling of natural materials

In addition to *Worms Eat Our Garbage: Classroom Activities for a Better Environment*, please see the following resources for more information on vermicomposting: enchantedlearning.com, *At Home and at Work with Anna Lid and Her Friends*, and *The Rodale Book of Composting*. For information on composting lunchroom wastes, see *Mid-Scale Vermicomposting of Lunchroom Wastes*, also published by Flower Press. The above books are available for checkout from Calypso Farm and Ecology Center.

Activity: Building and Maintaining a Worm Bin

(adapted from *The National Wildlife Federation Book of Family Nature Activities*, *GrowLab*, and *Worms Eat Our Garbage: Classroom Activities for a Better Environment*)

Objectives:

Students will build and maintain a worm bin.

Materials: 10 gallon container with lid, 5 gallon container, newspaper (about 200 pages), 1 pound of redworms (about 1000 individuals), brace and bit or power drill with 1/8" or smaller bit, fine screen or mesh, heavy-duty tape, scissors, three-pronged gardening hand tool, handful of soil or sand

Procedure:

Building a Worm Bin:

1. Note: This activity provides general directions for building a simple, standard worm bin. In order to build a worm bin more specific to the amount of garbage your class produces, please see the "Mathematics Connections" in the "Curricular Connections" section on pages 79-80.
2. Drill at least 30 holes into the lid of your ten gallon container. Cover the inside of the lid with a screen. Tape the screen into place.
3. Drill drainage holes through the bottom of your container. The ten gallon container will sit inside of the smaller container, which will catch any liquid draining from your composting bin.
4. Tear newspaper into inch-wide strips and put them in the bin. Fluff them up and add water. Squeeze water out until the strips are like a moist sponge – damp but not dripping.
5. Spread bedding, and sprinkle with a heaping handful of soil. This soil will be the grit necessary for the worms' gizzards.
6. Add kitchen scraps and distribute your worms among the scraps. Cover everything with bedding and close the lid.

Maintaining a Worm Bin:

7. Add food scraps over time as the worms digest the food in the bin. Don't feed bones, fatty, or pickled materials to your worms. Composting meats is not recommended and may attract rodents. Eggshells will disappear faster if you dry and crush them.
8. Replenish the bedding over time.
9. If a brown liquid accumulates in the box, soak it up and use it to water your houseplants; this liquid is full of good nutrients for plants.
10. Your bin will most likely have an odor to it, though this smell should be earthy, not icky.
11. Turn the contents of your bin from time to time with a three-pronged garden tool to maintain a healthy air supply.
12. Choose a location for your worm bin carefully. Worm bins may attract fruit flies. In order to control fruit flies, keep your scrap pile covered in several inches of shredded newspaper or a layer of folded newspaper sections. Also, avoid banana peels in your pile to prevent fruit flies. The finer the material that you put in, the less of an issue you will have with fruit flies, so cut food scraps into small pieces
13. Once the worm bin is about ¾ full (or one month before you intend to use the finished compost), begin to only place food in one section of the worm bin (for example, only in the left side). After one month of consistent feeding on this side of the bin, there will little to no worms left on the side of the bin with no food. You can scoop out a handful of the composted material at a time.
14. The following is another option for moving the worms to one area of the bin. This option is more time intensive than the first one. Shine a bright light on one side of the worm bin. Wait a few minutes as the worms work their way to the other side of the bin to avoid the light. Scoop out the composted material underneath the light; it should be relatively worm-free. Continue to do the same, shining a light on different parts of the worm bin to move worms out of this area so that you may take the finished material.

Curricular Connections: Building and Maintaining a Worm Bin

Mathematics Connections:

- Worms can consume about half their weight in garbage each day, which means that the worm to garbage ratio is 2:1. Have students create word problems for each other that use this ratio. For example, "Ten families in downtown Fairbanks have decided to build a common worm bin. They will build this worm bin in a central location. Each family will put their food waste in this bin each day. Together, these families produce about 40 oz of garbage each day. How many ounces of worms will they need to set up this worm bin?" (GLE [4,5,6] PS-3)
- The following lesson from *Worms Eat our Garbage: Classroom Activities for a Better Environment* combines the following mathematical concepts: weight, averages, ratios, and conversion of measurements. Each of these concepts should be reviewed before beginning this lesson. Weigh the amount of compostable lunch wastes your class produces each day (Remember to subtract the weight of the pail or container in which you are weighing the matter). Maintain a class chart with this information. (GLE [5] MEA-3, 4, GLE [4,5,6] S&P-1)

COMPOSTABLE LUNCH WASTES				
	Week One	Week Two	Week Three	Week Four
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
TOTAL ounces per week				

Find the average amount of compostable waste that your class produces each day using the following equation. (GLE [4,5,6] S&P-2,3)

