3.D.4 Growing Plants

Designing a container for live plants using the Engineering Design Process

Grade Level	3
Sessions	(4): 2 at 35 minutes, 1 at 40-80 minutes, 1 at 5-15 minutes
Seasonality	Spring
Instructional Mode(s)	Whole Class, Small Groups
Team Size	2-4 Students
WPS Benchmarks	03.SC.TE.01, 03.SC.TE.02, 03.SC.TE.03, 03.SC.TE.05, 03.SC.IS.01, 03.SC.IS.02, 03.SC.IS.03, 03.SC.IS.04, 03.SC.IS.05, 03.SC.IS.06, 03.SC.LS.07, 03.SC.LS.08
MA Frameworks	3-5.TE.1.1, 3-5.TE.1.2, 3-5.TE.2.1, 3-5.TE.2.2, 3-5.TE.2.3, 3-5.LS.0.3, 3-5.LS.0.9
Key Words	Container, Engineering Design Process, Graph, Grow, Metric System, Plant

Summary

This lesson provides students with the opportunity to design, construct, and test a container for growing plants. Students will apply their knowledge of the Engineering Design Process and will observe the various stages of the plant life cycle. After making observations, students will also record information in an organized manner and will practice sketching various plant structures.

Learning Objectives

2002 Worcester Public Schools (WPS) Benchmarks for Grade 3

1. 03.SC.TE.01 Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.
2. 03.SC.TE.02 Identify and explain the appropriate materials and tools (e.g., hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) to construct a given prototype safely.
3. 03.SC.TE.03 Identify a problem that reflects the need for shelter, storage, or convenience.
4. 03.SC.TE.05 Develop a knowledge and understanding of the metric measurement system.
5. 03.SC.IS.01 Ask questions and make predictions that can be tested.

6. 03.SC.IS.02 Select and use appropriate tools and technology (e.g., calculators, computers, balances, scales, meter sticks, graduated cylinders) in order to extend observations.
7. 03.SC.IS.03 Keep accurate records while conducting simple investigations or experiments.
8. 03.SC.IS.04 Conduct multiple trials to test a prediction. Compare the results of an investigation or experiment with the prediction.
9. 03.SC.IS.05 Recognize simple patterns in data and use data to create a reasonable explanation for the results of an investigation or experiment.
10. 03.SC.IS.06 Record data and communicate findings to others using graphs, charts, maps, models, oral and written reports.
11. 03.SC.LS.07 Recognize that plants and animals go through life cycles that include birth, growth, development, reproduction and death.
12. 03.SC.LS.08 Grow plants from seeds. Document the complete life cycle of the plant. Emphasize emergence of structures and the functions of these structures. Record changes in height over time. Graph the data.

2001 Massachusetts Frameworks for Grade 3

1. 3-5.TE.1.1 Identify materials used to accomplish a design task based on a specific property, i.e., weight, strength, hardness, and flexibility.
2. 3-5.TE.1.2 Identify and explain the appropriate materials and tools (e.g., hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) to construct a given prototype safely.
3. 3-5.TE.2.1 Identify a problem that reflects the need for shelter, storage, or convenience.
4. 3-5.TE.2.2 Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists.
5. 3-5.TE.2.3 Identify relevant design features (e.g., size, shape, weight) for building a prototype of a solution to a given problem.
6. 3-5.LS.03 Recognize that plants and animals go through predictable life cycles that include birth, growth, development, reproduction, and death.

7. 3-5.LS.09 Recognize plant behaviors, such as the way seedlings' stems grow toward light and their roots grow downward in response to gravity. Recognize that many plants and animals can survive harsh environments because of seasonal behaviors, e.g., in winter, some trees shed leaves, some animals hibernate, and other animals migrate.

Additional Learning Objectives

1. Students will strengthen observation skills.
2. Students will apply their knowledge of the metric system and the Engineering Design Process.
3. Students will strengthen manipulative skills.

