Discovery of a New Planet
Part of: Inquiry Science with Dartmouth
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Adapted From: ASU Mars K-12 Education Program (1999) and NASA Education Brief “EB-112: How to Explore a Planet” (1993)

Overview
In this activity students will gain firsthand experience in the scientific process of discovering a new planet.

Science Standards

S 5-6: 1 – Students demonstrate their understanding of SCIENTIFIC QUESTIONING by ...
- Distinguishing between observational, experimental, and research questions
- Identifying multiple variables that affect a system and using the variables to generate experimental questions that include cause and effect relationships.

S 5-6: 2 – Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...
- Using logical inferences derived from evidence to predict what may happen or be observed in the future.
- Providing an explanation (hypothesis) that is reasonable in terms of available evidence.

S 5-6: 6 – Students demonstrate their ability to ANALYZE DATA by...
- Identifying relationships of variables based upon evidence.
- Questioning data that might not seem accurate or does not fit into the pattern of other findings.

S 5-6: 4 – Students demonstrate their ability to CONDUCT EXPERIMENTS by...
- Choosing appropriate measurements for the task and measuring accurately.
- Collecting data and recording accurate and complete data from multiple trials.
- Drawing scientifically: Selecting an appropriate perspective (e.g., cross section, top view, side view) and recording precise proportions.

S 5-6: 45 – Students demonstrate their understanding of Processes and Change over Time within Systems of the Universe by...
- Explaining how technology has allowed scientists to extend existing ideas about the solar system.

S 5-6: 49 – Students demonstrate their understanding of Processes and Change within Natural Resources by...
- Identifying examples of good and poor management of natural resources.

Focus Question
Challenge yourselves to think beyond what you know about Earth. Does an ocean always have to be blue and made of water? Are plants always green? Could an alien that looks like an Earth fish be more closely related to an Earth monkey?
Objectives
Through this lesson, students will:

- Learn to work well as a team.
- Think critically and develop strategies to further their understanding.
- Be creative and ask questions.
- Compare and contrast scientific methods.

Background
The study of exoplanets, planets outside of our solar system, is a relatively new branch of astronomy, with the first exoplanets only having been discovered within the past few decades. As such, expeditions to these planets are far into the future and may not even be possible. It is important, however, to understand the general make and properties of these distant neighbors and scientists are working toward this understanding with astronomical observations. This particular activity encapsulates the standard methods used by scientists and engineers to explore objects in our solar system and may be a good representation of the future of exoplanet exploration. Unlike a teacher-led activity, students will experience a real scientific environment where they get to pick the direction of their research. This includes the engineering of their exploration devices with the very real limitations that scientists experience, lack of funding and a limit on fuel life! This activity requires strategic thinking, teamwork, and creativity and it will be sure to test the assumptions that we humans make about other worlds.

Materials

- Planet (already created – See preparation)
- 1 push-pin
- Viewer (See preparation – one per student or enough for one group)
- 5” x 5” blue cellophane squares (one per viewer)
- Rubber bands (one per viewer)
- “ Surprise Grant Money” (See preparation – two per group)
- Stool or table for planet
- Ruler/Measuring tape for measuring distances
- Masking tape to mark distances
- Stopwatch
- Student Data Sheet (one per person)

Preparation

- The planet will take some time and creativity. Pictures have been included for inspiration.
  - Start with a large foam sphere that can be found at any craft store.
  - Paint it, cut it, and glue it! Add geological features such as:
    - Mountains
    - Ravines
    - Lakes
    - Oceans
    - Hills
    - Deserts
  - Is there life? Add in some “life” such as
    - Aliens?
    - Alien bones?
Procedure

1. **Hook:** You and your colleges at NASA have discovered a new planet and now you get to lead an investigation to learn all you can about this new world! You will be following the same steps that real scientists use to learn more about space.

2. **Background:** Explain to the students that they are going to be acting as real scientists; making observations, planning experiments, budgeting for technology, and working together in larger groups than they are used to (~5 per group). This is an inquiry-based activity so encourage them to use all of their senses (except taste) and ask questions!

3. **Explanation of Materials:**
   a. Show the students that they hold the viewer up to their eyes with the cellophane on the opposite end at first and have them look at objects around the room. Explain that the cellophane is like the Earth’s atmosphere, which blocks out some of the color and detail of things in space.
   b. Hold up the “Surprise Grant Money” and explain that most scientists have to work with very strict budgets when designing telescopes and satellites. They apply for grants in order to fund their research. Explain that this “Surprise Grant Money” can be used to upgrade their “Orbiter” or “Lander” in one of three ways:
      i. Radar System: Radar helps scientists to peer under thick clouds and atmosphere to see the surface below.
      ii. Doppler/Sonar System: Doppler/Sonar systems are used for “seeing” through the water. It may tell you about a storm or about the ocean floor.
      iii. Fuel: Upgrade your fuel tank to spend an extra minute orbiting or exploring the land further!

