Voyage: A Journey through our Solar System

Grades 3-4

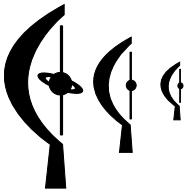
Lesson 3: Voyage Through the Solar System

On a visit to the National Mall in Washington, DC, one can see monuments of a nation—Memorials to Lincoln, Jefferson, and WWII, the Vietnam Veterans Memorial Wall, and Washington Monument. Standing among them is *Voyage*—a one to 10-billion scale model of our Solar System—spanning 2,000 feet from the National Air and Space Museum to the Smithsonian Castle. *Voyage* provides visitors a powerful understanding of what we know about Earth's place in space and celebrates our ability to know it. It reveals the true nature of humanity's existence—six billion souls occupying a tiny, fragile, beautiful world in a vast space.

Voyage is an exhibition that speaks to all humanity. Replicas of *Voyage* are therefore available for permanent installation in communities worldwide (http://voyagesolarsystem.org.)

This lesson is one of many grade K-12 lessons developed to bring the *Voyage* experience to classrooms across the nation through the *Journey through the Universe* program. *Journey through the Universe* takes entire communities to the space frontier (http://journeythroughtheuniverse.org.)

Voyage and *Journey through the Universe* are programs of the National Center for Earth and Space Science Education (http://ncesse.org). The exhibition on the National Mall was developed by Challenger Center for Space Science Education, the Smithsonian Institution, and NASA.



Lesson 3: Voyage Through the Solar System

Lesson at a Glance

Lesson Overview

Students build the *Voyage* scale model of the Solar System on a playground and "travel" to each planet. This exercise allows students to recognize that the Sun and planets are tiny worlds in a vast space. Students also explore the similarities and differences in the patterns and cycles observable on the planets. The students come to realize that while seasonal variation (except for the length of seasons) seems independent of planet location, both the length of the day and length of the year do reflect planetary position. Students then explore why this occurs, with length of year dependent on the distance from the Sun, and length of day dependent on whether the planet is an inner Earth-like planet, an outer Jupiter-like planet, or a Pluto-like object further out in the Solar System. This experience gives students a new perspective on the Solar System, and allows them to gain a new sense of home.

Lesson Duration

One 45-minute class period

Core Education Standards

National Science Education Standards

Standard D2: Objects in the sky

- The Sun, Moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.

AAAS Benchmarks for Science Literacy

Benchmark 4A4:

- The earth is one of several planets that orbit the sun, and the moon orbits around the earth.

Benchmark 11B2:

- Geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and oral and written descriptions can be used to represent objects, events, and processes in the real world.

Related Education Standards

AAAS Benchmarks for Science Literacy

Benchmark 9C6:

- Scale drawings show shapes and compare locations of things very different in size.

Essential Question

- While we explore places far away from Earth, what do we learn about our home planet and ourselves?

Concepts

Students will learn the following concepts:

- The Earth is only a small component of the Solar System.
- The Sun and the planets are tiny worlds in a vast amount of space.

Objectives

Students will be able to do the following:

- Measure, construct, and travel the *Voyage* scale model of the Solar System.
- Discuss insights they have gained about Earth, other planets, cycles, and space.

Science Overview

Voyage is a 1 to 10-billion scale model of the Solar System that was permanently installed in Washington, DC, in October 2001. The real Solar System is exactly 10 billion times larger than the *Voyage* model. On this scale the Sun is about the size of a large grapefruit. The Earth is 15 meters (50 feet) away and smaller than the head of a pin. The entire orbit of the Moon fits comfortably in the palm of your hand. Pluto, a dwarf planet in the outer parts of the planetary realm of the Solar System, is approximately 600 meters (2,000 feet or 6.5 football fields) away from the Sun. The nearest star to the Sun would be the size of a cherry located in coastal California.

You are going to use the *Voyage* model in this lesson. The student worksheets have graphical representations of the Sun and planets at the scale of *Voyage*.

We are going to set up the *Voyage* Scale Model Solar System with the planets all in a row. This will allow students to see the relative distances from the Sun to each planet. However, in the real Solar System, the planets never line up as they orbit the Sun.

The chart on this page allows you to start at the Sun, and provides the number of paces to walk from planet to planet. The second chart provides a running total of the number of meters from the Sun. Pluto is included as an example of dwarf planets.

