LESSON PLAN

Teacher:

Date: Prior to "Give Me Space!" presentation

Grade Level/Subject: 5th/Math & Science

Co-Teaching Model Utilized:

Central Focus:

To only serve as a predecessor classroom activity accompaniment for students meant to experience the performance of "GIVE ME SPACE!" During the performance, students in the fifth grade should be reminded of their previously conducted study on Kepler's Laws of Planetary Motion (especially 1 and 2) by use of ellipse construction identifying planet orbiting sun system and sweeping out equal time with equal area on planet travel.

Standards:

Math
5.OA.B.3 Generate two numerical patterns using two given rules.
5.NBT.B.5 Fluently multiply multi-digit whole numbers using appropriate strategies and algorithms.
5.NBT.B.6 Find whole number quotients and remainders of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division.
5.NBT.B.7 Add, subtract, multiply, divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between operations; assess the reasonableness of answers using estimation strategies.
5.NF.A.1 Add and subtract fractions with unlike denominators by replacing given fractions with equivalent fractions in such a way as to produce and equivalent sum or difference of fractions with like denominators.
5.NF.A.2 Solve contextual problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators.
5.NF.B.4 Apply and extend previous understanding of multiplication to multiply a fraction by a whole number or a fraction by a fraction.
5.NF.B.5 Interpret multiplication as scaling.
5.NF.B.6 Solve real-world problems involving multiplication of fractions and mixed numbers by using visual fraction models or equations o represent the problem.

Science
5.PS2:2) Make observations and measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
5.PS2:4) Explain the cause and effect relationship of two factors (mass and distance) that affect gravity.
5.PS2:5) Explain how forces can create patterns within a system (moving in one direction, shifting back and forth, or moving in cycles), and describe conditions that affect how fast or slowly these patterns occur.
5.ESS1:2) Research and explain the position of the Earth and the solar system within the Milky Way galaxy, and compare the size and shape of the Milky Way to other galaxies in the universe.
5.ESS1:3) Use data to categorize different bodies in our solar system including moons, asteroids, comets, and meteoroids according to their physical properties and motion.
5.ETS2:2) Describe how human beings have made tools and machines (X-ray cameras, microscopes, satellites, computers to observe and do things that they could not otherwise sense or do at all, or as quickly or efficiently.
5.ETS2:3) Identify how scientific discoveries lead to new and improved technologies.

Objective(s):

Constructing ellipse with identification of all mathematical parts then replacing with a planet orbiting system labels and showing how the planet dynamically moves around the elliptical path thus explaining Kepler's Laws. Opportunity: Compare this to measures in musical scores and how quantity of notes in a measure still have to maintain an equal time throughout a piece unless intentionally changed by its composer.

Academic Language Demands:

Ellipse	Aphelion	Area	Proportion
Focus (foci)	Perihelion	Square	Spacecraft
Major axis	Orbit	Cube	Telescopes
Minor axis	Orbital period	Delta	Cone
Semi-major axis	Eccentricity	Mass	Base
Semi-minor axis	Measure	Volume	Plane

Accommodations:

Some material in this lesson is advanced beyond their grade level, however an introductory grasping is still possible for relevant interest sake.

Assessment Measures:

Formative: Q & A during lesson and success of activity accomplishment determined visually
Summative: None

Materials:

Paper
Foam board (as backstop if necessary)
Push pins
Un-stretchable string or yarn
Ruler

PROCEDURES & TIMELINE

Introductory Set:

The geometry of an ellipse is discussed with the class and all principle parts are indicated realizing its formation comes by a slanted intersecting plane through a cone not parallel to the cones base. It resembles an elongated (flattened) circle. Notice how the head of a musical note from a musical score resembles it.

Work Session:

Start by constructing an ellipse on paper, supported with a foam board as necessary, place 2 push pins about 4 inches apart and with a 12-inch string tied back to itself, trace a resultant enclosed curve by pulling tautly from the interior of the string which is wrapped around the 2 pins. Label with mathematical nomenclature and eventually transform the names with planetary terms.

Highlight that:
Law 1. The orbit of a planet is an ellipse with the Sun at one of the two foci.
&
Law 2. A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time.

Law 1 can been seen with the label swaps.
Law 2 can be visualized by seeing two extremes in practice.

- Remove only one of the two pins at the foci of your constructed ellipse.
- From the now pinned foci, take at least two pins, more if required, and maintain the string over the ellipse at the opposite end of the ellipse farthest from the pinned foci.
- Mark where the most separation occurs between those pins on the ellipse.
- Repeat the preceding steps again, only for a part of the ellipse much closer to the pinned foci
- Since the area inside the string remains unchanged because its perimeter remains the same, the resulting different distances along the ellipse represent how far a planet is to move in the same time period.

What does this tell you about the speed of the planet as it gets closer to its sun, farther from its sun? (Increases, decreases)
If the orbit of a planet were circular instead of an ellipse, would the distance traveled by it for a given time be the same? (Yes, but the speed would remain constant)

Closure:

Although not specifically studied in this lesson plan, Kepler's 3rd Planetary Law of Motion relates the orbital period of a planet and the semi-major axis of its orbit and bears mentioning. A proportional relationship exists such that $T^2 \propto r^3$ if circular, or $\frac{a^3}{T^2}$ = constant; about 7.496 x 10^{-6}.

For the concert, remember that planets are moving in ellipses around the sun with their velocities always changing. Even more mind-boggling is that considering the distance between the Sun and Pluto is 1 meter from the 3rd grade lesson plan, being drastically scaled smaller in size, we would need to travel around the real equator of the Earth about once to get to the center of our Milky Way galaxy and travel around Earth's equator really 4 times to span the width of the Milky Way. One small galaxy in the midst of so many more.

Lesson References:

https://en.wikipedia.org/wiki/Kepler's_laws_of_planetary_motion
https://en.wikipedia.org/wiki/Light-year