ELEM

Engineering By Design

Advancing Technological Literacy

A Standards-Based Program Series

Moon Munchies

Human Exploration Project
Engineering Design Challenge

A Standards-Based Elementary School Model Unit Guide

Moon Munchies

Design, Build and Evaluate (Lessons 1-6)

International Technology Education Association
Center to Advance the Teaching of Technology & Science

Inspiration + Innovation + Discovery = Future

Preface

Moon Munchies

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The ITEA-CATTS Human Exploration Project (HEP)
People, Education and Technology

In May 2005, ITEA was funded by the National Aeronautics and Space Administration (NASA) to develop curricular units for Grades K-12 on Space Exploration. The units focus on aspects of the themes that NASA Engineers and Scientists—as well as future generations of explorers—must consider, such as Energy and Power, Transportation and Lunar Plant Growth Chambers (the STS-118 Design Challenges). Moreover, the units are embedded within a larger Model Program for technology education known as Engineering byDesign™.

The Human Exploration Project (HEP) units have several common characteristics. All units:

- Are based upon the Technological Literacy standards (ITEA, 2000/2002).
- Coordinate with Science (AAAS, 1993) and Mathematics standards (NCTM, 2000).
- Utilize a standards-based development approach (ITEA, 2005).
- Stand alone and coordinate with ITEA-CATTS Engineering byDesign™ curricular offerings.
- Reflect a unique partnership between NASA scientists and engineers and education professionals.

These unit guides are designed to be practical and user-friendly. ITEA welcomes feedback from users in the field as we continually refine these curricular products, ensuring that the content remains as dynamic as the technological world in which we live. Please email ebd@iteaconnect.org or call 703-860-2100.

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Unit Overview

Design is a creative problem-solving process. In this unit, students will design and build a lunar plant growth chamber using the Engineering Design Process.

> ***Big Idea***
> *The design process helps humans to solve the problems of growing plants for food on the moon.*

Standards

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the characteristics and scope of technology. (ITEA/*STL* – 1)
- Students will develop an understanding of the core concepts of technology. (ITEA/*STL* 2)
- Students will develop an understanding of the attributes of design. (ITEA/*STL* 8)
- Students will develop an understanding of engineering design. (ITEA/*STL* 9)
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving. (ITEA/*STL* 10)
- Students will develop the abilities to apply the design process. (ITEA/*STL* 11)
- Students will develop the abilities to use and maintain technological products and systems. (ITEA/*STL* 12)
- Students will develop an understanding of and be able to select and use energy and power technologies. (ITEA/*STL* 16)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- The Nature of Technology/Technology and Science (AAAS 3A)
- The Nature of Technology/Issues in Technology (AAAS 3C)
- The Living Environment/Diversity of Life (AAAS 5A)
- The Living Environment/Cells (AAAS 5C)
- The Living Environment/Flow of Matter and Energy (AAAS 5E)
- The Human Organism/Human Identity (AAAS 6A)
- The Human Organism/Physical Health (AAAS 6E)
- The Designed World/Materials and Manufacturing (AAAS 8B)
- Common Themes/Systems (AAAS 11A)
- Common Themes/Models (AAAS 11B)
- Habits of Mind/Values and Attitudes (AAAS 12A)
- Habits of Mind/Manipulation and Observation (AAAS 12C)
- Habits of Mind/Communication Skills (AAAS 12D)

Mathematics: Principles and Standards for School Mathematics *(NCTM, 2000)*

- Number and Operations
- Geometry
- Measurement
- Data Analysis and Probability

Science: National Science Education Standards *(NRC, 1996)*

- Physical Sciences/Students should develop an understanding of light, heat, electricity and magnetism. (NRC B)

- Earth and Space Science/All students should develop an understanding of properties of earth materials. (NCR D)
- Earth and Space Science/All students should develop an understanding of objects in the sky. (NCR D)

Social Studies: Expectations of Excellence *(NCSS, 1994)*

- Social studies programs should include experiences that provide for the study of people, places and environments, so that the learner can consider existing uses and propose and evaluate alternative uses of resources and land in home, school, community, the region and beyond.