Total oz. compostable waste/week
÷ 5 days
The average oz. of garbage/ day

It takes twice the weight of worms to garbage in order to consume a given amount of garbage in one day. For example, one pound of worms can consume about ½ pound of food waste each day. It does not matter if that one pound is made up of 1500 small worms or 600 big worms. In order to find out how many worms you need to compost the food waste of your entire class, use the following equation. (GLE [4,5,6] PS-5)

Average ounces of garbage per day
x 2
Number of worms needed (in ounces)

Using the following equation, convert this number to pounds to decide how many pounds of worms are needed for your class compost bin. (GLE [5]

Ounces of worms needed
÷ 16 ounces/pound
The pounds of worms needed

- As a class, find as many different worm bin shapes as possible that would have a surface area of 12 square feet. (GLE [5,6]G-6)
- Worms require a certain amount of work space (volume) in order to process garbage. A rule of thumb is to set up a worm bin with about one cubic foot for every ¼ pound of worms. The ideal worm bin is usually no more than one foot deep. Shallow bins allow for more air to contact bedding. A worm bin can be any shape. The chart below shows the relative size a worm bin should be in order to accommodate a given

amount of garbage. Each of the worm bins below is one foot deep.

Worm Bin Number	Food Waste per Day	Initial Weight of Worms	Surface Area of Worm Bin	Food Waste per Week
1	0.25 lb	0.5 lb	2 sq ft	1.75 lb
2	0.5 lb	1.0 lb	4 sq ft	3.5 lb
3	1.0 lb	2.0 lb	8 sq ft	7.0 lb
4	1.5 lb	3.0 lb	12 sq ft	10.5 lb
5	2.0 lb	4.0 lb	16 sq ft	14.0 lb
6	3.0 lb	6.0 lb	24 sq ft	21.0 lb
7	4.0 lb	8.0 lb	32 sq ft	28.0 lb

Challenge students to answer the following questions from *Worms Eat Our Garbage: Classroom Activities for a Better Environment* (GLE [4,5,6] S&P-2):

1. How many pounds of worms will you need to set up a worm bin if the amount of food waste produced per day is 1.5 pounds?
2. How many square feet of surface area are needed to provide a home for 3 pounds of worms and 1.5 pounds of food waste per day?
3. How many pounds of food waste can a worm bin handle per week if it has 4 square feet of surface area?
4. If you had a worm bin that was 16 square feet in surface area, how many pounds of garbage could it handle per week?

Science Connections:

- In addition to weighing compostable lunch wastes each day, also weigh and keep a record of non-compostable lunch wastes produced by your class. As a class, discuss the following questions (FNSBSD *Ecology Concept – Grade 4*):
  - What types of non-compostable waste does our class produce?
  - How can we reduce the amount of packaging waste produced by our class?
  - What types of foods are most often wasted in our class? Why do you think certain foods are wasted more often than others?
  - Is it important to reduce the amount of waste we produce? Why?
  - How could our class reduce the total amount of waste we produce?
- A worm bin has the potential to attract animals other than the earthworm. In the case of rodents and larger animals, this addition is often unwelcome. However, a worm bin can also become a thriving miniature ecosystem, complete with worms, sow bugs, snails, millipedes, ground beetles, ants, and more. Pages 85 – 89 of *Worms Eat Our Garbage: Classroom Activities for a Better Environment* includes a series of activities to explore your worm bin ecosystem, including information on the different animals and an example food web that might occur in a worm bin. (GLE[6]SC3.2)
- Use the classification activities on pages 2 – 13 of *Worms Eat Our Garbage: Classroom Activities for a Better Environment* to learn about the scientific classification of the redworm, *Eisenia fetida*, and its relatives. (GLE[5]SC2.1)

English/Language Arts Connections:

- Write out the directions for making and maintaining a worm bin (see the next page as an example). Cut out each direction and mix them up. Have students work to put them in the right order. Encourage students to add details to the directions to make them clearer. (Reading GLE [4,5,6] 2.6.2)

Building and Maintaining a Worm Bin

- Determine what size your worm bin should be.
- Find or build a container that is the correct size for a worm bin.
- Put bedding into the worm bin.
- Bury food waste in the bedding.
- Add worms to the worm bin.
- Harvest worm castings to feed to your plants.
- Replace castings with fresh bedding.

- Write out each letter of the alphabet down the side of a piece of paper. Come up with one or multiple things that start with each letter that could be composted using vermiculture. Use brand names if necessary.
- Read aloud the book *Compost, By Gosh!* by Michelle Eva Portman about vermicomposting. Challenge students to write a poem or story about their own vermicomposting project. Make this poem or story into a class book to be shared with other classes in the school. (Writing GLE [4,5,6] 2.2.1)

Social Studies Connections:

- Current Events: Research large-scale vermicomposting projects. Is a community-wide vermicomposting project possible?

