Science Sensors/Probes

Vernier Sensors and Probes

Vernier is a company that manufacturers several items that help educators bring science to life for their students. One of their most prominent contributions to learning about science is their line of sensors and probes. With various types of technology being used in classrooms, the sensors and probes have

been developed to work with a variety of technology. Connections can be made through USB cables or also via wireless technology. Probes can be used with PCs, Macs, Chromebooks, and mobile devices like iPads (Apple OS), and Android devices, as well as graphing calculators.

There are activities for using these sensors and probes that can be adapted to all levels of students from Kindergarten through High School.

There are even packages of sensors that can be combined with Lego Mindstorm NXT and EV3 robots. https://www.vernier.com/products/packages/

A complete list of Vernier sensors and probes can be found on their website at https://www.vernier.com/products/sensors/

What software/devices will I need to use the Vernier sensors and probes?

The software needed to run these items will vary depending on the machine that you use and the age of the sensors and probes. The download page on their website offers links to software and apps needed to run the equipment. https://www.vernier.com/downloads/ Be sure to ask as you are purchasing the probes which software you will need and be sure to specify what device you will be using the sensors and probes with.

Logger Pro comes with some of the sensors when purchased. For limited times, you can update the software from the Vernier website. The current version is Logger Pro 3, which can be updated for free to 3.13 if you have purchased version 3.

The most common software that you will use with the sensors and probes is the **Logger Lite**. This is a free version of software that can be downloaded directly from the Vernier website, and is a simplified version of the Logger Pro software.

Labquest is another software that you might use with certain probes. This software is used on a standalone Labquest device which uses a touchscreen to manipulate and collect data directly from the sensors and probes.

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Graphical Analysis is the main app that can be installed on mobile devices such as chromebooks and ipads/phones. Note that if you are using the app you will also need to have a device that allows Bluetooth connections so that you can connect the sensors and probes on that device that does not have a USB port.

Using the Logger Lite software

The Logger Lite software can be used on computers with USB ports to connect most of the sensors/probes to. The software is free and can be downloaded from https://www.vernier.com/products/software/logger-lite/

The Logger Lite software (usually) automatically recognizes the sensor or probe that you connect to the computer. The graph parameters and the data collection display in the center of the window will change depending on the item you connect for data collection. The example below shows what the temperature probe main screen looks like.
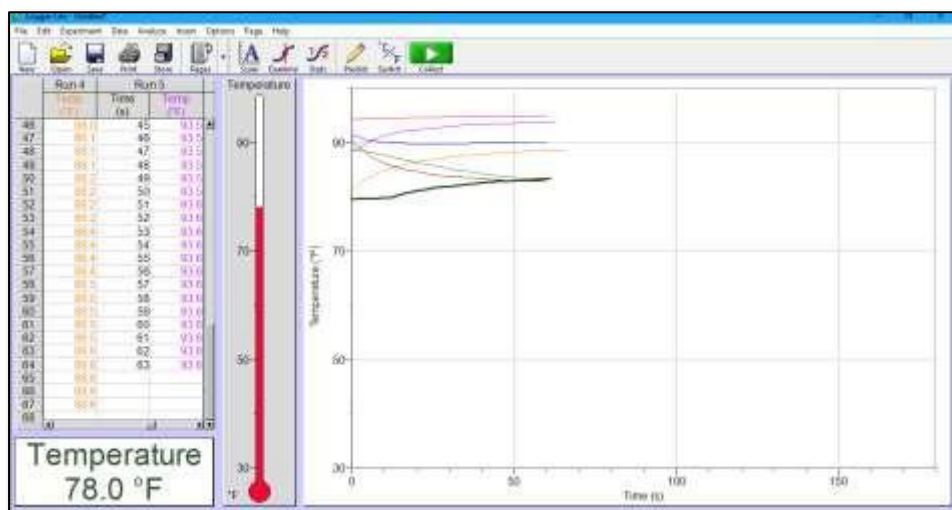
There are some aspects of the main window that remain constant.

The Menu Bar and Button Bar
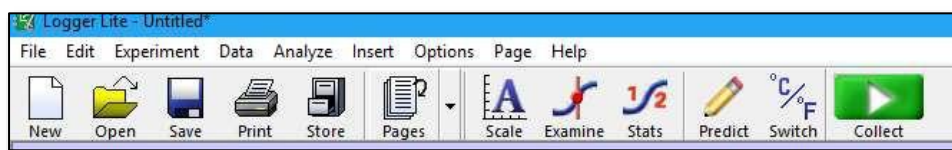
The Menu Bar and Button Bar can be used to collect data, make predictions, and capture data as you are using the sensors and probes.

