Finding Our Top Speed

This lesson sets the stage for a discussion of travel in the solar system. By considering a real-world, hands-on activity, students develop their understanding of time and distance. Finally, students plot the data they have collected.

Learning Objective Students will:

- determine the length of time needed to walk or run or walk a given distance
- plot the data on a graph
- use results of data collection to develop the concept of slope

Materials

- Yardsticks or 50-foot measuring tape
- Stopwatches
- Grid Paper
- Index cards
- Masking tape

Instructional Plan

In December 1995, the probe that had been released by the Galileo spacecraft in July 1995 entered Jupiter' atmosphere. Galileo had traveled 2.3 billion miles since its launch in October 1989. It spent the first 3 years in the inner solar system. During one flyby in Venus and two flybys of Earth, it gathered enough velocity from the gravity of the planets to reach Jupiter. Throughout its long journey, Galileo had been sending data about solar system back to Earth.

The Galileo Space Probe orbiting Jupiter

Studying the passage of time and time versus distance, students are better able to think about the time required to travel the long distances in space. Of course, the long time required for this type of travel is exactly why it is difficult for humans to make journeys to the planets. "Are we there yet?" This query really has meaning for space travel. Remember, Galileo traveled for more than 6 years one way to get to Jupiter.

Getting Started

Start the lesson by asking the students how far they can go in 8 seconds. Typically, students answer in a variety of ways. Some may respond with distances from a few feet to the length of a football field. Others may ask, "Are we traveling by foot, on a bicycle, or in a car?" Confine the discussion at this point to travel on foot.

The passing of time is a difficult concept for everyone. In certain settings, when we are enjoying ourselves, time seems to fly by; in other contexts, time seems to stand still. To help students develop their sense of time in a neutral context, ask them to close their eyes. Tell students when to start, and ask them to raise their hands after exactly 1 minute has passed. Practice with estimating the passing of time improves performance. Ask students to share the techniques they used to guess about the length of a minute. Let students practice with time intervals less than a minute. Conclude this activity by estimating the duration of 8 seconds.

After students have practiced estimating the passing of time, they are ready to see how far a teacher can walk in 8 seconds. Give a student a stopwatch, and have him or her time the teacher walking from the front to the rear of the classroom. The teacher's rate of walking might be a topic of discussion. Ask students to discuss factors which might affect the distance traveled by the teacher.

Activity: Walking Speeds

To gather data about their walking speeds, students mark off in a school hallway or outdoors distances from 25 feet to approximately 100 feet in increments of 5 feet. Mark the intervals with masking tape. Have each student carry an index card that has his or her name and lines for recording as many trials as you intend to do.

A school hallway marked off in 5-foot increments

For this first experiment, everyone walks 100 feet, and the timers tell students the time each took to complete the distance. Each mission team takes a turn timing another team.

Line up students and begin the trials. The teacher tells members of a mission team when to go. Three students should have stopwatches to time each walker. The time recorded is the median of the three times shown on the timers' watches. Using multiple timers avoids losing data because of difficulties using a stopwatch. If sufficient stopwatches are not available for this scheme, have each timer pick a participant and keep time for that student. Some students may need to repeat their walks if a timer makes a mistake.

To facilitate making a graph of the class data, have each student record her or his time on the reverse side of the index card in large writing. Begin by making a graph of the class data using the students themselves. Ask five students to come to the front of the room and stand in order according to their times, from the least to the greatest. Ask another group to come to the front and put themselves into the ordered group. If the times are the same, the students should stand behind one another. When all students are in the ordered group, the graph is complete.

The teacher should record on the chalkboard or an overhead transparency a frequency table for the "human" graph. When seated again, each student should make a bar graph of the data in the frequency table.

Students may choose to use the Bar Grapher Tool to graph the data. Alternatively, students may use grid paper to graph the data.

Activity: How Far Can I Walk in 8 Seconds?

The next phase of this lesson requires students to collect data about how far they can walk in 8 seconds. That is, the time allowed for walking is held constant and the distance varies from student to student. The marked-off, 5-foot increments are used to measure the distances.

Only one timer is necessary. The teacher is probably the best timer here because the stop and go commands need to be authoritative.

At the stop command, each student looks at the distance markers and records the distance walked. Of course, students do not always stop on a mark. They need to agree on how to estimate the number of feet they have walked beyond a mark, add that distance to the marked distance, and record their results for the final graphing activities.

Different students can walk varying distances in 8 seconds

Closing The Activity

Have each mission team record its results on one graph. The graph should show distance versus time, with distance on the vertical axis and time on the horizontal axis. Be sure to talk about the point where time is zero and distance is zero, which is also a potential data point. Connect each point on the graph (representing how far each student on the mission team walked in 8 seconds) with (0,0). The steepness of the lines connecting (0,0) to the data pints shows the average rate of speed, or slope. Use this opportunity to discuss the concept of slope and to give a formal definition of the slope of a line.

Students may choose to use the Line of Best Fit Tool to graph the data. Alternatively, students may use grid paper to graph the data.

Extensions

Students may want to check their speed over longer distances to confirm that in 16 seconds they go twice as far. Note that the empirical data most likely do not show a linear relationship. As the length of time increases, the average speed usually decreases. Talk about the effects of tiring over time. If shorter times are used, the speed could be faster. Discuss that the linear graph approximates where each walker would be in the intervening times if he or she walks at a constant rate of speed. This result explains why we characterize the graph as showing the average rate of speed.

The effects of tiring on speed

NCTM Standards and Expectations

Algebra 6-8

Use graphs to analyze the nature of changes in quantities in linear relationships.

Explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope.

Measurement 6-8

Select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels of precision.

Solve simple problems involving rates and derived measurements for such attributes as velocity and density.

Understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume.

Use common benchmarks to select appropriate methods for estimating measurements.

References

Adapted from Finding Our Top Speed in Mission Mathematics, Linking Aerospace and the NCTM Standards, a NASA/NCTM project, NCTM 1997.