ACTIVITY 4

WHY ARE THE PLANETS SOMETIMES NOT VISIBLE FROM EARTH?

EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students learn about how the planets revolve around the Sun. They also become familiar with certain tools and models used in astronomy.

ESSENTIAL KNOWLEDGE

EARTH AND SPACE

Systems and interaction:

- Solar system
- The stars and the galaxies

Techniques and instrumentation:

- Use of simple observational instruments
- Use of simple measuring instruments
- Design and manufacture of prototypes

Appropriate language:

- Terminology related to an understanding of the Earth and the universe
- Conventions and types of representations

SUGGESTED MATERIALS

Scientific equipment:

- Computer connected to the Internet
- Posters of the solar system
- Telescope
- Spotting scopes
- Copernican planetary system
- Stellarium (free planetarium software)

Household materials:

- Newspaper
- Pedestal lamp
- Wooden skewers
- Party balloons

School supplies:

- Colored pencils, glue, rulers
- Geometry compass, adhesive tape, stapler, string
- Papier-mâché glue
- Paint, paint brushes
- Modeling clay
- Wooden dowels (approx. 5 mm in diameter)
- Various sizes of Styrofoam balls
- Large pieces of cardboard

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

One night while looking up at the stars, you notice one very bright star. You heard on the news that the planet Venus was now visible on Earth and that it would still be visible for some time. Questions cross your mind: Does that mean we can't always see this planet? Why? Is it the same for other planets? How can you go about finding answers?

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

The teacher can talk to the students about what planets are and what distinguishes them from stars. The teacher can also ask how many planets there are in the solar system and draw the students' attention to certain characteristics of planets such as their size, shape, composition or distance from the Sun. The students can then be asked to say if they believe the planets move, and if so, how.

INITIAL IDEAS AND HYPOTHESES

Here are a few examples of hypotheses the students might formulate based on their initial ideas:

Example 1
I predict that we can't always see the other planets when we look at the night sky because they are too far away and too small. I predict this because when I look at the horizon, I cannot see small objects.

Example 2
I predict that we do not always see the other planets from Earth because they are sometimes hidden by the Sun. I predict this because when I move around a column, it hides me from objects that are behind it.

Example 3
I predict that we cannot always see the other planets from Earth because our planet rotates on its axis. I predict this because when I spin around, certain objects leave my field of vision.

WORK PLAN AND EXPERIMENTATION

Here are a few examples of experiments the students can carry out to verify their hypotheses:

Example A
The students look at the end of a street with the naked eye and then with a telescope or spotting scope (placed horizontally). They then compare their observations and record whether objects located at the end of the street appear different (in shape or size, for example) or if their perception of the distance between themselves and the objects has changed. They then determine whether distance can play a role in how the planets are perceived.

CAUTION! NEVER LOOK DIRECTLY AT THE SUN. MAKE SURE YOUR BACK IS TO THE SUN WHEN YOU MAKE YOUR OBSERVATIONS.

Example B
Students make their own model of the solar system by first making a base out of modeling clay, into which they stick a piece of wood with a Styrofoam ball on the end to represent the Sun. They repeat this operation for each planet of the solar system and position them around the Sun in locations they consider accurate. Then, using their model, they try to recreate the movements of the planets. They record their observations. They then compare their results with an astronomy program, such as the free planetarium program "Stellarium."

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

Example C
The students make a mobile that looks like the solar system. They blow up small party balloons to the desired size for the Sun and the different planets. They then cover them with papier-mâché, let them dry and decorate them. They attach them all to wooden dowels using adhesive tape and string and then discuss among themselves and try to find an explanation to represent the movements of the planets. Finally, they compare their model to an animated model of the solar system they might find on an Internet site. They can also validate their results with an expert.

Example D
The students draw a point in the centre of a large piece of cardboard to represent the location of the Sun. They then trace the orbit of each planet using a ruler and a compass, and select different sized Styrofoam balls to represent the Sun and the planets. Into each ball they insert a piece of dowel with a piece of modeling clay on the other end and they place them on the cardboard according to their position in relation to the Sun. A table lamp without a shade can be used for the Sun. They use their model to try and recreate the movements of the planets. They record their observations, including how shadows move on the planet Earth.

EXPERIMENTAL FACTORS
To ensure scientific rigor, the students should evaluate the experimental factors that might influence the experimental results.

- Materials used
- Relative proportions of heavenly bodies
- Relative proportions of the distance between the heavenly bodies
- Ability of planets to revolve and rotate
- Reference documents used for validation
- Strength of telescope or spotting scope
- Distance of objects from telescope or spotting scope

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

The teacher asks the students to present the results of their experiments to the class. Some teams will have complementary results, which will enrich the thought process of the whole class. Then the teacher reviews what they have learned by showing the students how the planets move in the solar system using a Copernican solar system (3D model) or using posters.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The teacher asks the students to do further research on a specific planet and has them present their results in the form of a poster. Part of the poster could have a drawing of the planet and another part could be dedicated to a list of its principle characteristics (e.g., size, make-up, satellites, number of Earth days to revolve around the Sun). These posters could form an exhibition in a school hallway. Finally, the students could write a report on the constellations and their visibility in the sky.

SCIENTIFIC CONCEPTUAL CONTENT

Solar system

The solar system includes the Sun and all the heavenly bodies orbiting it, i.e., the eight planets and their satellites. The solar system also includes comets and asteroids.