- Use the **Pencil Button** to draw predictions on the chart to determine what you think the data should look like.
- Use the **Collect Button** to start and stop the data collection.
- Use the **Experiment > Store Latest Run** menu item to keep the date from the last collection and then allow for a new set of collection data to be overlaid on top.
- Use the **Stats Button** to see statistics of a specific line of data that includes minimum, maximum, mean, medium, and mode of each data set.

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- Use the **Examine Button** to compare multiple sets of data along a common time.

The Graphing Area
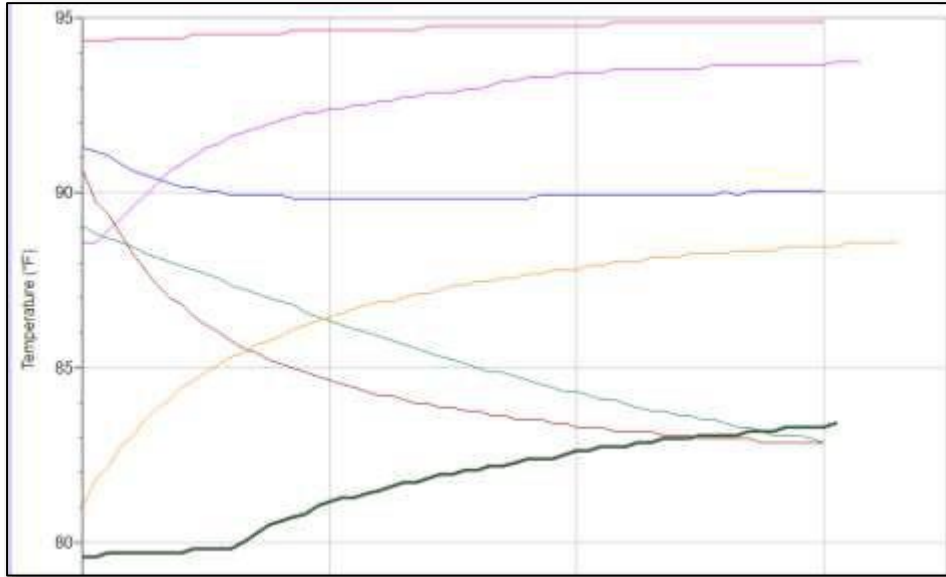
The graphing area allows you to see data that is collected each time you use a probe or sensor. Note that in this example, the graphing area shows multiple collections. As you collect a new set of data you can choose to only collect one set at a time, or collect data multiple times to make comparisons. The graphing area X and Y axis will automatically change as different probes or sensors are connected. Typically time is always represented in seconds along the bottom of the graphing area.

Using the **Scale Button** from the Button Bar allows you to "zoom in" on the data and see it in a more detailed view as shown above.

The Probe/ Sensor Area
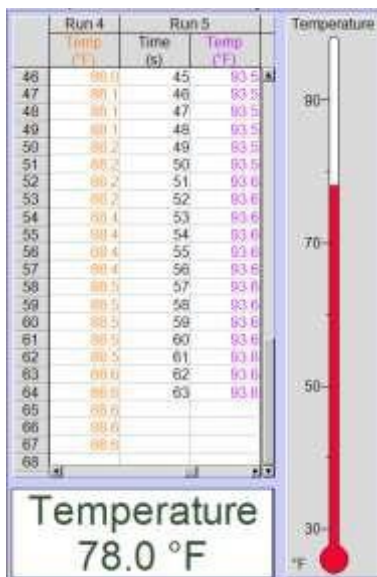
This is the location in the window that allows you to see the current activity of the sensor or probe. This changes depending on the item you have connected to the computer to collect data. In this example, the temperature sensor is connected to the computer.

Note the white window at the bottom of this section that will show you real time data that the sensor is collecting.

If you have started collecting data then you will also see specific timed data from each data collection attempt in the window to the left. Scrolling up and down or left and right in this area will allow you to see multiple attempts or information per second as the sensor has collected data.

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Connecting the Probes and Sensors

There are several different ways to connect the sensors and probes based on the following conditions
- Age of sensor or probe
- Type of device being used
- Whether the sensor/probe reads an analog signal or digital signal
- Whether the sensor/probe connects directly to the computer or needs a link between them

As we experiment with the probes in the ITC we will also discuss how they connect to the computer. For ease, we will only be working with sensors/ probes that connect to a computer so we will not be using Bluetooth and we will not be using the Labquest touchscreen device.

Available Sensors/Probes and Accessories (Located in the ITC)
- Temperature (3)
- Magnetic Field
- Voltage
- Motion
- Go Link! (connector for some of the sensors/probes)
- Logger Lite software

Temperature Sensor

The ITC has two different types of temperature sensors. One requires the Go Link! Connector and the others plug directly into the USB port of the computer. They all work the same way and are made from stainless steel.