Hot Composting

Hot Composting

Introduction

Composting can occur in many ways. In natural forest systems, organic matter accumulates on the forest floor and decomposes, slowing releasing nutrients and creating a rich humus layer supporting new growth. In farm and garden settings, this natural process is mimicked through composting. There are several general methods:

- In **sheet composting** organic matter is spread thin and evenly over the soil surface, allowing natural decomposition processes to take place.
- In **cold composting** a pile of organic matter is left to slowly rot and decompose. Old piles of horse manure are a good example of cold composting.
- In **hot composting** a large pile of organic matter is layered with a Carbon to Nitrogen ratio of about 30:1 and kept moist. Decomposition occurs rapidly using this method.

There are many pros and cons of each method:

	Pros	Cons
Sheet Composting	• A natural process	• Takes years to complete
Cold Composting	• Material is added a little at a time • Conserves nitrogen	• Doesn't kill weed seeds • Takes years to complete in Alaska
Hot Composting	• Fast composting (process can be completed in one Alaska summer) • Kills weeds and pathogens • Builds soil fertility	• More labor intensive • Loses more nitrogen Carbon : Nitrogen ratio must be correct

Here in Alaska we *can* compost; it takes a little more effort but following a few key steps we can make 'black gold' with hot composting in one summer. Hot composting is merely the recycling of waste materials in an accelerated decay process.

The components of a successful Hot Compost pile are:

- Location: Choose a well-drained site that is away from structures (not touching buildings), but close to a water source. Locate the pile so that's it's easy to bring in composting materials and accessible to your garden space.
- Size: A hot pile requires that you build the main pile mass at one time (kitchen or garden scraps can be used in the pile and can be added once the pile is constructed by incorporating the material into the pile center). Make the pile at least 3 by 3 by 3 feet [~1 cubic yard]; this size ensures a thermal mass that will hold the heat and will provide ample food for the myriad of organisms that will be doing the work.
- Aeration: Air is essential for proper decomposition. Break up material that might mat and fluff up the layers. An aerobic pile decomposes. Without air, the pile will ferment which causes the nitrogen to be driven off and the pile will smell bad.

- Moisture: As with most biological processes, microorganisms require water for their functioning. Moisture content of the pile is very important; as you build the pile you should be watering the layers. Test for proper moisture content by squeezing a handful of material from the pile. You should just barely get water coming out on the edges between your fingers at the end of the squeeze.
- Pile Construction Materials: Microorganisms are the engines of our compost pile and they require a balanced diet of proteins (nitrogen) and carbohydrates (carbon). The compost piles initial C/N ratio should be around 25 to 30:1 (ratio by weight not volume).

Carbon to Nitrogen Ratios for Some of Common Composting Materials

Materials greater than 40:1 are considered Carbons (browns)
Materials less than 30:1 are considered Nitrogens (greens)

food waste	12:1	leaves	40 to 80 :1		
grass clippings (green)	15:1	grass clipping (dry)	70:1	newspaper	300: 1
manure	20:1	straw	80:1	sawdust	400:1
coffee grounds	20:1	old hay	80:1	cardboard	200 to 500 :1
young weeds	30: 1	paper	170:1		

To obtain the correct C/N ratio throughout the pile, build the pile in thin layers of material placing thicker Browns (C layers) with thinner Greens (N layers). A simple compost pile can be built with three main ingredients: horse manure (Carbon layer), coffee grounds (Nitrogen layer), and greens, like grass clippings and vegetable parts (Nitrogen layer). Avoid the following in your pile: diseased plants, pet feces, meat or dairy products, and humanure. Layers should not exceed three inches in thickness. Thin layers help speed the composting process. The rough rule of thumb is three brown units to one green unit. While constructing the pile add plenty of water as you go and (if you have it on hand) add a thin layer or two of rock phosphate. The compost chemistry (humic acids) will create a more available phosphorous for your plants in the finished compost. As you finish building your compost pile, end with a thick layer of dry browns; this will act as a mulch and aid in holding in moisture. When you turn the pile you

What's happening in the compost pile?

Initially the cold loving organisms begin the decomposition. Due to the pile mass (it holds in the organisms metabolic heat) the internal pile temperature will begin to climb. As the pile temperature raises the regime of microorganisms changes. Finally the heat loving microorganisms take over. These thermophilic organisms will get to work in the pile and a well-constructed pile will reach 100 degrees F in a day and peak at 140 to 150 degrees F within two to four days.

should incorporate this high carbon layer into the center. During the dry seasons make your piles flat topped to catch rain. When you turn the pile for the fall you can make it more pointed to help shed water.

The pile height will decrease with time due to the material breakdown and compacting (a 5 foot pile can drop to 3 feet in a week). When the pile temperature breaks aerate the pile by forking and when it lowers a second time turn the pile to incorporate the outer cooler edge to the center and fluff up the pile.