Chart of Paces Between Model Planets								
Sun to Mercury	Mercury to Venus	Venus to Earth	Earth to Mars	Mars to Jupiter	Jupiter to Saturn	Saturn to Uranus	Uranus to Neptune	Neptune to Pluto
6 paces	5 paces	4 paces	8 paces	55 paces	65 paces	144 paces	163 paces	142 paces

Chart of Total Distances (Meters) from Model Sun to Each Model Planet								
Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto (dwarf planet)
6 meters	11 meters	15 meters	23 meters	78 meters	143 meters	287 meters	450 meters	592 meters

In this activity a "pace" is equal to one (1) meter. Have students practice how to walk a one meter-long pace. (See *Preparation & Procedures*.)

NOTES:

Conducting the Lesson

Warm-Up & Pre-Assessment

Preparation & Procedures

Tell the students you have models of planets in the Solar System that are one ten-billionth their actual size. Ask for student volunteers to estimate how far apart the planets need to be placed to accurately represent the distance between them.

NOTES:

Activity: Voyage Through the Solar System

Students construct the *Voyage* scale model Solar System and travel to each planet to explore the similarities and differences between the planets.

Teacher Materials

- A meter stick
- *Teacher Fact Sheet* with model Sun and planets
- 10 pieces of cardboard or 10 posterboards (about 24" x 36"), brightly colored, if possible
- Thick-edged black magic marker
- 10 wooden dowels or sticks about 3' long and the thickness of a pencil or thicker. They need to be strong enough to be pushed into the ground
- Roll of wide masking tape or packing tape
- Long, flat playground. A sidewalk is also appropriate if the dowels can be pushed into the dirt adjacent to the sidewalk

Student Materials

- Copy of the last page of the *Teacher Fact Sheet* (pacing chart)

Preparation & Procedures

1. Find an outdoor site for setting up the *Voyage* model. Make sure it is clear and flat.

2. Sharpen dowels so that they can be pushed into the ground.

3. Label one posterboard, "Sun," with the name filling the whole board so that it can be seen from a distance. Make sure the lettering is thick. Label each of the remaining nine posterboards for each of the remaining planets. Tape the model Sun and planets to the appropriate posterboards and tape the posterboard to the dowels.

Teaching Tip

Because of the great distances between the model planets, you may choose to pace out only from the Sun to Mars or Jupiter (which can be done inside, down a long school hallway). You may want to lay out markers for the rest of the planets along the street in front of the school, so that children walking home or riding the bus can see the positions of all the planets in the Solar System.

4. In this lesson a "pace" is two steps. Before taking the students outside, show them how to make a "pace" of one meter length. You can put a few tape strips on the floor one meter apart and have students practice walking one pace (or two steps) per meter.

5. Ask the students how they could model the Solar System distances. Assign a different student to hold the Sun and each of the planet signs.

6. Take the class outside with the planet signs and ensure each student has a copy of the pacing chart.

7. Outside, push the Sun sign into the ground.

8. A student calls out the number of paces from the Sun to the first planet (Mercury).

9. At least two students (one holding Mercury) march out the distance and push the stick into the ground. (It is better to have at least two students pace out the steps, to ensure some consistency.)

10. Repeat for each of the remaining planets, placing them in a straight line for as far as you can (even though the planets never line up in a straight line in the real world).

11. As you arrive at each of the planets, you might want to tell students a fun fact about it. These can be found on the *Teacher Fact Sheet*.

12. Have the students walk to different planets and see if they can still see the Earth or the Sun from each new location.

13. Have the students make other generalizations about what they have observed, noting their comments in their notebooks for later use.

Reflection & Discussion

Setting up a scale model of the Solar System almost always surprises students when they see how small the Sun and planets are compared to the distances between them. Explore this with the class. Use these questions to prompt further discussion:

- How did the distances between the planets in the inner Solar System (out to Mars) compare to the distances between planets in the outer Solar System?
- Where do you find rocky (terrestrial, or Earth-like) planets? (Close to the Sun.)
- Where do you find the gas giant (Jovian, or Jupiter-like) planets? (Far from the Sun.)
- Do you notice similarities or differences in the patterns and cycles observable on the planets? For example, does the length of the day or the length of the year depend on where the planet is located (Yes; longer days and shorter years on terrestrial planets close to the Sun, shorter days and longer years on Jovian planets far from the Sun, and a long day and a long year on Pluto.) Do the seasons depend on where the planet is located? (Just the length of seasons, which depends on length of the year; otherwise not.)

Curriculum Connection

Language Arts: Read stories about the Solar System and the Milky Way Galaxy, using language and context to describe relative size, distance, location, and time.

Discuss with students insights they have gained about Earth, other planets, cycles, and space.

Transfer of Knowledge

The Sun, our star, has a family of planets called the Solar System. What about all the stars in the sky? Could they also have their own families of planets? (Yes, since 1995 scientists have discovered dozens of solar systems around other stars similar to the Sun.)