English Language Arts: Standards for the English Language Arts *(NCTE, 1996)*

- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- The natural world and human-made world are different. (ITEA/*STL* 1A)
- Systems have parts or components that work together to accomplish a goal. (ITEA/*STL* 2B)
- Everyone can design solutions to a problem. (ITEA/*STL* 8A)
- Design is a creative process. (ITEA/*STL* 8B)
- The engineering design process includes identifying a problem, looking for ideas, developing solutions and sharing solutions with others. (ITEA/*STL* 9A)
- Expressing ideas to others verbally and through sketches and models is an important part of the design process. (ITEA/*STL* 9B)
- Asking questions and making observations helps a person to figure out how things work. (ITEA/*STL* 10A)
- Build or construct an object using the design process. (ITEA/*STL* 11B)
- Use hand tools correctly and safely and be able to name them correctly. (ITEA/*STL* 12B)
- Energy comes in many forms. (ITEA/*STL* 16A)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure and make things. (AAAS 3A)

- The tools and ways of doing things that people have invented affect all aspects of life. (AAAS 3C)
- When a group of people wants to build something or try something new, they should try to figure out ahead of time how it might affect other people. (AAAS 3C)
- Plants and animals have features that help them live in different environments. (AAAS 5A)
- Most living things need water, food and air. (AAAS 5C)
- Magnifiers help people see things they could not see without them. (AAAS 5C)
- Plants and animals both need to take in water, and animals need to take in food. In addition, plants need light. (AAAS 5E)
- People need water, food, air, waste removal and a particular range of temperatures in their environment, just as other animals do. (AAAS 6A)
- Eating a variety of healthful foods and getting enough exercise and rest help people to stay healthy. (AAAS 6E)
- Several steps are usually involved in making things. (AAAS 8B)
- Some kinds of materials are better than others for making any particular thing. Materials that are better in some ways (such as stronger or cheaper) may be worse in other ways (heavier or harder to cut). (AAAS 8B)
- People, alone or in groups, are always inventing new ways to solve problems and get work Most things are made of parts. (AAAS 11A)
- Something may not work if some of its parts are missing. (AAAS 11A)
- When parts are put together, they can do things that they couldn't do by themselves. (AAAS 11A)
- A model of something is different from the real thing but can be used to learn something about the real thing. (AAAS 11B)
- Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out. (AAAS 12A)
- Tools are used to help make things and some things cannot be made at all without tools. Each kind of tool has a special purpose. (AAAS 12C)
- Use hammers, screwdrivers, clamps, rulers, scissors and hand lenses and operate ordinary audio equipment. (AAAS 12C)
- Make something out of paper, cardboard, wood, plastic, metal or existing objects that can actually be used to perform a task. (AAAS 12C)
- Measure the length in whole units of objects having straight edges. (AAAS 12C)
- Draw pictures that correctly portray at least some features of the thing being described. (AAAS 12D)

Mathematics: Principles and Standards for School Mathematics *(NCTM, 2000)*

- Understand the effects of adding and subtracting whole numbers. (NCTM Number and Operations)
- Recognize, name, build, draw, compare and sort two- and three-dimensional shapes. (NCTM Geometry)
- Describe attributes and parts of two- and three-dimensional shapes. (NCTM Geometry)
- Recognize the attributes of length, volume, weight, area and time. (NCTM Measurement)
- Understand how to measure using nonstandard and standard units. (NCTM Measurement)
- Select an appropriate unit and tool for the attribute being measured. (NCTM Measurement)
- Use tools to measure. (NCTM Measurement)
- Represent data using concrete objects, pictures and graphs. (NCTM Data Analysis and Probability)

Science: National Science Education Standards *(NRC, 1996)*

- Electricity in circuits can produce light, heat, sound and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.
- Earth materials are solid rocks and soils, water and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel or for growing the plants we use as food. Earth materials provide many of the resources that humans use.
- The sun, moon, stars, clouds, birds and airplanes all have properties, locations and movements that can be observed and described.
- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials, such as air, water and soil; some are produced from basic resources, such as food, fuel and building materials; and some resources are nonmaterial, such as quiet places, beauty, security and safety.

Purpose of Unit

To understand and apply the design process as it relates to plant growth on the moon.