A pile can completely decompose in one month, though it may take longer depending on the weather. Regardless, your compost should be ready to use at the start of the next growing season if it is built by mid-September. Though oxygen-free compost piles will decompose with the help of anaerobic bacteria, these tend to smell strongly, so be sure to create a pile that has plenty of moisture and air in which oxygen-loving aerobic bacteria can thrive. Here are a few more trouble-shooting tips for maintaining your compost pile:

Problem	Possible Causes/Fixes
Pile does not heat up	Too dry: check moisture level **or** the C/N ratio is too high: add nitrogen
Pile does not heat up (or it only heats in the center) and it feels moist	Pile is probably too small
Decomposition is not complete	Aerate pile and mix well
Pile is soggy and smells from rain	Add carbon material to dry pile and cover pile
Ammonia smell but not wet	Aerate and add carbon source

Once compost is ready, it provides the nutrients that growing plants need to thrive. Garlic beds may be covered with compost before the first snow in the fall, though most other beds can wait until spring to be composted. If your class has created a hot compost pile, it may be ready for use in as short as one month. Compost is ready when the original materials are no longer distinguishable. At this point, it will resemble soil and smell earthy.

Here's a simple test to determine if your compost pile is done. Fill a Ziploc bag with compost, seal it and leave it for 24 to 48 hours. Open and smell it. If there is a bad odor (which is a sign of fermentation), the process is not completed and the end product is not stable humus yet.

For more information on hot composting, please see *The Rodale Book of Composting*, which is available for check-out from Calypso.

Curricular Connections: Building a Hot Compost Pile

Follow the directions on the previous pages to construct a hot compost pile with your class and then try some of the following activities with your class.

Mathematics Connections:

- Measure and chart the temperature and dimensions of the pile over time.*
- Calculate the proportion of school lunch trash that could potentially be composted. Teach other students how to sort school lunch trash into compostable and non-compostable items.*
- Conduct a survey to determine what percentage of student families and teachers compost at home.*

Science Connections:

- Devise a plan to hasten decomposition in your class compost pile. Consider increasing aeration, decreasing the size of materials, adding microbes, or increasing pH.* (GLE[6]SC3.1)
- Draw or build a model of the layers or components in your pile. Describe how they change. Which original ingredients can be identified over time? * (GLE[6]SC3.1)
- Examine the different compost components under a microscope. Draw, describe, and try to identify them.* (GLE[6]SD2.1)
- Sort and classify organic materials outdoors as either dry (high carbon) or fresh (high nitrogen). Discuss how you made decisions about how to classify them.*
- Based in what you've learned about decomposition and composting, draw a diagram to illustrate how an apple core could become part of a tomato and then part of you.* (GLE[6]SC3.1)

English/Language Arts Connections:

- Develop a newsletter or presentation to help teach others about composting.*
- Discuss this quote by Loren Eisley: "Nature has no interest in the preservation of her dead; her purpose is to start their elements upon the eternal road to life once more."*
- Listen to *The Garden Song* and then have your children create new lyrics to change it into *The Compost Song*. *The Garden Song* may be found on the audiotape: *Rosenshontz Tickles You*, available from Lightyear Records (ISBN 1-87949-634-8). The words may also be found in *Guide to Kids' Gardening* by Ocone and Pranis or *Let's Grow!* by Tilgner. Also, *Inch by Inch*, written by David Mallet and illustrated by Ora Eitan, portrays the lyrics and provides the musical score (from *Beyond the Bean Seeds: Gardening Activities for Grades K – 6*).
- Read "Sarah Sylvia Cynthia Stout Would Not Take the Garbage Out" in Shel Silverstein's *Where the Sidewalk Ends* (♥♣♦♦). Categorize the things mentioned in the poem as either compostable or non-compostable.
- Create a slogan to encourage people to compost. Some slogan that already exist as bumper stickers and t-shirts include: (from *Beyond the Bean Seeds: Gardening Activities for Grades K – 6*)
  - "Compost happens."
  - "Compost because a rind is a terrible thing to waste."
  - "Compost with a sense of humus."

Social Studies Connections:

- Investigate unique decomposition systems and the cultures that devised them. For examples, farmers in China dig parallel trenches and fill them with organic waste and redworm cocoons. They then plant soybeans between the trenches to take advantage of the nutrients released by the worms. Other gardeners bury organic waste in holes, cover it with soil, then plant seeds or seedlings directly above the pit.*
- Find out what happens with grass clippings, leaves, and other yard wastes collected in your town or city.*

* = activity from www.kidsgardening.com

Activity: Family Compost Feud

(adapted from *French Fries and the Food System*)

Objective:

Students will learn about the ingredients and processes that make a functioning compost pile.

Materials:

For structure of compost: chicken wire, loose bricks, wood scraps, stakes, buckets, crates

For inside of pile: food waste, greens (grass, etc.), leaves, hay, soil, manure, coffee grounds

For construction of pile: pitchforks, shovels, hammers, nails, wire cutters

Procedure:

1. Set up the area for the game. Choose a space with enough room for two teams to build their piles. In the center of the spot create two piles: one with materials for building the structure that encases the compost (chicken wire, bricks, wood) and another with ingredients for the pile itself.
2. Split the group into two teams.

