SPRK

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MacroLab Lesson 1
Time, Speed, and Distance: Teacher Guide

Overview

Students will use Sphero to show that there is a linear relationship between time, speed, and distance. They will program Sphero to move at a particular speed for a particular amount of time, and then measure how far it has gone. They will use division to find the relationships between time, speed, and distance. Finally, they will be given a challenge to take what they've learned and to have Sphero return to the place where it started.

The mathematics could be made to be more complex (for example, students could derive a formula where they predict the distance). Read through the student guide. At the start of the lesson, go over the concepts of time, speed, and distance.

Objective

Students will:

- Create a one-line program that moves Sphero at a steady speed for a specified amount of time
- Perform measurements to determine the distance traveled.
- Perform division to compare different measurements
- Create a two-line program that moves Sphero to a certain position and then moves itback to where it started.

Common Core Math Standards

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

- CCSS.MATH.CONTENT.4.OA.C.5: Generate and analyze patterns.
- CCSS.MATH.CONTENT.4.MD.A.2: Use the four operations to solve word problems involving distances, intervals of time, etc.
- CCSS.MATH.CONTENT.4.OA.C.5: Generate and analyze patterns.
- CCSS.MATH.CONTENT.5.OA.B.3: Analyze patterns and relationships.
- 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 via Bluetooth on either Apple (iPod, IPhone, or iPad) or Android devices. 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 iPads, but other devices could be used. Here is what each group would need:

Materials Needed (continued)

- iPad with Sphero Macrolab loaded. You can get Sphero Macrolab for free from the iTunes app store.
- Sphero that has been fully charged
- Masking tape
- Tape measure
- Print-out of the worksheet (last page of teacher's guide)
- A flat clear path of at least 15 feet. (Preferably not very slippery.)

Part 1: Connect the Sphero

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

- Wake up the Sphero
- Turn on Bluetooth
- 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 OrbBasic 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: Time and Distance

In part 3, students will create a macro (computer program for Sphero) and modify it in order to do an experiment. They will play the macro, measure how far the Sphero goes each time, and record the values in on their worksheet.

To create a macro to roll the Sphero, they will:

1. Create a new macro
2. Add a Roll command
3. Set the Roll command to move at 20% speed for 3000 milliseconds (3 seconds).
4. Add a Stop command to stop the Sphero immediately.

The final macro looks like this:
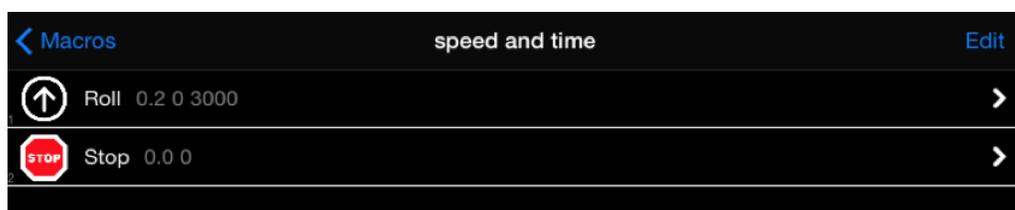
To run the experiment, they will:

1. Put a small piece of masking tape on the floor and put the Sphero on the tape.
2. Tap Play in MacroLab
3. Once the ball has moved, they will use the measuring tape to measure from the ball to the masking tape. They only need to be accurate within 1 inch or 2cm.
4. They will write the number down in the worksheet.
5. Then they will modify the macro so that it runs for 6 seconds and they will repeat the experiment, recording the result in the worksheet.
6. Finally, they will modify the macro so that it runs for 9 seconds and they will repeat the experiment, recording the result in the worksheet.
7. At the end they will divide the distance from the 6 second experiment by the 3 second experiment, and also the distance from the 9 second experiment by the 3 second experiment.

Ask them what they notice. They should be able to notice that when something travels at a particular speed, if it goes twice as long, it goes twice a far. If it goes three times as long, it goes three times as far. This is what's known as a linear relationship.

Why isn't it exactly twice or three times? The reason is that Sphero (or any real object) takes time to speed up and time to slow to a stop. This little bit of time at the beginning and end makes it so that it doesn't exactly travel the time we would expect it to.

Part 4: Speed and Distance

For part 4, the students will:

1. Modify the macro so that it once again rolls at 20% speed for 3000 milliseconds (3 seconds). They will run the experiment again and measure how far it goes, recording it in their worksheet. It should be close to what they had before.
2. Modify the macro so that it rolls at 40% speed for 3000 milliseconds. They will run the experiment again and measure how far it goes, recording it in their worksheet.
3. Modify the macro one last time so that it rolls at 60% speed for 3000 milliseconds. They will run the experiment again and measure how far it goes, recording it in their worksheet.
4. At the end they will divide the distance from the 40% experiment by the 20% experiment, and also the distance from the 60% experiment by the 20% experiment.

The final macro looks like this:

Ask them what they notice. They should be able to notice that when something travels for a particular speed, if it goes twice as fast, it goes twice a far. If it goes three times as fast, it goes three times as far.

Both the speed and time experiments show that distance is a linear factor of speed in time. In other words, we can find the distance traveled multiplying the speed times the time in motion. Right now, we are defining speed in terms of percent, but the actual speed that ball moves will be the distance traveled divided by the time it took to get there.

Part 5: Challenge

Part 5 is a challenge to see if the students have understood the concepts. For the challenge, students will have Sphero move a distance out, and then have to figure out how to move it back at a given speed in order to have it stop about where it started. They will:

1. Modify the Roll command to have it have a speed of 40% and a delay of 5000 milliseconds (5 seconds).
2. Add a new Roll command that has a speed of 20% and a heading of 180 degrees. The 180 degree heading is what will bring Sphero back in the direction it came.
3. Add a new Stop command to stop Sphero immediately.
4. Then they need to decide how long the delay time should be (that is, how long should it roll for). Let them try out different values until they get it right.

The final macro looks like this:

Macros	speed and time	Edit
⬆ Roll 0.4 0 5000		>
🛑 Stop 0.0 255		>
⬇ Roll 0.2 180 10000		>
🛑 Stop 0.0 0		>