Zooming with Dash

Overview:

If you give Dash more power, it will go faster. But what does that mean? The speed, time, and distance that Dash travels are all related. In this lesson, students run speed trials with Dash, and then do the math to calculate and compare speeds, times, and distances.

Curriculum: Math, Science

Group Size: 2 per Dash	Target Grades: 4 - 5	Time Required: 1 - 1.5 hours

Content Standards:

NGSS:

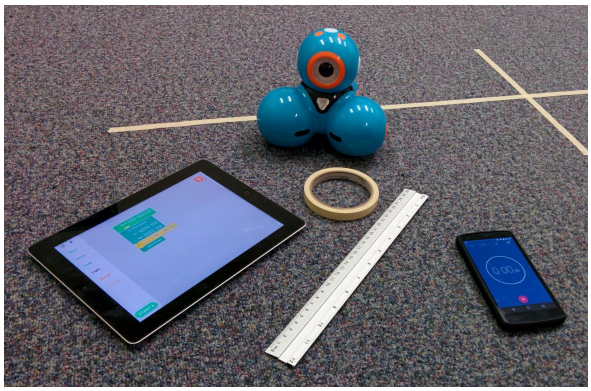
- 4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

MATH:

- 4.MD.A.2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
- 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; relate the strategy to a written method and explain the reasoning used.

Materials Needed:

- 1 Dash per 2 - 4 students
- Ruler
- Tape
- Stopwatch (real or digital)
- Speed Recording Table



Lesson Objectives:

- Conduct an experiment involving repeated trials.
- Understand the concept of a control variable in an experiment.
- Learn about speed and how to calculate speed given a time and distance.

Lesson Procedure:

This lesson can be broken into three classes or sections.

Class 1: Speed versus Time and Distance (25 minutes)
Class 2: Time Trials (35 minutes)
Class 3: How Fast is Dash? (20 minutes)

Class 1: Speed versus Time and Distance

You see and hear about speeds everywhere. What are some examples of speeds that students see?

- Some examples include transportation (automobiles and speed limits), nature (animals and wind), sports (balls that are thrown or hit), and space (Earth's spin).

But do you know what speed really means? Take the speed limit near a school for example, 25 mph. If a car is travelling 25 miles per hour, how far does the car travel in one hour? In two hours? Perform these calculations with the students.

25 mi/hr for 1 hr = 25 mi
25 mi/hr for 2 hrs = 50 mi

- The units should be a distance. Since the unit of distance used in the speed is miles, the distance should also be in miles.

Speed is a way of telling you how far something will travel in a given period of time.

If you know the distance traveled and the time it took, you can calculate the speed:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

The speed formula says: “Speed is equal to the total distance traveled divided by the time it took to travel that distance.”

Practice:

This image gives the results of a bike race. Have students point out the important information, if they wanted to find the speed of each racer.

Ask students to pick out the relevant information here.

- They should identify the total length of the race and individual times.
- Students should not include the record time or the numbers on the bikes.
- Make sure students include the units of each quantity.

Using that information, calculate each racer’s speed.

For example, Julia’s speed is the distance divided by her time:

$$100\text{m} / 28\text{s} \approx 3.57\ \text{m/s}$$

Students can use a calculator to estimate the answers.

Review the answers with students. They should all have the same speeds for all racers. In the review, talk about this race as an ‘experiment’ with many ‘trials’ (racers). In this case, the ‘control variable’ is the race length, 100 m. Discuss why this value is the control variable, and not any of the times.

Class 2: Time Trials

Students will now prepare to run 2 experiments.

Begin by writing a hypothesis about the outcome of each experiment. Each student should write their own hypotheses. Students should try to answer the question for each experiment, and provide an explanation for their answers.

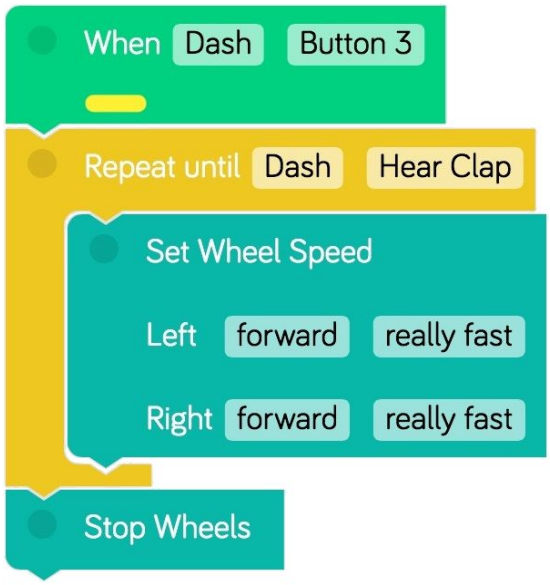
Experiment 1: The distance for each trial is 100 cm. Vary the wheel speed. Measure the time. How does changing the speed affect the time it takes to complete the trial?

