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MacroLab Lesson 3
Mean, Median, & Mode: Teacher Guide

Overview

Students will use Sphero to conduct an experiment. They will identify how long they need Sphero to move at 10% speed to reach and knock over a target object (such as a whiteboard marker). Using this information, they will then calculate how long Sphero will need to move at higher speeds to reach the same target. Finally, they will be given a bowling challenge where they can use any speed they like to knock over as many "pins" (whiteboard markers) as they can. In the challenge, they will record their results and then they will determine the mean, median, and mode of the results from the entire class.

Read through the student guide. At the start of the lesson, review the relationship between time, speed, and distance. Also introduce mean, median, and mode.

Objective

Students will:

- Students will solve an open ended problem with guess and check.
- Students will use division and the relationship between rate, distance, and time to determine the time needed to reach a target
- Students will calculate mean, median, and mode from a data set that they helped generate

Common Core Math Standards

The following Common Core Math Standards for 4th, 5th and 6th grade apply to this lesson:

- CCSS.MATH.CONTENT.6.SP.A: Develop understanding of statistical variability
- CCSS.MATH.CONTENT.6.SP.B: Summarize and describe distrubutions
- CCSS.MATH.CONTENT.4.OA.A: Use the four operations with whole numbers to solve problems.
- CCSS.MATH.PRACTICE.MP1: Make sense of problems and persevere in solving them.
- CCSS.MATH.PRACTICE.MP2: Reason abstractly and quantitatively.
- CCSS.MATH.PRACTICE.MP4: Model with mathematics.
- CCSS.MATH.PRACTICE.MP8: Look for and express regularity in repeated reasoning.

Materials Needed

Spheros are controlled by mobile devices, either Apple (iPhone or iPad) or Android. Ideally, you would do this lesson in groups of 3 or 4 students, each with their own Sphero and device. This lesson is designed for iPad, but other devices could be used. Here is what each group would need:

- iPad with Sphero MacroLab loaded. You can get Sphero MacroLab for free from the iTunes app store.
- Sphero that has been fully charged
- A flat clear area of at least 8 feet by 8 feet. (Preferably not very slippery.)
- Masking tape
- 5-7 Whiteboard Markers or other object students can knock over with Sphero

Part 1: Connect the Sphero

In part 1, students need to connect each iPad with a Sphero. They will:

1. Wake up the Sphero
2. Turn on Bluetooth
3. Connect the correct Sphero to the iPad, using the colors that it flashes as a way to tell which Sphero has which name

Part 2: Aim the Sphero

In part 2, students need to set the orientation, which is the direction of 0 degrees heading for Sphero. This is called "aiming". It's important that they get this right so that the Sphero will follow the path and not bump into anything. To do this, they need to adjust the blue "taillight" so that it is pointing directly at them. If they do this correctly, then the Sphero will roll directly away from them. Students will:

1. Open up MacroLab on the iPad
2. Hold the Sphero in front of them as they look down the path
3. Tap and hold the aim icon at the bottom of the screen and adjust the taillight so that it is pointing directly at them.

Part 3: Reaching the target

Set up the target object 7 feet away from a starting line. You can use masking tape on the floor to mark the starting line.

To begin this portion, let the students have a few practice rounds to ensure Sphero is heading straight towards the target.

Now that the students have Sphero moving straight, they need to figure out when Sphero is set to 10% speed how long of a delay they need to knock over the target object and stop within 6 inches of it.

Part 4: Calculations

Once they have determined the correct delay to knock ober the target, then they need to figure out how long of a delay to use for Sphero being driven at 30%, 50%, 80%, and 100% speeds. Students may need to use the calculator on the I-pad, otherwise they should be able to complete all of the calculations using long division. Students then should fill in the table on their worksheet.

% speed	10	20	30	40	50	60	70	80	90	100
delay (ms)	10,000	5,000	3,333	2,500	2,000	1,667	1,429	1,250	1,111	1,000

Example of solution (note: for your reference this table includes all delays, not just the 30,50,80, and 100% speeds):

Part 4: Calculations (continued)

Here is a simple approach for students to solve for the delays of different speeds:

If 10% of speed needs 10,000 ms to reach the target:

Distance= Speed*Delay

Distance= 10*10,000

Distance= 100,000

For 20%, we still need to go the same distance (this one is straight forward because the speed has doubled but just to outline the process)