Required Background Knowledge

1. Students should be familiar with a variety of plant structures (see lesson 3.D.1. Plant Structures).
2. Students should have a good understanding of the generic plant life cycle (see lesson 3.D.2 Plant Life Cycles).

Essential Questions

1. What do plants need in order to grow?
2. What type of container is best for growing plants?
3. How can the Engineering Design Process be used to design a plant container?
4. How can plant growth be measured and graphed in the metric system?

Introduction / Motivation

The instructor may wish to begin the lesson by discussing the basic necessities of plants. Students should understand that plants require sunlight, water, nutrients, and air. It is important to note that too much or too little of each of these required items can be harmful to a plant. For example, too much water or too much sunlight will kill some varieties of plants.

Procedure

The instructor will:

Part 1: (35 minutes)

1. Provide each student with a Design My Own Plant Container worksheet.
2. Lead students though questions 1 and 2. They may wish to discuss their ideas with a partner or within groups. Encourage students to feel confident in unique ideas. There is no incorrect container design.
3. Show students the materials available for container design (see Materials List – Materials per Student).
4. Ask students to complete the chart on page 3 of their worksheets. Note that if students plan to use “potting soil”, they should write the “amount” that they will use as a metric measurement. It may be helpful to allow students to look at a set of metric measuring cups.

Part 2: (35 minutes)

1. Ask students to revisit the Design My Own Plant Container worksheet.
2. Encourage students to look over responses to questions 1 and 2.
3. Provide each student with a single large sheet of white paper.
4. Ask students to complete question 3, taking care to label each part of the diagram and to mark which materials will be used for each part of the Plant Container.

Part 3: (40-80 minutes)

1. Ask each student to write his/her name on a craft stick using a permanent marker.
2. Allow students to collect the materials that they have chosen for their plant container.
3. Provide students with sufficient time to construct their plant containers.
4. Ask each student to plant five marigold seeds in the newly designed plant container. If students plan to use potting soil, they should measure the correct amount of soil by using metric measuring cups.
5. As a class, review a plant’s basic necessities (water, air, nutrients, sunlight).

6. Determine the most appropriate location in the classroom for the marigold seeds to germinate (see Vocabulary with Definitions).
7. Place all plant containers (each containing five planted seeds) in a disposable aluminum baking pan (see Materials List) and leave pan in the elected location. The pan serves to catch drained water and to keep all students' containers together.
8. Remind students on this day and in subsequent days that plants require water; the potting soil should always stay moist (see Troubleshooting Tips).

Part 4: (completed regularly 5-15 minutes each time)

1. Ask students to record observations of their plants using the chart in question 4 of their Design My Own Plant Container worksheet.
2. Once plants have flowered, ask students to complete the worksheet, The Metric System – Plants.

Materials List

Materials per class	Amount	Location
Indelible Marker (ex. Sharpie®)	Several	Classroom
Disposable Aluminum 9x13" Baking Pan	Two or three	Dollar store, grocery store
Water	Varies	Classroom
Metric Measuring Cups	Several sets	Grocery store, home

Materials per student	Amount	Location
Scissors	One pair	Classroom
Marigold Seeds	Five	Garden supply store
Craft Stick	One	Craft store
Paper Cups	Varies	Grocery store
Plastic Cups	Varies	Grocery store
Styrofoam Egg Carton	Varies	Recycle bin
Plastic Wrap	Varies	Grocery store
Paper Towels	Varies	Grocery store

Potting Soil	Varies	Garden supply store, Wal-Mart
Metric Ruler	One	Classroom

Vocabulary with Definitions

1. *Germinate* – to begin to grow.
2. *Graph* – a visual representation of information.
3. *Grow* – to increase in size, develop, and mature.
4. *Metric System* – a system of measurement in which length is measure in meters, or increments of meters, and weight is measure in grams, or increments of grams.
5. *Plant* – a photosynthetic organism that reproduces itself, usually by producing fruit and seeds.