- *Example hypothesis:* at higher speeds, it takes less time to cover the same distance; at lower speeds, it takes more time

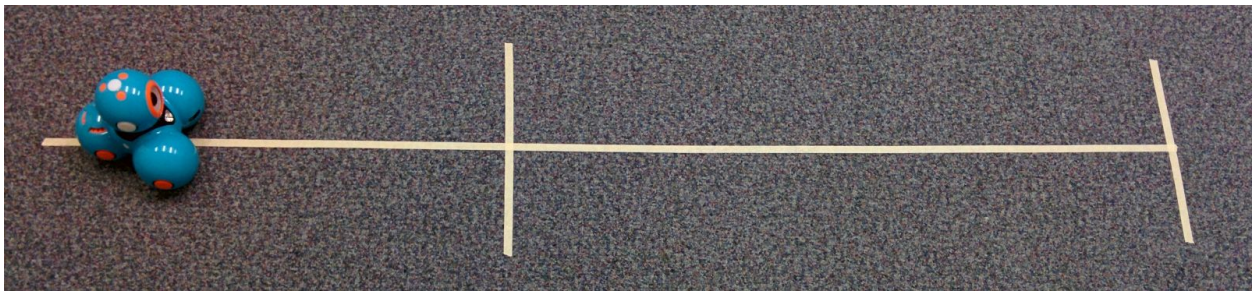
Experiment 2: The time for each trial is 5 seconds. Vary the wheel speed. Measure the distance. How does changing the speed affect the distance travelled in 5 seconds?

- *Example hypothesis:* at higher speeds, Dash travels a greater distance in the same amount of time; at lower speeds, Dash travels a smaller distance

To set up the experiment, use Blockly to program Dash. Set up triggers so Dash moves forward and stops when students want it to. The triggers could involve making a sound, pressing a button, or moving Dot in some way. Then students can reuse the code and modify the speed for each trial. Here is an example:

Start when the third top button is pressed.	
Continue until a clap is heard.	
Move forward with both wheels set to really fast.	
After a clap is heard, stop moving forward.	

Then set up the racetrack: tape down a starting line, and use a ruler to measure 100 cm. Place tape at the finish line. Connect the start and finish lines, extending the tape beyond the start line to help with alignment.



To run a trial:

- Place Dash well behind the starting line. Make sure Dash is lined up properly to move straight ahead.
- Have one student in each group use the stopwatch and another watch the measuring tape.
- Trigger Dash to start, and then start the stopwatch as Dash crosses the starting line.
    - For experiment 1, stop the stopwatch as Dash reaches the finish line. Then stop Dash. This will give the time it takes Dash to travel 100 cm at the set speed.
    - For experiment 2, stop Dash when the target time has been reached. Mark the place that Dash stopped and measure the distance.
- Record the actual distance and time of each trial in the Speed Recording Table. Students can decide what units to use for both time and distance, but they should be consistent throughout the trials.
- Repeat each speed trial several times to make sure the results are accurate. Reset Dash well behind the starting line for each trial.

Class 3: How fast is Dash?

Review with students the formula for speed: distance divided by time.

For each trial, have students calculate Dash's speed in the Recording Table.

- Write the formula on the board if needed.
- Make sure students use units in their answers.
- Students can use a calculator, and round their answers to the nearest hundredth.

Then have students summarize the data and compare Dash's different speed settings in a research report. Prompt students to include:

- Their hypotheses
- The research method that they used
- Their data tables, including:
    - Any outliers, explaining why they can be rejected

        - e.g. someone wasn't paying attention, Dash encountered an obstacle, or Dash's wheels caught so it didn't drive straight
    - If there were differences between trials at the same speed, what could explain them? How would you pick which trial time to use to represent Dash's speed?
        - There may be slight differences due to Dash's wheels getting caught or slipping
        - If students did not line Dash up straight each time, the measured distance or time would be slightly different
        - After removing the outliers, any selection would work, but students should give an explanation for their choice (e.g. students may choose the most frequently occurring speed, or the middle speed)
    - The 'control variable,' or value that didn't change between trials, in each experiment
        - Think about how the control variable helps when drawing conclusions about the other aspects that were measured
- Any conclusions they made, including answers to the questions:
    - How do the hypotheses compare to the data? Do they have the same results?
    - What are the differences between Dash's speed settings?
    - What are the relationships between distance, time, and speed?

If there is time, have some students present their findings and conclusions to the class. Lead a class discussion to make conclusions about Dash's speed settings, and make sure to discuss any differences in the data between different groups.

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Speed Recording Table

Experiment #	Speed Setting	Distance	Time	Speed Calculation

Evaluation Rubric

	Excellent	Competent	Needs work
Participation and Teamwork	The student actively participates in classroom discussions, answering questions and cooperating with group member(s) during the activity.	The student occasionally participates in classroom discussions and cooperates somewhat with group member(s).	The student does not participate in classroom discussion. The student does not cooperate with their group member(s) during the activity.
Calculations	The student applies the speed formula to accurately calculate all values needed from the data.	The student applies the speed formula to calculate all values needed from the data, with some help from the teacher.	The student cannot independently apply the speed formula to the data, even with coaching from the teacher.
Programming	The student correctly applies the Blockly commands to run the trials smoothly.	The student correctly applies the Blockly commands in some cases, but the trials do not run smoothly.	The student does not correctly apply the Blockly commands to run the trials.
Conclusions	The student accurately answers all of the prompts and draws logical conclusions from their collected data. The student compares the data to their hypotheses. If asked, the student clearly presents their conclusions to the class.	The student answers all of the prompts and draws some conclusions from their collected data. The student tries to compare the data to their hypotheses. If asked, the student presents some conclusions to the class.	The student does not answer all of the prompts or draw logical conclusions from their collected data. The student does not compare the data to their hypotheses. The student cannot present their conclusions to the class when asked.