Activity*engage*

The Vastness of Space

Are we alone in the universe?

Overview

Students are introduced to the unanswered question of whether there is life in space. They learn how scientists are looking for planets outside of our solar system and are evaluating the possibility of finding a habitable planet within their lifetimes.

For the complete activity with media resources, visit:
http://nationalgeographic.org/activity/vastness-space/

Content Created by

The Concord Consortium

Directions

1. Activate students' prior knowledge about our solar system.

Tell students that Earth is the only planet in our solar system known to have life. Ask:

- *What factors do you think are necessary for life to exist on a planet?* (Some commonly known factors for life include liquid water, an atmosphere, and

having energy sources. Some students may say that oxygen is necessary. If this happens, you can point out that there are some organisms on Earth that do not require oxygen.)

Tell students that scientists are looking for planets and moons that might have characteristics necessary for supporting life. Explain that scientists have already found thousands of planets outside our solar system. Let students know that they will be learning how scientists search for planets and how they determine whether the planets they find have the potential to support life.

2. Discuss the role of uncertainty in the scientific process.

Introduce students to the concept of uncertainty in the scientific process. Explain that science is a process of learning how the world works and that scientists do not know the “right” answers when they start to investigate a question. Tell students that they can see examples of scientists' uncertainty in determining whether or not the data collected from telescopes show the presence of planets.

Show the **Kepler Planet Candidates graph** from the NASA Exoplanet Archive. Tell students that the red dots indicate potential planets the Kepler telescope has detected and the blue dots indicate the planets the Kepler telescope detected and have been confirmed by other means. Ask:

- *Why do you think there are more red dots than blue dots (more potential planets than confirmed planets)?* (The telescope may detect planets that are not there. The technology may not be good enough to tell the difference between a planet and some other phenomenon.)
- *Why do scientists need to independently confirm the presence of planets?* (Scientists need to check the accuracy of the telescope's predictions of a planet. If the telescope shows a planet and the scientists confirm that it is a planet, then the scientists can spend more time trying to learn about the planet.)

Let students know that they will be asked questions about the certainty of their predictions and that they should think about what scientific and model-based data are available as they assess their certainty with their answers. Encourage students to discuss the scientific evidence with each other to better assess their level of certainty with their predictions.

3. Have students launch the interactive The Vastness of Space.

Provide students with the link to the interactive The Vastness of Space. Divide students into groups of two or three, with two being the ideal grouping to allow students to share computer work stations. Tell students they will be working through a series of pages of data with questions related to the data. Ask students to work through the activity in their groups, discussing and responding to questions as they go.

Tell students this is Activity 1 in the **Is There Life in Space?** lesson.

4. Discuss the issues.

After students have completed the activity, bring the groups back together and lead them in a discussion focusing on these questions:

- *How do scientists detect planets?* (Scientists use light from stars to detect planets.)
- *Why do scientists have to use stars to find planets?* (Planets don't give off their own light so they are difficult to see in the darkness of space. Stars are bright, so they are easier to see.)
- *How do scientists use light from stars to find planets?* (Scientists can use light from stars in two ways: [1] they can look at the movement of the light towards and away from Earth to find a wobble in the star's orbit, and [2] they can look for dimming of the light from the star.)
- *What factors are necessary for life to exist on a planet?* (Scientists think that

liquid water is necessary for life. Living things also need a source of energy and a place to exist [rocky body, such as a planet, moon, or asteroid].)

Tip

The Vastness of Space activity is part of a sequence of activities in the Is There Life in Space? lesson. The activities work best if used in sequence.

Modification

This activity may be used individually or in groups of two or three students. It may also be modified for a whole-class format. If using as a whole-class activity, use an LCD projector or interactive whiteboard to project the activity. Turn embedded questions into class discussions. Uncertainty items allow for classroom debates over the evidence.

Tip

You can save student data for grading online by registering your class for free at the High-Adventure Science portal page.

Informal Assessment

1. Check students' comprehension by asking students the following questions:

- Why do scientists use stars to find planets?
- What factors are necessary for life?
- Why is it difficult to figure out if there is life on other planets?
- Why are some scientists confident that they will find life on another planet?

2. Use the answer key to check students' answers on embedded assessments.

Objectives

Subjects & Disciplines

Science

- Earth science
- Space sciences

Learning Objectives

Students will:

- explain how scientists use light from distant stars to find planets
- describe the factors scientists look for to determine if life could be possible on distant planets
- explore the probability of scientists finding a habitable planet or moon

Teaching Approach

- Learning-for-use

Teaching Methods

- Multimedia instruction
- Self-paced learning
- Visual instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy

    - Learning and Innovation Skills
        - Critical Thinking and Problem Solving
- Critical Thinking Skills
    - Analyzing
    - Evaluating
    - Understanding