- Plants?
- Be creative!
  - Give it color, texture, smell – students should use all senses except taste!
  - (Optional) Add moons with smaller spheres and toothpicks!
  - Use leaves, grass, paint, glue, glitter, foam, etc! Give it as much detail as possible!
  - **Use cotton balls or other fluffy materials to create clouds that are removable in the event they upgrade to a radar system (described in procedure).**
  - **Use leftover cellophane or fabric to create water features like an oceans or lakes that are removable in the event they upgrade to a radar system (described in procedure).**

**Keep track of everything you use to make up planet details, i.e. green grass could be copper deposits embedded in rock beds. Be creative! You are challenging their view of what is “normal” – oceans don’t need to be blue!**

- Viewers may be created by the students, or can be supplied by the teacher.
  - Viewers may be a rolled piece of paper or a paper towel or toilet paper roll
- Cellophane squares should be cut in 5” x 5” squares (or large enough to cover the viewer and be secured by a rubber band).
- “Surprise Grant Money” can be made from construction paper or fake money you already have. Cut construction paper into rectangles and label it as “Surprise Grant Money”. For extra style add in a picture of a telescope, satellite, or other astronomical image!
- Before class, set up a Planet Location and Mission Control. A Planet Location may be created by putting a stool on one side of the room (or hallway) and creating a 2-foot and 5-foot ring around it with masking tape. Set the planet on the stool and cover it from prying eyes. On the other side of the room should be Mission Control. Putting a line of tape for students to stand behind is a good way of defining the space.

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Remind them that they only get two upgrades and once used, they are not transferable!

4. **Pre-Launch: Earth Observations**
   a. Send students to Mission Control with their groups spread out evenly.
   The next steps may be done as a whole class (one viewer each) or by group (enough viewers for one group) with the other groups’ backs facing the planet.
   b. Have them hold their viewer up with the cellophane attached.
   c. Remove the planet cover for 60 seconds while they observe with their viewers.
   d. Cover the planet.
   e. Have them record their observations.
   f. Discuss observations with Mission Control groups and come up with further exploration questions.

5. **Mission 1: The Fly-by**
   a. Remove the cellophane. Fly-bys are done in space where there isn’t an atmosphere to get in the way!
   b. Have backs facing the planet.
   c. Remove the cover.
   d. One by one have them turn and walk quickly by one side of the planet at a distance of five feet constantly looking through the viewer. (You may want to demonstrate.)
   e. Return to Mission Control with backs to the planet and record observations.
   f. Discuss observations with Mission Control groups and come up with further exploration questions.
   g. Remind them to start to think about when they want to use their “Surprise Grant Money” and for what upgrade!
   h. Cover the planet.

6. **Class Comparison: The Fly-by versus Earth Observations**
   a. Come together as a class to discuss the differences between observing the planet from “Earth” and walking by it quickly during a “Fly-by”.
   b. Which was more difficult?
   c. Which gave more information?

7. **Mission 2: The Orbiter**
   a. This mission is done group by group. During their turn, ask a group quietly if they would like to use their upgrade dollars. If so apply the upgrade by removing clouds, water, or setting the timer for extra fuel time (3 min).
   b. Using the viewer, each group will have two minutes to circle (orbit) the planet at a distance of two feet. This distance should be maintained – no leaning or crossing the line!
   c. After two minutes, the group should return to Mission Control to record and discuss their observations.
   d. Cover the planet.

8. **Class Comparison: The Orbiter versus The Fly-by**
   a. Come together as a class to discuss the differences between observing the planet while walking by it quickly during a “Fly-by” and orbiting the planet.
   b. Which was more difficult?
   c. Which gave more information?
   d. Why do scientists still use “Fly-bys” when “Orbiters” provide more information? Hint: Opportunity to see more objects, Fly-bys are generally less $ and require less complicated math to determine the flight plan (think throwing a baseball versus a boomerang).
9. **Pre-Launch: Lander Strategies**
   a. Have teams go through the Lander Expedition thought process outlined in the Student Worksheet.
   b. Remind them to be specific and use their imaginations!
   c. Explain that they should try to guess what kind of equipment their Lander might need to experiment on the surroundings. *For example, a camera to take pictures, a DNA kit to test for “life”, chemical strips to test for acidity of liquids, weather gauges to test if there is an atmosphere, etc.*

10. **Mission 3: The Lander**
    a. Each team will one by one approach the planet and select a landing site with a pushpin.
    b. After this selection, ask the group quietly if they would like to use their upgrade dollars. If so apply the upgrade by removing clouds, water, or setting the timer for extra fuel time (4 min).
    c. Team members will take turns observing the site while keeping the pushpin in the center of the viewer for a cumulative total of three minutes. (If an upgrade has been used for more fuel, they are given four minutes and may move the viewer around so that the pushpin may stray from the center, but should not leave the sight of the viewer.)
    d. Once the time is complete, teams will move back to Mission Control to record observations.
    e. Cover the planet.

11. **Reflection**
    a. Have teams go through the final reflection questions outlined on the Student Worksheet.
    b. Remind them that reflection on personal challenges as well as team challenges are important and that they can use what they've learned about themselves and working as a team in the future.

**Assessment**
- The assessment in this activity may be found:
  - At the conclusion of each Mission as teams are encouraged to “think ahead” to the next Mission by coming up with questions and strategies.
  - During the worksheet and class discussions asking students to think critically about differences, similarities, and how effective each method is.
  - In the thought process and strategies of where to place a Lander and what technology should be included on it.
  - During the reflection on the mission.
    - Was it successful? Insight into how they measure success.
    - What are the greatest challenges? Reflective thinking about personal and team challenges faced.
    - What would you change for the next mission? Critical thinking about how to fix any mistakes.
    - How did you use your “Surprise Grant Money”? An inside look into their strategy and how their mind processed the situation.
**Extensions**

Students could be encouraged to:

- Use this experience to come up with teamwork strategies in future activities.
- Inquire more in class and in homework and be creative with their thought processes.
- Create their own planets for other groups to observe.

**Planet Inspiration**