Assessment / Evaluation of Students

The instructor may assess the students in any/all of the following manners:

1. Listen to class discussions to determine whether students understand the basic necessities of plants.
2. Collect student worksheets and evaluate whether students are able to correctly utilize the Engineering Design Process to design and create a container for growing a plant.
3. Collect student worksheets to determine whether students are able to correctly measure length and volume in metric units.

Lesson Extensions

1. Demonstrate and/or involve students in composting.
2. As a class, grow sweet potatoes (see Additional Resources and Appendix B: Instructor's Notes).

Attachments

1. Appendix A: Instructor's Notes
2. Appendix B: The Engineering Design Process
3. Design My Own Plant Container

Troubleshooting Tips

1. For germinating seeds, potting soil should always feel damp, but not wet. If some students' plants are frequently dry, the students may wish to "improve" their containers, perhaps by placing clear plastic wrap over the tops of their containers and poking several holes for air.
2. The teacher may wish to grow extra plants at home in case several students' plants fail to sprout or do not survive.

Safety Issues

1. Scissors should be used with caution.
2. The edge of the plastic wrap box is quite sharp; the instructor should pass out plastic to students that chose it.

Additional Resources

1. Virginia Department of Agriculture and Consumer Services. Resources for Teachers: Growing Activities for Tomorrow's Consumers. Accessed 31 December 2005 from http://www.vdacs.virginia.gov/teachers/growing.html.

Appendix A: Instructor's Notes

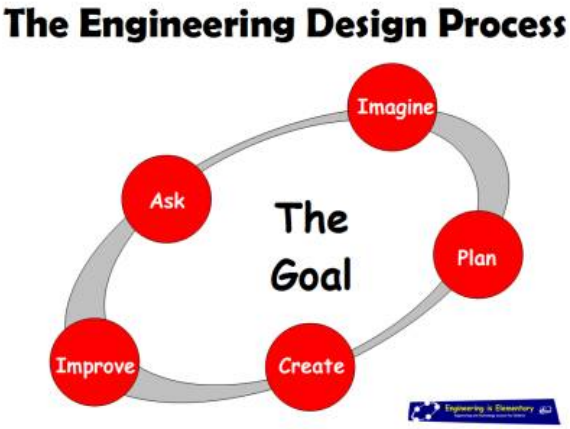
The following excerpt comes from: Forrester, Tina. "Sweet potato vine: Amaze your kids by sprouting a lush vine from this grocery-cart staple". Canadian Gardening. Accessed 31 December 2005 from http://www.canoe.ca/LifewiseHomeYardWeekend00/0513potato.html.

Growing a Sweet Potato

"To help your kids grow their own vine, choose a firm sweet potato. Some are treated with heat to keep them from sprouting on grocery-store shelves, but most grow roots in a matter of days after being placed in water. Using four toothpicks, have your child suspend the vegetable on the rim of a jar or mug filled with water. Make sure the bottom half - the pointed end - is under water. Place in a sunny spot, and change or add water as needed. In a few days, roots will form below the water. And, two to three weeks later, leaves and stems will sprout from the top. Continue to grow the plant in water or, after a month or two, pot the sweet potato in a houseplant potting mix. Keep the soil moist. The stems are weak, so help your child tie them to strings, wire or a stake. Feed once a month with a balanced water-soluble fertilizer such as 20-20-20. As the vine grows, cut it back a few inches to force the plant to grow bushy. If your kids want to try growing sweet potatoes in your garden, you can have them root 25- to 30-centimetre (10- to 12-inch) cuttings in water, then plant them outside in late May to produce sweet potatoes they can dig and eat in the fall. Plant 30 centimeters (one foot) apart and feed once a month with 5-10-10 fertilizer. Mulch with straw or dry leaves to control weeds, and keep the soil moist. The tubers need approximately 120 days to mature, so let them grow as long as you can. But don't let frost hit them. In case of an early frost, cover the plant overnight with newspaper to keep the vines growing. Late in the season, probe beneath the vines to test the size of the tubers. Be careful not to puncture or bruise them. Store the tubers in a cool, dry place, and wrap them in newspaper to keep them from sprouting."