Round One:

3. The ultimate goal of this game is to see which team can create the best compost pile. This includes the structure that holds the piles as well as the ingredients inside. Not all compost piles require a structure to hold them in, so students have the freedom to build a compost pile without a physical structure to hold it in. Before constructing the piles, play a game to provide students with hints on building the pile. The game is in the style of the television game show Family Feud. Each team will be awarded points for each correct answer that they provide. During the compost building section of the competition (Round Two), a team will be allowed to ask the facilitator/teacher one question for each point they earn during the game show (Round One).
4. Make sure the teams are standing across from each other. Appoint an impartial judge. Hold a book or something flat in front of you to act as the buzzer. You can have one or two people from each team come to the buzzer to answer the question.
5. Use the Family Compost Feud Questions on the next page to ask the questions. The first person to hit the buzzer answers the question. If they answer incorrectly, the other team can try to answer the question and get the point. Teams receive one point per right answer and two points for the bonus question.
6. After all the questions have been answered, tally up the points and tell each team how many points they have going into Round Two.

Round Two:

7. Each team stands on opposite sides of the ingredient piles and chooses the spot where they will build their compost structure. Read these instructions aloud:
   a. You will design a compost structure and recipe for home use. Use the information from Round One to build a pile that will decompose over time. (You may want to remind students of the key points covered in Round One.)
   b. Use the materials provided as well as those in the area – especially the green and brown stuff that may already exist around here (like leaves and dirt).
   c. If you have five points from Round One, you may ask five clarifying questions in Round Two. (If you have two points, you may ask two questions.) Questions must be specific. You may not ask, "What are the ingredients in a compost pile?" You may ask, "Will these grass clippings decompose in the pile?"

8. Circulate as students work and announce how much time is left. As you circulate, remind them to ask their questions.
9. When time is up, ask each team to present their structure. After one presents, the facilitator and the other team should ask clarifying questions. After each team presents, the facilitator talks with the judges to decide how many additional points each team should receive. Score piles on a scale of one to five, five being the best, and add those points to the ones that they received during Round One.
10. During the question/answer session, when each crew is presenting their pile, ask relevant questions to bring up more advanced concepts about compost that were not raised in Round One. Teams can receive bonus points for answering them. Leading questions:
    a. You need a good balance of carbon and nitrogen in the pile. Which materials do you think represent carbon and which represent nitrogen?
    b. Do the sizes of the piles matter?
    c. Do we need air and water in our piles?
    d. How hot will the pile get and why? Why is this significant?
11. Tally up each team's points and announce the winning team.
12. Extensions: If you are unable to go outside and build actual piles, you could provide props or cards that list/represent different compost ingredients (green shredded paper as grass clippings, etc.). You could also have them build a pile with words ("vegetable waste," "soil," "manure") that they write on cards themselves.

Family Compost Feud Questions

What parts of the forest does the action in composting imitate? (The floor.)

Who are the major players in your compost pile? Who eats the stuff to make the end product? What does the decomposing? (Microorganisms, bacteria, fungi, worms, grubs.)

Give one example of something that is considered to be organic matter. (Plants, leaves.)

What materials does compost become after it is broken down? (Soil, fertilizer, humus.)

Why do we compost? (To reduce waste, to reduce what goes to the landfill, to provide fertile amendments for the garden or farm.)

Bonus (worth two points): *What are the five main ingredients in your compost pile?* (Green stuff, brown stuff, air, water, heat.)

Curricular Connections: Family Compost Feud

Mathematics Connections:

- Design a rubric to judge the other team's pile. (GLE [4,5,6] S&P-1)
- Study volume by creating a compost holding structure given a certain amount and proportion of materials. Use manipulatives to build miniature versions of your structure. (GLE [6] G-9)

Science Connections:

- Compare and contrast the materials available for compost (or decomposition in nature) that exist in different ecosystems. What would you have available if your schoolyard was in Hawaii? Or South America? (GLE[6]SC1.2)
- Keep track over time of the volume and rate of decomposition in each pile. Compare and contrast the factors that may have caused one pile to become completed compost first. (GLE[6]SC3.1)

English/Language Arts Connections:

- Write up your team's compost "recipe." Be sure to document your resources. Publicize this recipe to local Fairbanks gardeners. (Writing GLE [4] 2.1.2, Writing GLE [4,5,6] 2.2.2, Writing GLE [4,5,6] 2.5.1)
- Write a newspaper article on composting. Describe your class competition and challenge others to build compost. (Writing GLE [4,5,6] 2.2.2)

Fine Arts Connections:

- Decorate your compost holding structures. Create an interactive educational display to keep near the compost piles.