The Sun and other stars

The Sun is the only star in our solar system. A star is a huge sphere of gas that burns and generates its own light from nuclear reactions. The Sun is at the centre of the solar system and Earth, and the seven other planets, revolve around it. The Sun radius is about 110 times the size of Earth if you compare their radii; Earth's radius is 6,378 km, while the Sun's is about 697,000 km.

Planets

Planets are bodies orbiting around a star. To be considered a planet, a body must be large and massive enough to be spherical due to its own mass. Unlike stars, planets do not generate light; they can only reflect the light of their star. Our solar system has eight official planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Earth is the third planet from the Sun and is the only one with abundant liquid water and a rich biodiversity.

Satellites

Natural satellites are bodies that orbit a planet (e.g., the Moon orbiting around Earth) or another more massive body. There are also artificial satellites such as space probes. These are human-made objects placed into orbit around Earth or sent into space to explore other planets.

Asteroids and comets

Other than planets and satellites, the solar system contains a large number of smaller bodies. There are asteroids, comets and smaller particles. Asteroids are distinguished from comets by their distance from the Sun and their composition. Asteroids orbit the Sun between the orbits of Jupiter and Mars and are made up of rocks, while comets are generally found much farther away from the Sun and are made up of ice and dust.

Revolution
Revolution is the movement that each planet makes around the Sun. The orbits correspond to the elliptical paths they take. In the case of Earth, a complete revolution represents one year and is what causes our different seasons. Satellites also revolve around their planets. For example, the Moon orbits the Earth and takes 27 days, 7 hours, 43 minutes and 11 seconds to complete one revolution.

Rotation
In addition to revolving around the Sun, each planet spins on an axis that goes through its centre (central polar axis). The time it takes Earth to complete one rotation is equivalent to one day, i.e., 24 hours. In fact, the apparent movement of the stars in the sky is directly related to Earth's rotation. Natural satellites also rotate on their axes.

CULTURAL REFERENCES

Pluto demoted
Pluto was discovered in 1930 by the astronaut Clyde W. Tombaugh and was for a long time considered the smallest and most distant of the planets in the solar system. It takes its name from the Greek God of the underworld. However, after other small bodies were discovered at the outer reaches of the solar system, its status as a planet began to be questioned, and on August 24, 2006, the International Astronomical Union voted in favor of creating two classes of planets: "planets" and "dwarf planets." Pluto was placed in the latter category, along with the bodies Charon, Ceres, and Xena, all of which could not or no longer be called planets. Hence, the solar system now only contains eight planets.

Earth was once the centre of the universe
For a long time, humans thought Earth was the centre of the universe and that the Sun, Moon and other heavenly bodies revolved around it. The ancient Greek astronomer Aristarchus of Samos, who lived in the 3rd century BCE and very little of whose writings survive, was apparently the first person to try to prove that Earth revolved around the Sun, long before the arrival of Copernicus, Kepler and Galileo. All that we know about Aristarchus comes from other scholars of that era, who cite him but do not share his point of view about the universe. His theories were rejected because they could not be tested with the instruments available at the time. It was not until the 16th century that Copernicus proposed a similar theory that was likely inspired by that of Aristarchus. Perhaps if the work of Aristarchus had not been destroyed, we would have discovered that Earth is not the centre of the universe much more quickly.

FOR MORE CULTURAL REFERENCES,
VISIT THE ÉCLAIRS DE SCIENCES WEBSITE:
www.eclairsdesciences.qc.ca

REFERENCES

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PROCESS OF ACTIVE DISCOVERY

GENERAL LEARNING PROCESS IN SCIENCE AND TECHNOLOGY (IN ELEMENTARY SCHOOL)

Context related to everyday life

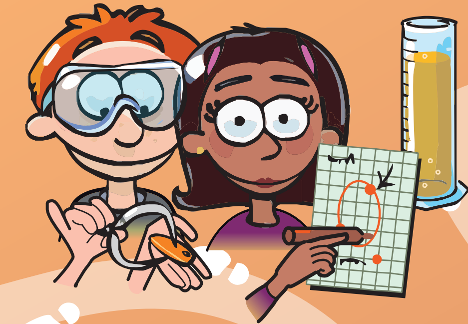
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

Initial ideas and hypothesis

My initial ideas:
- I share my own ideas.

My hypothesis:
- I predict that...
  I think that because…
- I imagine my prototype.
- I think it works like this…

Planning and carrying out



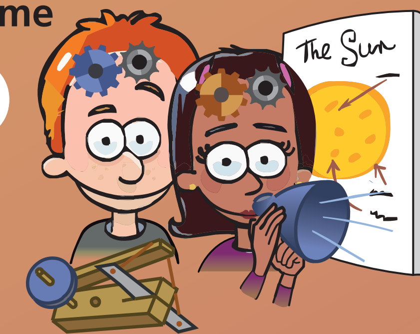
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

Carrying out my process:
- What will the steps be?
- What precautions should I take?

My actions:
- I carry out the steps of my protocol.
- I note or draw what I observe, what I do and what I discover.

My results:
- What is my answer to the problem, question or need?

Outcome



My outcome:
- Do my results confirm my hypothesis or not?
- Are my results similar to those of the other teams?
- Can the other teams' results help me to find answers to my problem, my question or my initial need?
- What could I communicate concerning my discoveries?

New question?

What I learned:
- What do I retain from this activity?
- What could I communicate concerning my results or my discoveries?

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