

Farming: The Future Frontier

Subject: STEM

**Grade: Kindergarten
through 8th Grade**

**Time: Two 30-
minute Sessions**

Learning Objectives:

- Utilize the materials provided to design and construct a veggie pillow to grow a plant
- Encourage creativity, problem-solving, and collaboration while incorporating various materials and techniques
- Maintain a budget and track the costs of materials that can be used for the veggie pillow

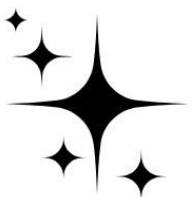
Standards and Competencies:

NGSS Elementary (K-5)

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

NGSS Middle School (6-8)

- MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



Background Knowledge:

- Read the book “PIP Goes Incredibly Fast”
- Review the [Engineering Design Process](#), as needed, using your preferred steps.
- Familiarize yourself with the current Veggie system onboard the ISS ([FACT SHEET](#))
- As future space missions are anticipated to take astronauts farther from Earth, NASA is working on developing a solution to the challenge of supplies and food during long-duration missions. The current food systems used by crews on the ISS works well, but relies on resupply missions to bring resources frequently. This is not an option for future missions to the Moon, Mars, or beyond. During long-duration missions, the nutrients and quality of the pre-packaged foods will degrade. Supplementing astronaut diets with fresh crops will provide necessary vitamins and minerals, while also supporting psychological benefits of eating and caring for plants.
- The Veggie system on the ISS was developed and installed in 2014, and astronauts have been enjoying fresh crops from the system since 2015. The pillows used in Veggie are made of Kevlar and Nomex, both are expensive materials.

Materials:

Design a Veggie Pillow [Worksheet](#)

Design a Veggie Pillow [Presentation](#)

Pillow: (various fabrics)

- Felt
- Burlap
- Paper towels
- Shammy towel
- Landscape fabric

Grow medium:

- Floral foam
- Peat moss
- Sand
- Soil
- Rockwool

General:

- Seeds (variety: lettuce, radish, etc.)
- Coffee filters (for [seed tape](#)/wicking system)
- Grow lights
- Plastic sheeting (to enclose the pillows)
- Tray for water

Procedure:

Session 1: Design and Build

Introduction (10 minutes)

- Introduce the design challenge to the students: creating a veggie pillow for use on a spacecraft to use in long duration spaceflight.
- Explain the learning objectives and the importance of creativity and problem-solving in the design process.
- Have students watch a video on the current Veggie system on the ISS.

Material Selection and Planning (20 minutes)

- Provide students with an array of fabrics for the pillow itself, as well as different grow mediums to put inside the pillow.
- Allow students to work collaboratively to test the different materials for absorption and durability.
- Remind students to work within their budget constraints.
- Instruct students to select the materials based on expense.
 - Students will select a fabric for the bottom of the pillow (which will absorb the water), a fabric for the top of the pillow, and a grow medium for inside the pillow.
- For an additional challenge, you can create checks they would write to you as an additional skill.
- Guide students in planning the construction process, including the order of assembly and how different materials will be incorporated.

Session 2: Construct and Plant

Construction (20 minutes)

- Allow students to begin constructing their veggie pillows, based on the materials they purchased in the previous class.
- Encourage students to collaborate, share ideas, and assist each other during the construction process.
- Provide support and guidance as needed, ensuring students are using the tools safely and effectively. Hot glue guns can reach very high temperatures, so students should be supervised when using them.
 - Using the hot glue gun, spread a line of glue on three sides of the bottom pillow fabric, and place the top fabric on top to adhere them together on three sides.
 - When the glue cools, fill the inside of the pillow with the grow medium selected.
 - Close the pillow with one line of glue.

Planting (10 minutes)

- Once the pillow has been constructed, cut a slit in the top and have the students place a seed inside the pillow.
- Pillows will be placed in a shallow pan under grow lights
- Pour a small amount of water in the bottom of the pan, so the pillows can absorb from the bottom.

Assessment:

- Students will track the growth of their plants over the course of a few weeks, measuring the height of the plant and observing other characteristics
- Students will create a presentation of their predictions, and observations from the investigation.

Additional Resources:

Extension Activities

- Students can investigate how different plants would grow in the pillows
- Students can investigate how different plants provide various nutrients for astronauts

**Note: The duration and complexity of the design challenge can be adjusted based on the students' age, skill level, available materials, and time constraints.