Activity: What Good is Compost?

(adapted from *The Growing Classroom*)

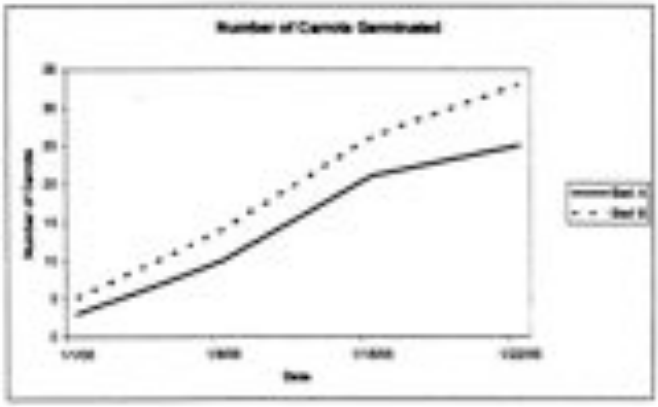
Objectives:

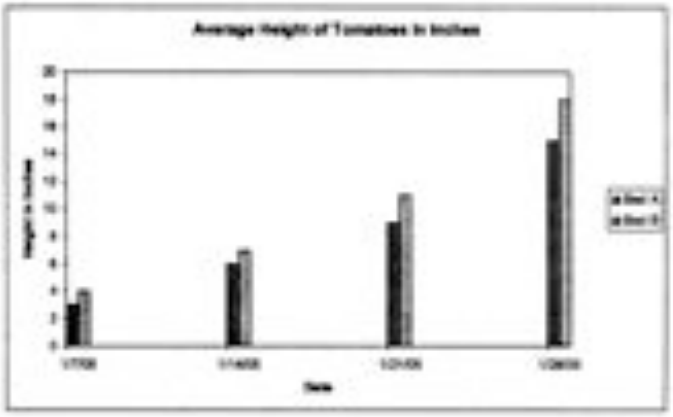
Students will design and conduct an experiment to test the effectiveness of compost on growing plants.

Materials: one garden bed filled with soil (or a large indoor planting container), finished compost, broadfork or garden fork, seeds, water, paper and pencils

Procedure:

1. Compost provides a healthy combination of important nutrients, including nitrogen, potassium, and phosphorous. Discuss as a class: *How could we design an experiment to see if compost helps plants grow?* (Record ideas and design plan.) *How will we tell if compost makes a difference?* (Design charts for measuring the difference.) Design an experiment with your class to test the effectiveness of compost, or use the design plan below.
2. Predict how the growth of a plant planted in compost will differ from the growth of a plant planted without compost. Record predictions.
3. Divide a bed in half. Fertilize one half with compost, turning it in to the first few inches of soil. Do not apply compost to the other half of the bed, but do similarly turn the top few inches of soil.
4. Plant the whole bed with one crop, or plant several kinds of the same types of crop in each bed. If you choose to plant multiple types of plants, try to choose one of each of the following: root crop (carrot, turnip, beet, etc.), leaf crop (lettuce, cabbage, spinach, etc.), and fruit crop (tomato, zucchini, etc.).
5. Have students make charts comparing the success of the crops in each bed. They could compare the speed of growth, health as they grow, and final size when they are harvested.
6. Have students set up a maintenance schedule so that both beds receive the same care.
7. Regularly collect and record data from the two beds.
8. Summarize the information you collected. *Which bed did better? Why did it do better? How do your results compare with your predictions?*





Curricular Connections: What Good is Compost?

Mathematics Connections:

- Explore the many ways your data could be represented and shared visually through charts and graphs. (GLE [4,5,6] S&P-1)

Science Connections:

- Explore the following: Compost provides nutrients that plants need to grow. Do people also grow better with better nutrition? Do they grow bigger, faster, and have fewer "pest" problems? (GLE[4]SC2.2, GLE[5]SC2.2)
- Given the same key question – "Does compost help plants grow?" – design another experiment to follow up with your findings. (GLE[4]SC3.1)

English/Language Arts Connections:

- Summarize your findings in written form. Write a letter to the editor of the Daily News-Miner about composting in Alaska or write an article to be included in a gardening journal about composting. Be sure to justify composting using evidence from your experiment. (Writing GLE [4,5,6] 2.2.2)

Annotated Resources

Teaching Resources: Garden and Food-Related

The following resources are available for check out from Calypso Farm and Ecology Center. These books were invaluable resources in writing *The Living Classroom Manual* and include many activities applicable to garden-based education in interior Alaska.

At Home and at Work with Anna Lid and her Friends (Sustainable Farming Association of Central Minnesota)

- This coloring book is the simple story of an earthworm and includes information for teachers.