Unit Objectives

Lesson 1: Natural Resources on Earth

Students will:

- Identify natural resources on Earth.
- Identify the natural resources that help seeds/plants grow.
- Identify plants that provide food for people.

Lesson 2: Exploring the Moon

Students will:

- Identify and describe properties of the moon.
- Compare and contrast the properties of the moon and Earth.
- Determine a growth chamber is needed to grow plants on the moon.

Lesson 3: Providing Light for Your Plants

Students will:

- Identify and describe two sources of electricity. (electrical outlets and batteries)
- Identify and describe parts that are needed to create an electrical circuit.
- Express their ideas by sketching a diagram of an electrical circuit.

Lesson 4: Watering Your Plants

Students will:

- Identify and describe a system.
- Identify and describe parts that are needed to create a watering system.
- Express their ideas by sketching a diagram of a watering system.

Lesson 5: Designing the Growth Chamber

Students will:

- Sketch a diagram of their lunar plant growth chamber.
- Verbally explain their design to others.

Lesson 6: Building a Lunar Plant Growth Chamber

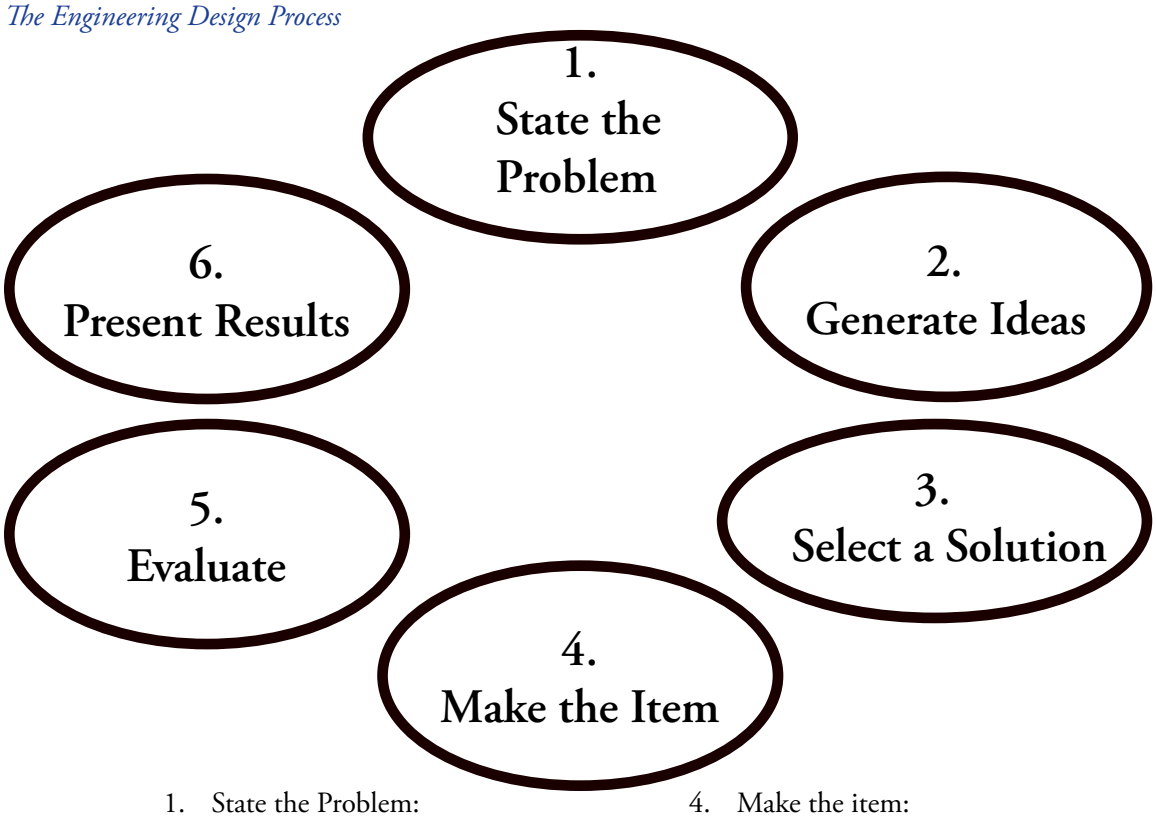
Students will:

- Understand the building process.
- Understand how to measure using standard units.
- Use an inch ruler.
- Use tools correctly and safely.
- Write about the building process.
- Explain and demonstrate the role of money in everyday life.