National Standards, Principles, and Practices

National Science Education Standards

• **(5-8) Standard A-1:**
Abilities necessary to do scientific inquiry
• **(5-8) Standard A-2:**
Understandings about scientific inquiry
• **(5-8) Standard G-1:**
Science as a human endeavor
• **(5-8) Standard G-2:**
Nature of science
• **(9-12) Standard A-1:**
Abilities necessary to do scientific inquiry
• **(9-12) Standard A-2:**
Understandings about scientific inquiry
• **(9-12) Standard G-1:**
Science as a human endeavor
• **(9-12) Standard G-2:**
Nature of scientific knowledge

Common Core State Standards for English Language Arts & Literacy

• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.11-12.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.11-12.1

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.6-8.1

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.6-8.3

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Craft and Structure, RST.6-8.4

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.9-10.1

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.9-10.3

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Craft and Structure, RST.9-10.4

- **Reading Standards for Literacy in Science and Technical Subjects 6-12:**

Key Ideas and Details, RST.11-12.3

ISTE Standards for Students (ISTE Standards*S)

- **Standard 3:**

Research and Information Fluency

- **Standard 4:**

Critical Thinking, Problem Solving, and Decision Making

Next Generation Science Standards

- **Crosscutting Concept 1:**

Patterns

- **Crosscutting Concept 2:**

Cause and effect: Mechanism and prediction

- **Crosscutting Concept 3:**

Scale, proportion, and quantity

- **Crosscutting Concept 4:**

Systems and system models

- **Science and Engineering Practice 1:**

Asking questions and defining problems
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 5:**
Using mathematics and computational thinking
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions
• **Science and Engineering Practice 7:**
Engaging in argument from evidence
• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information

Preparation

What You'll Need

Required Technology

- Internet Access: Required
- Tech Setup: 1 computer per classroom, 1 computer per learner, 1 computer per small group, Projector

Physical Space

- Classroom
- Computer lab
- Media Center/Library

Grouping

- Heterogeneous grouping
- Homogeneous grouping
- Large-group instruction

- Small-group instruction

Resources Provided: Handouts & Worksheets

- Answer Key: The Vastness of Space

Resources Provided: Images

- Kepler Planet Candidates Graph

Background & Vocabulary

Background Information

As of February 2016, Earth is the only planet known to have life. Whether there is life beyond Earth is an important and compelling question in science. With billions of galaxies each containing billions of stars, scientists think at least one of them is likely to have a planet like Earth. Scientists use the light from stars to find planets and other celestial bodies. The light from stars is visible, while the dark planets, moons, asteroids, etc. are invisible in the darkness of space.

As a planet orbits a star, the star moves (Newton's Third Law of Motion). Scientists use telescopes to detect the movement of stars, and infer the presence of planets. Scientists can also look for dimming of the star's light, which would indicate that a celestial body is orbiting the star.

Life on other planets does not need to be like life on Earth, however. Even on Earth, there is life in unlikely places. So-called extremophiles live in extreme conditions: high acid, high heat, extreme cold, extreme dry, and high radiation areas. Extremophiles broaden the range of planets that could be habitable for some form of life.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
asteroid	*noun*	irregularly shaped planetary body, ranging from 6 meters (20 feet) to 933 kilometers (580 miles) in diameter, orbiting the sun between Mars and Jupiter.
carbohydrate	*noun*	type of sugar that is an important nutrient for most organisms.
celestial	*adjective*	having to do with the sky or heavens.
celestial body	*noun*	natural object in space, such as a planet or star. Also called an astronomical object.
exoplanet	*noun*	planet outside the solar system, orbiting a star other than the sun. Also called an extrasolar planet.
galaxy	*noun*	collection of stars, planets, gases, and other celestial bodies bound together by gravity.
lipid	*noun*	one of a large group of organic compounds including fats, oils, waxes, sterols, and triglycerides.
moon	*noun*	natural satellite of a planet.
organic compound	*noun*	chemical substance that contains the element carbon.
planet	*noun*	large, spherical celestial body that regularly rotates around a star.
protein	*noun*	one of many complex compounds, made of chains of amino acids, that make up the majority of all cellular structures and are necessary for biological processes.
solar system	*noun*	the sun and the planets, asteroids, comets, and other bodies that orbit around it.

Term	Part of Speech	Definition
telescope	*noun*	scientific instrument that uses mirrors to view distant objects.
universe	*noun*	all known matter, energy, and space.

For Further Exploration

Articles & Profiles

- National Geographic: Article: Looking for Life
- National Geographic: This Day in Geographic History: November 27, 2001 Atmosphere on Extrasolar Planet Detected

Images

- National Geographic: Illustration: Media Spotlight: Orbital plane

Reference

- National Geographic: Encyclopedic Entry: Planet
- Wikipedia: Astrobiology
- Wikipedia: Methods of Detecting Exoplanets
- National Geographic: Encyclopedic Entry: Orbit

Video

- TED Talk: Tabetha Boyajian: The most mysterious star in the universe

Websites

- NASA Jet Propulsion Laboratory: PlanetQuest

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