Beyond the Bean Seed: Gardening Activities for Grades K-6 (Nancy Allen Jurenka, Rosanne J. Blass)

- Each chapter of this book is a series of activities focused around a children's book related to gardening and growing. Featured book topics include botany, flowers, vegetables, fruit, gardening, animals in the garden, habitats, and city gardening. Includes comprehensive annotated bibliography of children's literature related to gardening and growing.

Exploring Environmental Issues: Municipal Solid Waste (Project Learning Tree)

- This introduction and overview of municipal solid waste management issues includes activities on composting.

Food Choices: Student Edition and Teacher Resource Guide (E2: Environment and Education)

- This middle and high school textbook focuses on food choices, nutrition, and food and the environment. The book provides activities and steps toward completing a campus audit, evaluating food choices, and making campus-wide food choice proposals.

French Fries and the Food System: A year-round curriculum connecting youth with farming and food (Sara Coblyn at The Food Project)

- Divided into season-appropriate activities, these lessons focus on the whole of the gardening process, from planning to marketing and selling; it includes a great collection of winter gardening activities. This book is based on The Food Project in Boston, a well-renowned and established program that has been setting the standard for garden-based youth education programs for over fifteen years.

From A to Z in Sustainable Agriculture: A Curriculum Directory for Grades K-12 (The Center for Sustainable Agriculture, Division of Agriculture, Natural Resources and Extension, University of Vermont and State Agriculture College)
- This text outlines the names, topics, and availability of curriculum resources focused on sustainable agriculture topics, food, nutrition, natural resources, and communities.

Gardening Wizardry for Kids: Green Thumb Magic for the Great Outdoors (L. Patricia Kite)
- This brightly colored text includes the history and folklore of common herbs, fruits, and vegetables; activities involving fruits and vegetables (particularly cooking activities); indoor plant experiments; plant craft projects; and information on raising earthworms, pill bugs, and snails.

GrowLab: Activities for Growing Minds (National Gardening Association)
- The four main themes of this book – introduction to plants and ecology, life cycles, diversity, and interdependence – are covered through hands-on activities and supporting materials.

Growing Ventures: Starting a School Garden Business (National Gardening Association)
- An overview of school garden business, this book includes the general structure and instructions of businesses, successful project profiles, and sample classroom materials.

Healthy Foods from Healthy Soils: A hands-on resource for educators (Elizabeth Patten and Kathy Lyons)
- This fantastic resource of food and garden-based activities for elementary aged students includes activities for every subject area, including science, math, language arts, and the fine arts.

Let's Grow!: 72 Gardening Adventures with Children (Linda Tilgner)
- This collection of garden-based activities includes: tips for growing with children of different ages and abilities; activities and tips for growing vegetables, flowers, herbs, and trees; plant experiments; natural ecology; fauna observation activities; family and group projects; and activities for each season.

Looking at Plants (David Suzuki)
- A collection of plant-based, hands-on activities to learn the basics about roots, stems, leaves, and flowers.

Math in the Garden: Hands-on activities that bring math to life (National Gardening Association)
- This outstanding resource includes dynamic, garden-based mathematics lessons for kindergarten through eighth graders. Activities are hands-on and correlated to national science and mathematics standards.

Project Seasons: Hands-on activities for discovering the wonders of the world (Deborah Parrella, Shelburne Farms)

- This incredible text provides environmental education lessons for every season of the year. Because this book was created at Shelburne Farms in Vermont, most of these activities are applicable to interior Alaska.

The Growing Classroom: Garden-Based Science (Roberta Jaffe, Gary Appel)

- This comprehensive, garden-based approach to science includes sections on: problem solving and communication, awareness and discovery, soil, growing, outdoor gardening, cycles and changes, interdependence, garden ecology, garden creatures, climate, and nutrition.

The Worm Café: Mid-Scale Vermicomposting of Lunchroom Wastes (Binet Payen)

- This comprehensive book outlines the process of creating manageable vermicomposting projects for classes or schools. Topics include building workable compost bins, backgrounds on composting worms, organization of composted materials, and other logistics. A collection of worksheets and an annotated curriculum and children's literature bibliography are also included.

Worms Eat My Garbage: Classroom Activities for a Better Environment (Mary Appelhof, Mary Frances Fenton, Barbara Loss Harris)

- This accompaniment to *Worms Eat My Garbage* (Mary Appelhof) includes three sections: an introduction to worms ("The World of Worms"), vermiculture ("Worms at Work"), and applications of worms and environmentally responsible actions ("Beyond the Bin").

Additional Teaching Resources

Alaska Department of Fish and Game. (2001). *Alaska's Ecology: Alaska wildlife curriculum teacher's guide*. pp. 127-131.

- This text, correlated to Alaska's educational standards, is a fantastic resource for exploring the ecology of our area. A copy is available through the school district office.

Gardening Resources

The following resources are available for checkout from Calypso Farm and Ecology Center. Calypso also owns many additional technical gardening resources; if you are interested in checking out resources for use in your classroom, please contact Calypso!

