Percentage: Teacher Guide

Overview

Students will use Sphero to explore percentages using speed and color. The speed experiments are quantitative and the color experiments are qualitative. They will program the Sphero to move at 100% speed for a particular amount of time, and then measure how far it has gone. Then they will repeat the experiment with 50% and 30% speeds. They will calculate the speeds based on distance and time, and then they will perform division to show that the smaller speeds are (roughly) the expected percentages of the 100% speed. Then they will be given a challenge to figure out what percentage of 100% speed is required to move Sphero to a certain position.

For the color experiments, students will make Sphero turn different colors. They will explore what happens when percentages less than 100% are used, for both single primary colors and mixtures of primary colors. For their challenge, they will make the Sphero turn gray and purple.

Read through the student guide. At the start of the lesson, go over the concepts of percentage and how the Sphero uses percentages.

Objective

Students will:

- Create a one-line program that moves the Sphero at a steady speed for a specified amount of time
- Perform measurements to determine the distance traveled.
- Perform division to calculate speeds
- Perform division to calculate percentages
- Create a two-line program to display a color for a certain length of time.
- Have Sphero light up in primary colors (red)
- Have Sphero light up in colors that involve two primary colors (yellow and orange)

- Have Sphero light up in colors that involve two or three primary colors (gray and purple).

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.NBT.A.1: Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right.
- CCSS.MATH.CONTENT.4.MD.A.2: Use the four operations to solve word problems involving distances, intervals of time, etc.
- CCSS.MATH.CONTENT.5.OA.B.3: Analyze patterns and relationships
- CCSS.MATH.CONTENT.5.NBT.A.1: Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.
- CCSS.MATH.CONTENT.5.NBT.B.7: Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction
- 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 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
- Masking tape
- Tape measure
- Print-out of the worksheet (last page of teacher's guide)
- A flat clear path of at least 25 feet. (Preferably not very slippery.)

Part 1: Connect Sphero

In part 1, students need to connect each iPad with 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 Sphero

In part 2, students need to set the orientation, which is the direction of the 0 degrees heading for the 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 an icon at the bottom of the screen and adjust the taillight so that it is pointing directly at them.

Part 3: Speed

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

To create a macro to roll Sphero, they will:

1. Create a new macro
2. Add a Roll command
3. Set the Roll command to move at 100% speed for 3000 milliseconds (3 seconds).

Note that at 100% speed, the Sphero will go quite far in 3 seconds. Make sure you have room for it.

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. Watch for where the ball stops rolling and starts sliding and place a piece of masking tape there. Then 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. They will calculate the actual speed by dividing the distance by the time (3 seconds).
6. Then they will modify the macro so that the speed is 50% and they will repeat the experiment, recording the result in the worksheet, and calculating the speed.
7. Finally, they will modify the macro so that the speed is 30% and they will repeat the experiment, recording the result in the worksheet.
8. At the end they will divide the distance from the 50% experiment by the 100% experiment, and also the distance from the 30% experiment by the 100% experiment. They should have values close to 0.5 and 0.3, and they should be able to translate those into percentages.

Why won't their results be exactly 50% and 30%? The reason is that the Sphero (or any real object) takes time to speed up. This little bit of time at the beginning makes it so that it doesn't exactly travel the distance we would expect it to. They should especially be able to see how the Sphero takes time to speed up when running it at 100% speed.

## Part 4: Speed Challenge

For part 4, the students will:

1. Place a piece of masking tape along the path of the Sphero, closer to where the 100% speed Sphero stopped rolling. (Preferably around 75% of the way.)
2. They will measure how far that distance is.
3. They will use their worksheets to calculate the speed percentage they would expect to have the Sphero stop rolling at that point.
4. They will run the macro and see how close they get.

Part 5: Color

Students will experiment with mixing colors to light up the Sphero. Note that mixing colors with light is different than mixing colors with paint. When you mix red and green paint, you get brown; when you mix red and green light, you get yellow. Similarly, mixing all colors creates black for paint, but creates white for light. Note that the Sphero shell has some color, so that they colors that show up on the Sphero won't exactly match what's shown in MacroLab.

For part 5, the students will:

1. Create a new macro, adding a color (RGB) command and a delay command. The color will be set to 100% red and the delay will be set to 3000 msec (3 seconds).

‹ Macros	color	Edit
🔴 RGB 1.0 0.0 0.0 200		›
⏱ Delay 3000		›
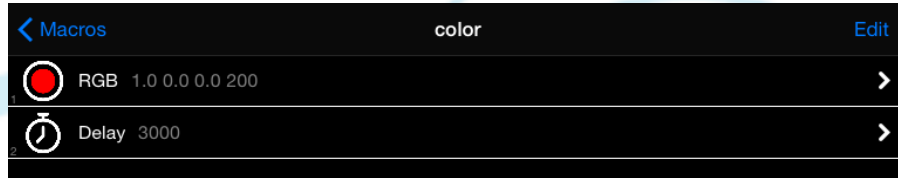
2. Modify the macro to see what happens if they only use 50% red. (It's a darker red.)
3. Modify the macro to make yellow with 100% red and 100% green.
4. Modify the macro to make orange (100% red, 50% green).

Part 6: Color Challenge

Students will experiment with creating two colors that use all three primary colors: red, green, and blue. First they will create white, which is 100% red, 100% green, and 100% blue. Then they are challenged to create gray, and hopefully they will realize equal parts of red, green, and blue, less than 100%, will create gray. (For example, 50% red, 50% green, and 50% blue.)

‹ Macros	color	Edit
⚪ RGB 0.5 0.5 0.5 200		›
⏱ Delay 3000		›
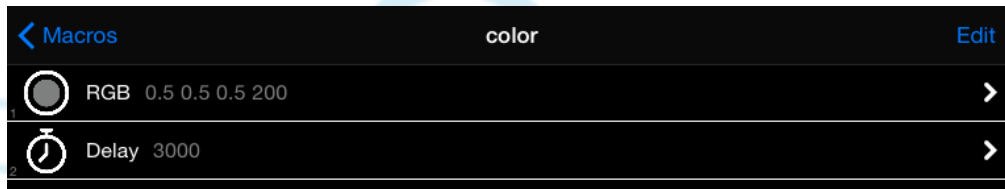
Lastly, they are challenged to create purple. This will take some playing around with percentages. In the end, they will hopefully end up with something like 70% red, 0% green, and 100% blue.

‹ Macros	color	Edit
🟣 RGB 0.7 0.0 1.0 200		›
⏱ Delay 3000		›