How Far apart are the Planets?

Theme: By recreating a scale model of the solar system, students will be able to visualize and understand that some planets are very close to the sun while some are very far away. Through demonstration and deductive reasoning, students will learn what affect this has on the planets.
Goal: To demonstrate the relative distances between planets and the sun.
Curriculum Match: 2- 5th grade
Time: approximately 1 hour

Objective: By the end of this lesson students will be able to:
1. Identify and name the planets in order.
2. State orally or in writing that the planets are not evenly spaced – some are very far from the sun while others are very close.
3. Explain that the distance from the sun affects the climate of the planet.
4. Explain that the distance of the planets affects the amount of time needed to orbit the sun.

Materials:
1. A large schoolyard or field
2. Paper signs – each sign should have the name of one of the objects in the solar system (Sun, Mercury, Venus, Earth, Mars, asteroid belt, Jupiter, Saturn, Uranus, Pluto).

Instructions:
1. Take the children outside to a large schoolyard or field.
2. Start the activity at the far end of the schoolyard. Select one child to be the sun. The child will hold up the sign that says "Sun". This child will remain in the same spot for the duration of the activity.
3. Select another child to be Mercury. This child will start from the sun, take one step, and then stop. They will hold the sign that says "Mercury" and stand at this spot for the duration of the activity.
4. Select a child to be Venus. They will start from the sun, take 2 steps, and then stop. They will have a sign to hold that says "Venus".
5. Continue to select children to represent the planets. You can use several children to represent the asteroid belt. Use the chart below to determine the number of steps that each "planet" should take from the sun. The chart also tells the actual distances in kilometers. All of the children should start their steps from the sun and walk in the same direction, so that by the end of the activity, all of the "planets" are stretched out in a long line.

6. It may be difficult to go all the way to Neptune, Pluto, and the Kuiper Belt. If there are space and time restrictions, tell students to imagine that these objects are so far away, that they would be outside of the schoolyard, or across the street. Try to use visual references that students can comprehend.
7. Once the sun and all of the planets are in a line, some of the students who did not get selected the first time can take turns becoming planets. This also allows children to have multiple visual perspectives of what the solar system looks like.
8. Next we will demonstrate that planets that are very close to the sun take much less time to orbit the sun than planets that are very far away. Ask "Mercury" or "Venus" to take 10 steps around the sun. Now ask "Jupiter" or "Saturn" to take 10 steps around the sun. Compare who made it farther around the sun. How many steps does it take for "Mercury" or "Venus" to completely orbit the sun? Ask students to guess how many steps it might take for a farther planet to orbit the sun.

Discussion Topics: The sun provides light and heat for the solar system. The sun can be compared to a large fire or a very large light bulb. We feel more heat when we are close to the fire and less when we are far away. The closer we are to the sun and the more direct the light, and the more heat we feel. Distance from the sun affects the climate of the planets. Mercury is the closest planet to the sun, however one side of Mercury always faces towards the sun and one side always faces away. Therefore, one side of Mercury is very hot while the other side is cooler. Venus is the hottest planet overall. Venus is very similar to the Earth, only slightly closer to the sun. However, greenhouse gasses on Venus trap in the heat, making the average temperature about 850° Fahrenheit. Pluto (the farthest planet from the sun) is very cold. Pluto only receives 1/1000th the amount of light that Earth receives, and on average Pluto is about - 380° Fahrenheit.

You can ask students a series of questions about each planet. For example:

1. If there were water on Jupiter, would it be in liquid form, or would it be frozen? What about Pluto? (it would be frozen)
2. Is it possible for there to be liquid or frozen water on Mercury or Venus? (On Venus, it is so hot, that all water would evaporate into the atmosphere. On the cool side of Mercury, it might be possible for there to be water)
3. Would it take Saturn longer to orbit around the sun than it takes Earth? How long might it take for some of the other planets to go around the sun? (Use chart for answers. It takes Pluto over 247 years!)

The asteroid belt is a region of the solar system falling roughly between the planets Mars and Jupiter where the greatest concentration of asteroid orbits can be found.

The Kuiper Belt (pronounced Ki- Per) is often called our solar system's 'final frontier.' This disk- shaped region of icy debris is about 12 to 15 billion kilometers (7.5 billion to 9.3 billion miles) from our Sun. Its existence confirmed only a decade ago, the Kuiper Belt and its collection of icy objects are an emerging area of research in planetary science.

In 1950, Dutch astronomer Jan Oort hypothesized that comets came from a vast shell of icy bodies about 50,000 times farther from the Sun than the Earth. A year later astronomer Gerard Kuiper suggested that some comet- like debris from the formation of the solar system should also be just beyond Neptune. In fact, he argued, it would be unusual not to find such a continuum of particles since this would imply the primordial solar system has a discrete "edge."

Kuiper's hypothesis was reinforced in the early 1980s when computer simulations of the solar system's formation predicted that a disk of debris should naturally form around the edge of the solar system. According to this scenario, planets would have agglomerated quickly in the inner region of the Sun's primordial circumstellar disk, and gravitationally swept up residual debris. However, beyond Neptune, the last of the gas giants, there should be a debris- field of icy objects that never coalesced to form planets.

The Kuiper belt remained theory until the 1992 detection of a 150- mile wide bodyat the distance of the suspected belt. Several similar- sized objects were discovered quickly confirming the Kuiper belt was real. The planet Pluto, discovered in 1930, is considered the largest member of this Kuiper belt region. Also, Neptune's satellites, Triton and Nereid, and Saturn's satellite, Phoebe are in unusual orbits and may be captured Kuiper belt objects.

Planet	**Approximate distance from Sun (km)**	**Number of paces from the Sun**	**Orbital period measured in Earth years**
Mercury	57,910,000 km	1	87.6 days
Venus	108,200,000 km	2	226.3 days
Earth	149,600,000 km	2.5	1 year (=365 days)
Mars	227,940,000 km	4	1 year, 321 days
Asteroid belt	414,436,363 km	7	
Jupiter	778,330,000 km	13	11 years, 314 days
Saturn	1,429,400,000 km	24	29 years, 219 days
Uranus	2,870,990,000 km	48	84 years
Neptune	4,504,000,000 km	76	164 years, 29 days
Pluto	5,913,520,000 km	100	247 years, 256 days
Kuiper Belt	12,000,000,000 km	200	