A Child's Organic Garden: Grow Your Own Delicious Nutritious Foods (Lee Fryer and Leigh Bradford)

- Anecdotal and instructive chapters move through the process of creating an organic garden, beginning with an overview of the concept.

Success with School Gardens: How to Create a Learning Oasis in the Desert (Linda A. Guy, Cathy Cromwell, Lucy K. Bradley)

- A how-to book for creating school gardens in the desert ecosystem, including information on volunteer recruitment, fundraising, publicity, and growing practices.

Discovering Wild Plants: Alaska, Western Canada, the Northwest (Janice J. Schofield)

- A comprehensive guide to identifying and using wild plants, this book is divided into sections according to where the plants can be founds (including marshes, ponds, and wet places; forests and open woods; wild grassy meadows; etc.).

Websites

Alaska Ag in the Classroom
www.alaskafb.org/~askaitc/

Cornell Waste Management Institute. *Composting: Waste to Resources.*
http://cwmi.css.cornell. edu/TrashGoesToSchool/Discover.html

Florida Gulf Coast University. *Solid Choices: Composting Supplement.*
http://www.fim.edu/doe/curriculum/environ/compost.html

National Gardening Association
www.kidsgardening.com
Every teacher should bookmark this website; it includes innumerable resources for integrating gardening into your elementary classroom!

The Edible Schoolyard
www.edibleschoolyard.org/homepage.html
The Edible Schoolyard, a school garden project in Berkeley, California, has set the standard for school garden programs across the country with their expansive garden, fully integrated into their middle school curriculum.

Calypso Farm and Ecology Center and The Schoolyard Garden Initiative

The Alaskan school garden is a dynamic outdoor classroom, ideal for teaching every subject! Calypso Farm and Ecology Center compiled *The Living Classroom Manual* to compliment the Schoolyard Garden Initiative in Fairbanks, Alaska.

Calypso Farm and Ecology Center

Calypso Farm and Ecology Center is a non-profit, education-based farm located in Ester, Alaska. Our mission is *to encourage local food production and environmental awareness through hands-on education in natural and farming ecosystems.* Calypso serves the greater Fairbanks area. Situated on thirty acres of land, the center consists of a small, diversified farm surrounded by boreal forest. Calypso provides 60 families with fresh, organically grown produce through our farm-based Community Shared Agriculture (CSA) program, through which families buy a share of vegetables and receive a weekly portion of the harvest throughout the growing season. Calypso's educational programs include: the Schoolyard Garden Initiative, Employing Alaskan Teens in Gardening (EATinG), Farm-Based Field Trips, a Children's Garden, the Ecological Gardening Workshop Series, and a Resource Library. In addition, Calypso provides organic gardening consulting, volunteer opportunities, and farm tours to our local community and visitors.

The Schoolyard Garden Initiative

The Schoolyard Garden Initiative responds to the need for hands-on education in the Fairbanks schools, a garden connection for kids, and locally grown food for the community. The goal of Calypso's Schoolyard Garden Initiative is to create a network of school gardens functioning as experiential learning environments during the school year and as food production sites during the summer months.

A Garden Committee is formed at each school participating in the Schoolyard Garden Initiative. With Calypso support, this group of parents, teachers, administrators, and students takes on the primary responsibility to fundraise for and create a garden at their school.

During the summer months, the schoolyard gardens are maintained by middle and high school students employed in Calypso's EATinG program under the direction of an adult supervisor. These youth participate in an intensive eleven-week summer training program to increase awareness of local agriculture potential and small business practices while building employable skills. The EATinG staff provides fresh, organically-grown produce to Fairbanks families through a school-based CSA program. Teenagers

are responsible for garden care, CSA operation, budget creation, building projects, and program evaluation. Students are compensated both monetarily and with a share of the vegetables they grow.

Ecological Gardening

Through the Schoolyard Garden Initiative, Calypso supports schools in creating school gardens founded on the principle of ecological gardening. Ecological gardening is a gardening approach that is organic by definition (not using chemical herbicides, pesticides or fertilizers), but encompasses much more. Ecological gardening considers the garden as a functioning ecosystem set within the surrounding natural ecosystem. The goal is to keep both the garden and surrounding ecosystems in balance and healthy.

Key components of ecological gardening are:

- developing a full understanding of the surrounding natural ecosystem
- creating a garden ecosystem to meet the needs of the plants that you want to grow and the people and other animals who will be a part of it
- building and maintaining natural soil fertility
- promoting species diversity (plants, animals, microbes…)
- long-term planning, observation and patience

Please contact Calypso Farm and Ecology Center with questions or for more information on *The Living Classroom Manual*, ecological gardening, or any of our programs!

For more information or support, please contact:

Calypso Farm and Ecology Center
PO Box 106
Ester, Alaska 99725
(907) 451-0691
(907) 451-0697 (fax)
www.calypsofarm.org
info@calypsofarm.org