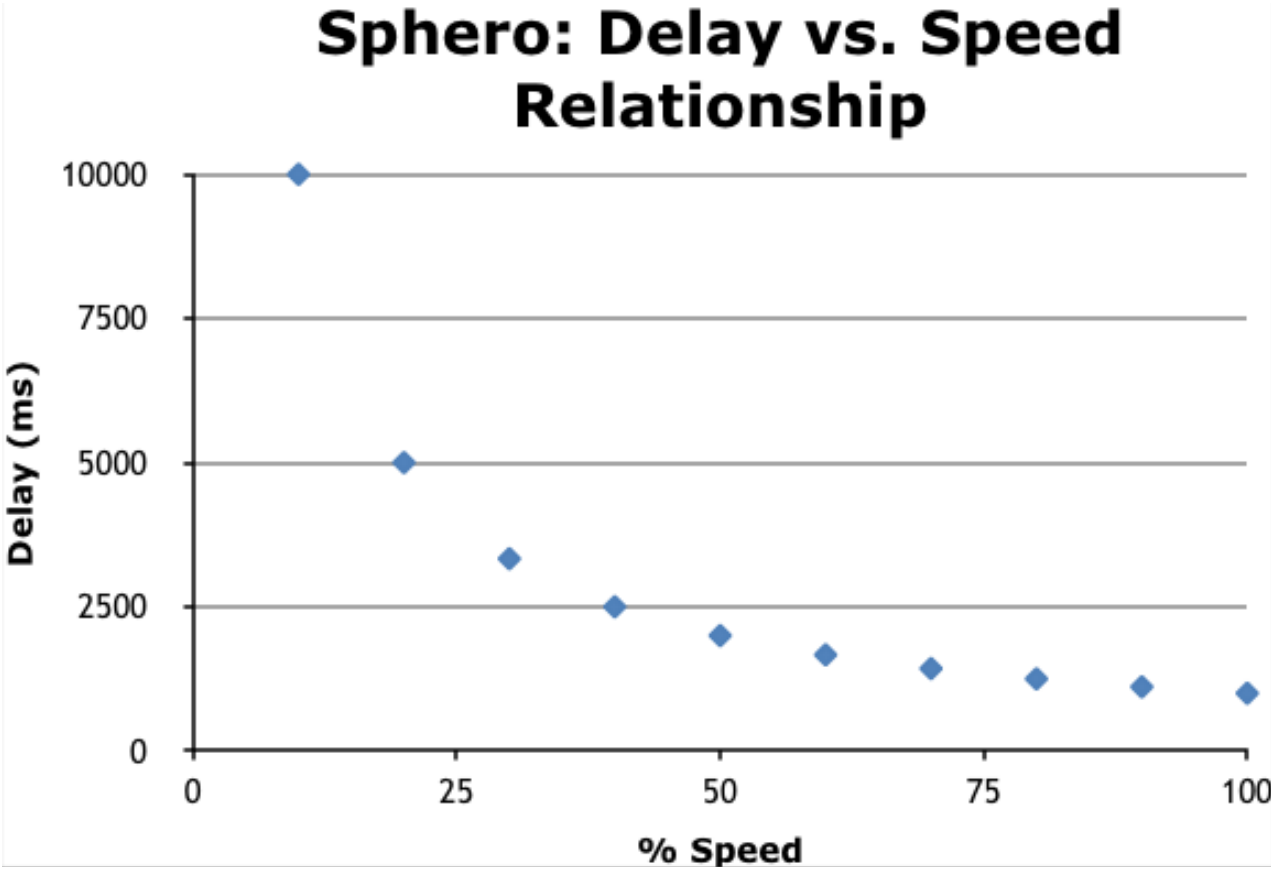
Distance= Speed*Delay

100,000= 20*delay

100,000/20= delay

5,000

While not included in the student guide, you may find it may be interesting to have students plot the Delay vs. Speed relationship and speak about the shape of the graph.



At the end of this section, there is time for students to test their math and see how close they can get to the target at each speed. They are prompted to take a few trials at 30%, 50%, 80%, and 100% to see if they can successfully knock over the target using the delay value they calculated.

Part 5: Challenge

For this challenge, set up 5 whiteboard markers at the same target location used earlier in the lesson. This challenge is a fun game of Sphero bowling where students determine which speed and delay they would like to use to knock over as many of the whiteboard markers over as they can. They need to record how many markers they knock over each of their 5 tries. Then, as a class compile the results of all trials and students will determine the mean, median, and mode of this data set.