Lesson Adaptations

Special Education:

- Ask students to make a generalization about the sizes of the inner and outer planets.

- Have students use miscellaneous boxes, fabrics, buttons, old toys, action figures, and other craft materials to construct a fantasy world for two or three characters. Have the students also create a daily schedule for the characters, taking into account the imaginary length of day, month, and year for the fantasy world in which they live.

Talented and Gifted:

- Remind students that the nearest star to the Sun is much further away than the farthest planet in our neighborhood, and that each star has a neighborhood of its own. Ask them to imagine where that closest star might be on their model of *Voyage*. (If the Sun were the size of a grapefruit located on the East coast of the U.S., Proxima Centuri would be the size of a cherry located on the West coast).

- Ask students to make a scale model of a place other than the Solar System. It can be a real place such as the Grand Canyon or the Milky Way Galaxy. It can be an imaginary place such as Peter Pan's Never-Never Land or some place they imagined in a dream.

Assessment Criteria for Activity

Grades 3-4 students may be evaluated as follows. They need not demonstrate all the characteristics of a category to fall within it, though strong evidence of their classification by the teacher should be provided.

4 Points

- Clearly and consistently demonstrates a sophisticated understanding of the concepts nearly 100% of the time by applying them accurately in activities, questions, comments, work, and projects both in the classroom and elsewhere.

3 Points

- Shows a nearly complete grasp of the concepts by using them appropriately at least 75% of the time in class, asking pertinent questions, and by making viable attempts at applying the concepts to other aspects of learning.

2 Points

- Responds correctly to direct questions regarding the meaning of the concepts, but cannot yet express them or demonstrate them consistently and accurately; still makes errors about 50% of the time.

1 Point

- Indicates little more than random guessing at understanding the concepts; cannot focus on essential elements or regularly respond correctly to leading questions; less than 50% accurate.

0 Points

- No work completed.

Placing the Activity Within the Lesson

Discuss with students how, by traveling to each planet, they can gain an appreciation for the vastness of the Solar System, and how Earth is only a small component. The Sun and the planets are truly tiny worlds in a vast amount of space.

Lesson Wrap-Up

Lesson Closure

Earth, our home, is just one several planets orbiting the Sun. The Sun is one of countless stars, some of which you see in the night sky. Maybe around one of those stars is a planet which is home to a class of students. If they look into their night sky, they might be looking at you!

Notes:

Resources

Internet Resources & References

Student-Friendly Web Sites:

Astronomy for Kids
www.frontiernet.net/~kidpower/astronomy.html

Kids Astronomy
www.kidsastronomy.com/solar_system.htm

NASA Kids' Club
www.nasa.gov/audience/forkids/kidsclub/flash/

NASA's Planetary Photojournal
photojournal.jpl.nasa.gov

Teacher-Oriented Web Sites:

American Association for the Advancement of Science, Project 2061 Benchmarks
www.project2061.org/tools/benchol/bolintro.htm

Exploring Planets in the Classroom
www.spacegrant.hawaii.edu/class_acts/

National Science Education Standards
www.nap.edu/html/nses/

The Nine Planets
www.nineplanets.org

Voyage: A Journey through Our Solar System
www.voyagesolarsystem.org

Journey through the Universe
www.journeythroughtheuniverse.org

Discussion about Pluto's reclassification as a dwarf planet
www.voyagesolarsystem.org/pluto/pluto_default.html

