

Introduction

Students often find the interpretation of graphs extremely difficult – this has been shown in research and from many stories of interviews with college students and with younger students. When faced with distance / time graphs for example, many students interpret the line that represents velocity as a picture, and think that a positive slope shows a person walking up a hill, and a horizontal line shows them walking across flat land. Our “walking the graph” activity helps students deeply understand the meaning of graphs, as they physically walk the line of graphs, which also enables the stimulation of sensory-motor areas of the brain. For this activity we used Pasco Sensors and software, pgs 3 - 4, that offer the opportunity to walk graphs that show velocity and acceleration.

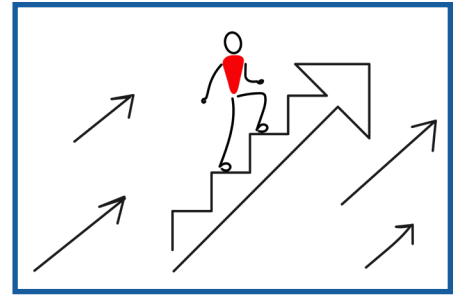
Materials

This lesson is written using one motion sensor setup per small group. However, the task can easily be adapted for a class with fewer sensors. It is even possible to conduct the activity with one motion sensor for the whole class, with groups nominating a person to come out and “walk the graph” and preparing them to do so.

- 1 laptop (per group) w/ MatchGraph software from PASCO downloaded
- 1 PASCO motion sensor per group
- graph paper

Agenda

Time	Task
10 mins	Introduce PASCO sensors: <ul style="list-style-type: none"> • Explain to the class that they will be working with this technology, and to decide how it works you need a volunteer • Display a graph • Do not tell the volunteer or the class how the sensor works, simply start the record button on the sensor and let the volunteer and class decide • Allow the volunteer to take multiple turns or bring other volunteers up to improve, if necessary
30 mins	Launch Task: <ul style="list-style-type: none"> • Students will “walk” several position function graphs and several velocity function graphs, each time attempting to match the given graph with their movement • Students should: <ul style="list-style-type: none"> ◇ Plan their path as a team ◇ Coach one person to walk it ◇ Repeat the process until they are satisfied and ready to try a new graph



40 mins	<p>Challenging Other Teams:</p> <ul style="list-style-type: none"> • Ask each group to: <ul style="list-style-type: none"> ◊ Draw a position graph (aka Challenge Graph) to challenge another team on a piece of graph paper ◊ Trade Challenge Graphs with another team • Once groups have traded, ask teams to: <ul style="list-style-type: none"> ◊ Draw a prediction of what the corresponding velocity graph would look like for the Challenge Graph you were given ◊ Use the motion sensor in velocity mode to test your prediction <p>Consider:</p> <ul style="list-style-type: none"> ◊ How can you decide whether or not you were accurate? ◊ What would the acceleration graph look like? ◊ Continue attempts at matching the graph until your group is satisfied ◊ (Extension): Try a new challenge graph by drawing a velocity graph and walking its position (the “backwards” or inverse version of the first Challenge Graph trade)
20 mins	<p>Whole-Class Debrief:</p> <ul style="list-style-type: none"> • What connections did you make between graphs? • What characteristics of the graphs were most challenging to produce? • What strategies did your group use that allowed you to be successful? (in predicting graphs, walking them, other areas, etc.)

Notes to the teacher:

The activity begins with a quick demonstration in front of the room of how the sensor works so all students start on the same page. We usually like beginning with a volunteer and simply starting the sensor without telling them what it is or giving much instruction. It makes for a fun discovery moment for the whole class.

Next students have some time to get familiar with the sensor and what walking different position and velocity graphs looks and feels like.

Then students draw a *position* “Challenge Graph” to trade with another team. Once teams have received their challenge graph, they don’t try to walk that, but instead, draw what the matching *velocity* graph would look like, pushing them to conceptually consider the derivative of the relationship.

Finally, we have a whole-class debrief for students to reflect on which features of the graphs (and the activity overall) were interesting to them and/or challenging. We find that groups tend to take different approaches and they learn from each other’s methods and observations.



PASCO Passport motion sensor



PASCO airlink

Materials Needed

1. PASCO PASPORT Motion Sensor (\$85) https://www.pasco.com/prodCatalog/PS/PS-2103_pasport-motion-sensor/index.cfm
2. PASCO airlink (\$59) https://www.pasco.com/prodCatalog/PS/PS-3200_airlink/index.cfm
3. USB-to-MicroUSB cable (included with PASCO airlink)
4. USB-to-wall plug or computer with USB port (for providing power)
5. MatchGraph or SPARKvue on a Bluetooth-enabled computer or mobile device. The software can be downloaded from the PASCO website under "Downloads", or from major app stores).

The airlink allows the motion sensor to connect to a computer, phone, or tablet over Bluetooth. It is battery powered, so it can be charged before using or used while plugged in. It charges via USB, using the included USB-to-MicroUSB cable. To plug in the airlink (either to charge or to use) connect the MicroUSB side of the USB-to-MicroUSB cable to the airlink. The plug for this is located next to the on/off button. Then connect the USB side of the of the USB-to-MicroUSB cable to either a computer or to the USB-to-wall plug and plug it into the wall. While the airlink charges its battery light will blink yellow, once the battery is fully charged it will blink green.

Steps for use:

1. Connect the Motion Sensor to the airlink. The plug is located on the taller side of the airlink, under the blue tab that reads "PASPORT."
2. Click on/off button on the airlink. The light next to the Bluetooth logo (stylized B) should begin to blink red.

For MatchGraph on a computer:

1. Open MatchGraph
2. If it doesn't automatically open a pop-up window asking to connect a motion sensor, click the yellow warning icon on the top of the screen.
3. Click "Choose Wireless Interface" in the pop-up window
4. Once the "Wireless Interfaces" pop-up window is open, your airlink should appear in an orange highlighted line. Click that orange line. The Bluetooth light on the airlink should start to blink green.
5. Your set-up should now be complete. Click the red button to start recording, or the button with the four graphs to change the graph displayed.



For SPARKvue:

1. Open SPARKvue
2. Click the Bluetooth icon on the top of the app (stylized B, first button from the left)
3. Once the "Wireless Devices" window is open, your airlink should appear in blue font. Click on the words. The Bluetooth light on the airlink should start to blink green.
4. Click "Done" on the bottom of the window.
5. Now your motion sensor is part of the available sensors in the app. Click any of the words in blue under the gray "Motion Sensor" tab to open graphing. Once you're in graphing mode click the green "play" button to record.

TROUBLESHOOTING:

If your airlink does not appear when you are trying to connect to it, try turning your computer's Bluetooth off, wait a few seconds, and turn it on again.

The airlink can only connect to one software interface at a time, so before connecting it check that the Bluetooth light on the airlink is blinking red. If it is blinking green, make sure to unlink it from any software that might be using it.