Mission Manifest Lesson Plan: Growing Beans in a Bag

Location of Mission Manifest

Gateway to Space

Overview of Mission Manifest

Creating and packing the manifest for a space mission is like packing your suitcase for a trip; you must understand what you will be doing on your trip, and pack accordingly to those needs. As the player of the *Mission Manifest* interactive game, you must choose one of three experiments to conduct in space and then correctly pack your manifest for that experiment. The three experimental questions are: 1) What direction do roots of a bean plant grow in space? 2) Will a spider be able to spin a web in space? and, 3) Will oil and water mix better in space than they do on Earth? Once you choose your experiment, you are shown the items needed to conduct that experiment and told you must pack them correctly in order to launch. After you launch, you then must choose your hypothesis for the outcome of your experiment. If successful, you are awarded a badge.

Lesson Overview

This lesson plan/unit could be used independently or to prepare for (or to extend the learning after) a visit to Spaceport America. It can be used by teachers or parents wishing to make the Spaceport visit a richer learning experience (for everyone!).

In this multi-day lesson, students will use observation to answer the experimental question is: Will roots grow “down” on Earth regardless of lima bean orientation? As extension activities, they will explore questions about what it takes to grow beans. The answer to this question has great implications for what it will take to grow food in space, necessary for long space flights in the future!

Your students will be growing lima beans that you have previously soaked overnight. (Soaking them overnight will greatly reduce the time it takes for the beans to sprout.) On day one, each child will create his or her own “bean bag” with five beans. All of the beans in one bag will be oriented in a specific direction with the rounded side up, down, left, or right. It is likely that not all the beans will sprout. To prevent an incorrect assumption (i.e. “Beans turned upside down will not sprout.”) it is better to put all beans in the same bag in the same position. (Cumulatively, you will have beans placed in every direction so you can determine the results of each.)

After creating their bean bag, each student will be asked to hypothesize which direction they think the root will grow. They are then asked to write up (and/or draw) the steps they have gone through to begin their experiment. Each day they will record the direction of growth and the length of the roots. Collecting this data will greatly improve their observation skills.

This is an easy experiment that yields quick results. Lima beans grow very fast. They can actually germinate without light (remember, they do sprout when underground), but they do need warmth. For this reason, the “bean bags” you create will render best results if taped to a window with at least 8 hours of sunlight. A southern exposure will probably do best. Especially for young children, it is important to warn students that not all beans will sprout even under the best conditions. For this reason, we have suggested that five beans are placed in each bag.

Grade Level

Kindergarten and up. Young students will need a lot of help in initially orienting and securing the beans, but they can do the rest of the experiment with very little assistance. Older students can do the prep independently.

Learning Objectives

1. Students will make hypotheses.
2. Students will be able to describe what they observed in their experiment.
3. Students will compare experimental results with hypotheses and describe conclusions.

Assessment

Depending on the age of the student, they will either draw a picture or write a description of the experiment they performed along with their results and conclusions.

Required Materials

- Five lima beans for each child (with a minimum of 20 beans per class)
- A bowl for soaking the beans
- Water
- Plastic, zipper sandwich bag (four minimum, but one for each child)
- Masking tape
- Paper towels
- Metric rulers (can be shared)
- Paper and pencil
- Crayons or markers

- Data sheet for each student (provided)
- Plastic drinking cups and/or potting soil (for Lesson Extension)

Time Required

One class period for the set up. Several minutes each day for up to a week to record results. (Another week or two if you do the Lesson Extension activities.)

Step-By-Step Procedures:

1. Dried lima beans (seeds!) can be purchased in a grocery store. Soak the lima beans in water overnight. This will stimulate growth and reduce the time needed for the beans to sprout. (Suggestion: Soak the beans on a Sunday, so you have a full week of class time to observe.)

2. In class the next day, introduce the topic by telling/reminding students about the *Mission Manifest* game. Tell them you are going to be conducting your own experiment in class to find out what direction the roots will grow on lima beans sprouted in the classroom.

3. Cut a piece of masking tape the same length as the width of your sandwich bag. Place it sticky-side up on the table.

4. Arrange five (already soaked) beans on the tape with at least a finger-space between each bean making sure the “round” side of the bean is facing <u>down</u>. (The finger space apart will allow you in the next step to stick the tape to the bag *in between* each seed.)