Other Resources

Glaser, Linda. *Our Big Home: An Earth Poem*

Leedy, Loreen. *Postcards from Pluto: A Tour of Our Solar System*

Mitton, Jacqueline. *Kingdom of the Sun. A Book of the Planets*

Mitton, Tony. *Roaring Rockets*

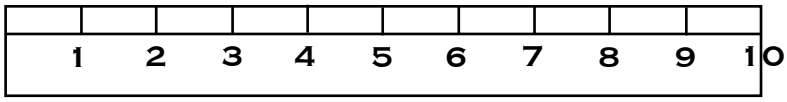
Moore, Patrick. *The Planets*

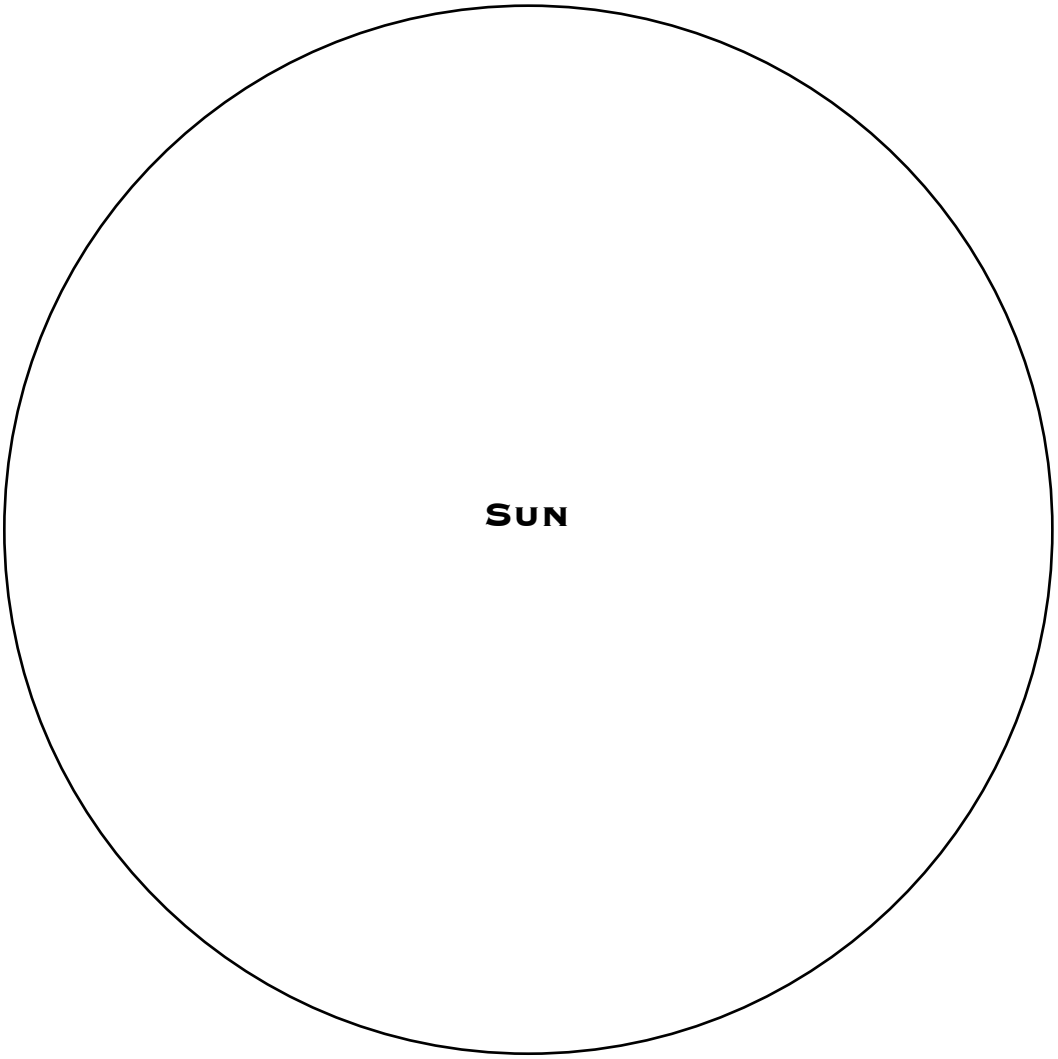
Nayer, Judy, et al. *Space at your Fingertips*

Rabe, Tish. *There's No Place Like Space! A Dr. Seuss book*

Teacher Fact Sheet

IMPORTANT NOTE: Your printer may not have produced the planets on these worksheets at their correct size. To check and correct, adjust the enlargement/reduction on your printer to ensure that this ruler measures exactly 10 cm long.





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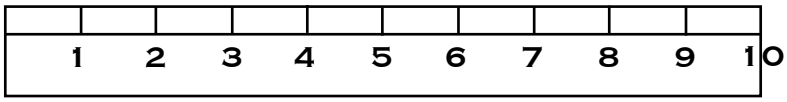


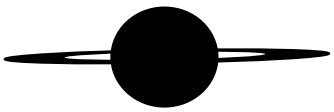
MERCURY

VENUS

EARTH

MARS

JUPITER



SATURN

URANUS

NEPTUNE

PLUTO

Fun Facts About the Planets	
Mercury	18 Mercuries would fit inside the Earth.
Venus	Venus is always cloudy.
Earth	Earth is the only planet we know with life.
Mars	Mars is red because it is covered with rust.
Jupiter	A storm (hurricane) on Jupiter can swallow two Earths.
Saturn	Each season on Saturn is more than seven years long.
Uranus	By the time you get to Uranus, you are only halfway to Pluto.
Neptune	Neptune is the windiest planet, with winds blowing over 1,000 miles-per-hour.
Pluto (dwarf planet)	Pluto is a ball of ice and rock.

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