Teacher Preparation and Resources

As children look up at the night sky, they are certain that the lunar "ball" changes its shape. Educators can teach children about the moon using exciting, hands-on activities. This unit is designed to help children understand the design process as well as engage them in activities that will help them learn more about our Earth and moon.

The Engineering Design Process



1. State the Problem:
   - Explain the problem
   - Explain the guidelines
   - Set goals or desired results (teacher explanation)
2. Generate Ideas:
   - Brainstorm with others
   - Read books
   - Search the Internet
3. Select a Solution:
   - Sketches
   - Trial and error
4. Make the item:
   - Use resources
5. Evaluate:
   - Test, Revise; Test, Revise
   - Make adjustments/Changes
   - Improve
6. Present Results:
   - Verbal explanations
   - Share models

Engineering Portfolio and Journal

An Engineering Portfolio and Journal or EPJ, is provided so students can document their creative work, such as sketches. Student efforts can be recorded as they acquire their materials and design and build their lunar plant growth chamber.

The EPJ provides a wonderful opportunity for the teacher to model writing and language skills. The daily journal, which is part of the EPJ, should be used to help students write about their daily experiences. This approach will enhance their writing and language skills by permitting them to

connect language skills to relevant and meaningful daily activities. Detailed records of the materials students purchase at the store should be recorded. Teachers should allow students to record as many informational details as possible. Students should also be encouraged to review their writing and reflect on what they have accomplished as they complete their lunar plant growth chamber. Reading time could be enhanced by having students read their journals aloud.

One helpful management strategy might be to place all engineering worksheets and journal pages in a folder or notebook for each student.

Teachers should tell the students that many jobs require that employees document their work.

Journal suggestions:

- Write about each day's building session.
- Write about changes they made in their designs.
- Write about new discoveries.
- Write about materials they purchased and their purpose.

Tip: Be sure to provide at least ten pages (front to back) per student.

Materials Store

It is highly recommended that a store be set up for students to purchase their materials during the building process. Students will apply and improve their basic computation skills. This is also a way to have students understand the role money plays in everyday life. A list of materials and their suggested costs has been provided within the EPJ. Teachers may change these items and prices if they desire to do so. A graph has been included in the engineering portfolio for students to document the materials they purchase at the store.

Teachers should schedule specific times for students to visit the store and purchase materials they need to build their systems and chamber. Small plastic containers and large plastic bags can be used to hold the various materials and money. (Pages of the coins and dollar bills are provided for the teacher to duplicate on construction paper. Each person or team should receive approximately $16.00.)

Students should be expected to count out the amount of money they need. Each visit to the store to obtain engineering materials should include a discussion of the items they want or need and the associated costs. Students should calculate exact change and report aloud to the teacher.

Suggestion: Replenish the students' bank accounts by paying them for being safe, correctly computing their total at the store or cleaning up when asked. Older students may be used to verify the correct totals.

Safety and Tools

Students have the opportunity to use tools during this unit. The teacher should discuss and demonstrate the tools that will be used. The teacher may want to have students brainstorm a list of safety rules to follow while using tools and display a copy of the safety rules in the tool area. Science education in the elementary school is crucial to the education of children. Hands-on science activities encourage students to become active participants in learning about the world around them. The materials contained in this unit may be too advanced for your students to use. Furthermore, there may be local or state regulations that prohibit the use of some of these items in your classroom. Safety in the classroom is very important, and science is safe as long as teachers and students are aware of potential hazards and take necessary and appropriate precautions and safety measures. Parts of this unit may have to be modified in order to meet safety regulations in your system

- As students use tools to cut and fasten the materials together, students must wear proper safety items.
- Students must wear safety goggles when cutting parts with saws or using other tools.
- Gloves are recommended to prevent cuts when using saws or burns from glue guns.

Safety Rules

1. Wear safety goggles at all times.
2. Be careful when using tools.
3. Make sure vises, clamps and miter boxes are fastened securely.
4. Do not use broken tools. Check to make sure all tools are safe.