5. Turn the sandwich bag <u>inside</u> <u>out</u>. Tape the beans horizontally on the inside of the bag (which is now facing outward) about an inch from the bottom.

6. Turn the sandwich bag <u>inside</u> <u>in</u> being careful not to dislodge the beans from their position on the tape.

7. Fold two paper towels so that they will fit snuggly in the bag. Wet them thoroughly but not such that they are dripping. Put them in the bag with the beans. Make sure the towel is touching the beans so it will wick water to them. Zip the bag up.

8. Tape the bag to a window with at least 8 hours of sunlight a day. You can face the beans inward so that they are easy to see.

9. Write the student’s name on their bag with the marker.

10. Repeat steps 3-10, but for each bag you create, turn all the beans in that bag in a new direction (i.e., round side up in one bag, round side left in one bag, round side right in one bag). Repeat this until each child has a bag with their name on it.

11. Have your students draw a picture of their “bean bag” on Day 1. Also, have your older students write down the steps they went through to set the experiment up.

12. Ask your students to hypothesize (and record) what direction they think the roots will grow in their bean bag on the Data Sheet (see below).

13. Each day, the students should check the bags to make sure they still have water. If not, they should add some to the bag. The students should also record the growth of all five beans in their bag. (See the Data Sheet below.)

14. Each day, discuss what is happening. Do the results match your hypotheses? What have you learned?

15. **LESSON EXTENSION:** On Monday, you may wish to extend this lesson. There are several experimental questions (below) you can answer if you put each sprouted seed in a large plastic cup with soil. Make sure you have students make predictions about each different option and record their results after several days.
    a. **How does the depth of planting affect growth?** Plant the sprouted seeds at different depths in the cup. Place the cups all in a *similar* location and give them the *same* amount of water each day. Predict which will continue to grow best.
    b. **How does light affect growth?** Put some of the plants in the light and place others in a dark cupboard or box closed up tightly. (Note: It only takes a small amount of light to trigger photosynthesis, but if you keep the plant in *total* darkness, it will *not* turn green.) Give your plants the same amount of water each day. Predict what will happen.
    c. **How does the amount of water affect growth?** Put several plants in the same location (same light and warmth factor) and vary the amount of water each gets daily, including NO water. (Measure out the number of ml of water easily with a medicine syringe obtained at your local pharmacy.) Predict which will grow best over time.
    d. **What do plants need to grow?** After you have some plants that are relatively healthy looking:
        i. Put some of them in the dark, but give them water.
        ii. Put some of them in the light, but give them no water.
        iii. Put some of them in the light and give them water.

DATA SHEET

Your Name _____ **Direction of your beans:** up down right left

I think the roots in my bean bag will grow (what direction?) _____
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	Direction of Growth and Length of Roots (in cm)				
	Bean 1	**Bean 2**	**Bean 3**	**Bean 4**	**Bean 5**
Day 1					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					

Alignment to Common Core Standards

You align this lesson to **Common Core** when you have your students take measurements and write about what they are observing each day. Take a look at the **Measurement and Data** standards and find the standard(s) that best fit for your students here: http://www.corestandards.org/Math/Content/MD/

Next Generation Science Standards also align well with this lesson. Specifically, those found below.

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.
3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Other Resources:

- **Space Farming: The Final Frontier.** To make long space flights, we must be able to produce our own food while traveling in space. This article about farming in space on the International Space Station has great illustrations and presents some good questions that scientists are considering while designing experiments. http://modernfarmer.com/2013/09/starship-salad-bar/
- **Vegetable Production System (VEGGIE).** This is a description of NASA's experimental design for growing vegetables in space. http://www.nasa.gov/mission_pages/station/research/experiments/Veggie.html
- **Jack and the Beanstalk animated cartoon.** This rendition of the story has a good moral worked through it; you must not steal but work hard to be happy. Beware, there are two ads in this story, but they can be skipped quickly. https://www.youtube.com/watch?v=fN_C-eGzEEs
- **Jack and the Beanstalk story (text).** This rendition of the story that you can read to students is not as "scary" for young children as the original (which actually mentions boys being eaten by giants!), but it does still end with the death of the giant. http://fairytales4u.com/story/jackand.htm