Appendix B: The Engineering Design Process

"The Engineering Design Process for Children" and associated text comes directly from: http://www.mos.org/doc/1559 (accessed 2 February 2006).



"The Engineering Design Process is a series of steps that engineers use to guide them as they solve problems. Many variations of the model exist. While having a guide is useful for novices who are learning about engineering, it is important to note that practicing engineers do not adhere to a rigid step-by-step interpretation of the process. Rather there are as many variations of the model as there are engineers. Because our curriculum project focuses on young children, we have created a simple process that depicts fewer steps than other renditions and that uses terminology that children can understand. The engineering design process is cyclical and can begin at any step. In real life, engineers often work on just one or two steps and then pass along their work to another team."

"A few questions can guide students through each of the steps:

"ASK

- What do I want to do?
- What is the problem?
- What have others done?

"IMAGINE

- What could be some solutions?
- Brainstorm ideas.
- Pick one to start with that you think will work the best.

“PLAN

- Draw a diagram of your idea.
- Make lists of materials you will need to make it.
- Decide how it works. How will you test it?

“CREATE

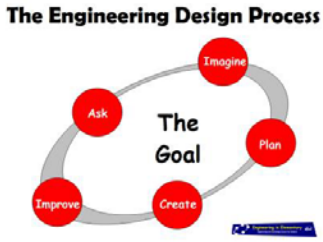
- Build a prototype.
- Test it.
- Talk about what works, what doesn't, and what could work better.

“IMPROVE

- Talk about how you could improve your product.
- Draw new designs.
- Make your product the best it can be!”

Design My Own Plant Container

Name: _____ Date: _____



The Engineering Design Process for Children: http://www.mos.org/doc/1559 (accessed 27 February 2006)

1. **Ask –**

What type of plant container do I want to build? _____

_____

_____

2. **Imagine** –

Imagine that you are a materials engineer. What is the purpose of your plant container? *Hint: think about what plants need to survive!*

_____

_____

_____

_____

Read the list of materials below. Think about which materials you would like to use. Beside the materials that you **will** use, write the **amount** that you will use and the **reasons** you will use each one.

Material	**Amount**	**Why will you use the material to construct your plant container?**
Paper Cup		
Plastic Cup		
Styrofoam Egg Carton		
Plastic Wrap		
Paper Towel		
Potting Soil		

3. **Plan –**

On a separate sheet of paper, draw a picture of the plant container that you would like to create. Label the parts of the container (“pot”, soil, drainage holes, etc.). Beside each part, write which material you will use to make that part of the container. Use the chart of materials above when you plan.

4. **Create –**

Collect the materials that you need and then plant your five marigold seeds. Place a craft stick with your name on it in your plant container. Test your container by observing your plants as they grow. Use the chart on the next page to record your observations.

What happened?	What date did it happen?	What did it look like? Draw a picture.
Roots appear (you *might* not be able to see the roots if you planted your seed in soil)		
A stem appears		
Leaves appear		

What happened?	What date did it happen?	What did it look like? Draw a picture.
A flower appears		
Flowers make seeds		
Seeds disperse or are collected		

5. Improve –

How can you make your plant container better?

The Metric System – Plants

Name: _____ Date: _____

The Metric System – In many parts of the world, people use a system for measuring called the "Metric System". The metric system uses meters, centimeters (cm), and millimeters (mm) to describe the length of an object. Use the metric side of your ruler, marked with centimeters (cm) to answer the following questions.

1. How **tall** did your tallest marigold grow? _____ centimeters
2. How **tall** is your plant container? _____ centimeters
3. How **wide** is your widest flower? _____ centimeters
4. How **wide** is your narrowest flower? _____ centimeters

Look at a **metric** measuring cup to answer the following questions.

5. **Estimate** how much water, in milliliters (ml), your plant drinks every day.

   _____ milliliters

6. About how much potting soil did you give your plant?

   _____ milliliters