The sensor can be placed in various liquids or near solids or gases to measure temperature. Use it like you would use a thermometer.

Visit this page on the Vernier website for sample ideas and experiments that can be completed by using this sensor. https://www.vernier.com/products/sensors/temperature-sensors/tmp-bta/ There are videos that who This page also shows compatibility charts for the sensor and different devices, the cost to order more, and similar sensors. In addition, there is a User Manual and Tips/Troubleshooting as well.

Motion Sensor

The Motion Sensor in the ITC connects through a USB port on the computer. The Motion Sensor has a gold circle on the front, which is where the motion is detected. This area can be pivoted so that motion can be measured from many different directions.

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There are settings on the sensor that recognize slower motion and quicker motion, as represented by a person and a bus. For most experiments, you will use the slow (person) setting.

Visit this page on the Vernier website for sample ideas and experiments that can be completed by using this sensor. https://www.vernier.com/products/sensors/motion-detectors/go-mot/

Voltage Probe

The Voltage Probe in the ITC requires the Go Link! Connector to connect to a computer. This sensor allows you to measure bipolar magnetic fields. It reports the difference between the ground (black) and the red lead.

Visit this page on the Vernier website for sample ideas and experiments that can be completed by using this sensor. https://www.vernier.com/products/sensors/voltage-probes/vp-bta/

Magnetic Field Sensor

The Magnetic Field Senor in the ITC requires the Go Link! Connector to connect to a computer. This sensor allows you to measure the magnetic field around magnets, coils, and other magnetic items. This sensor has two ranges of measurement which include strong and weak magnetic fields.

Visit this page on the Vernier website for sample ideas and experiments that can be completed by using this sensor. https://www.vernier.com/products/sensors/magnetic-field-sensors/mg-bta/

Go link! Connector

The Go Link! Connector is used to transfer data from the probe or sensor to a computer using a USB interface. This will need to be used with multiple sensors, so it is advised to have more than one of these available for students to use.

Visit this page on the Vernier website for ordering information and troubleshooting for this device. https://www.vernier.com/products/interfaces/go-link/

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Troubleshooting

Logger Lite does not recognize the sensor/probe
Sometimes a sensor is not recognized by the Logger Lite software. If this is the case, then you will need to manually tell the software which sensor it is connected to. Try these steps:
- Choose **Experiment** from the menu bar
- Click **Set Up Sensors**
- Click **Show All Interfaces**
- Find the sensor on the left side of the window
- Click on the sensor name and drag it to the white box on the right side of the window
- Once you see the name of the sensor on the right side of the window, then close the window
- You should see the blank graph screen showing in the main window of the Logger Lite software and can begin.

The sensor is not reading at zero
- Choose **Experiment** from the menu bar
- Click on Zero

OR
- In the menu bar, click the Zero icon

The Logger Lite window freezes
- Quit the program and reopen it

The probe is not sensing anything
- Quit the program and reopen it
- Pull the sensor out of the USB port and place it in another port
- Restart the computer

Vernier Probe/Sensor Activities

Choose one or more of these activities to complete to learn more about how these individual sensors and probes work.

Temperature Probe- Measure the temperature of your hand

SC Performance Indicators for Science

K-8.S.1A.3 With teacher guidance, conduct structured investigations to answer scientific questions, test predictions and develop explanations: (1) predict possible outcomes, (2) identify materials and follow procedures, (3) use appropriate tools or instruments to make qualitative observations and take nonstandard measurements, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

H.C.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses based on credible scientific information, (2) identify materials, procedures, and variables, (3) use appropriate laboratory equipment, technology, and techniques to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

In this activity you will measure the temperature of your hand and others' in your group. You will modify the temperature of your hand in different ways and then record the differences between the data.

1. Plug the temperature probe into the computer and place the probe on the table.
2. Open the Logger Lite software.
3. Pick up the temperature probe and place it in the palm of your hand so that your hand is cupped around the stainless steel tip.
4. Click **Collect** in the Logger Lite software and let the probe collect data for 60 seconds.
5. Click **Stop** in the Logger Lite software.
6. Place the probe on the table.
7. In the menu bar at the top of the window, click **Experiment > Store Latest Run**. This will "flatten" the data to the chart and allow you to collect data from more than one person
8. Record your name, highest temperature, and color of line in the attempt 1 boxes in the chart below.
9. Repeat steps 3-8 for each person in your group.

Recording the temperature of your hands - chart and questions.

Name	Highest Temperature- Attempt 1	Line Color- Attempt 1	Highest Temperature- Attempt 2	Line Color- Attempt 2

Who had the warmest hand? Why do you think that is?

Who had the coolest hand? Why do you think that is?

10. In the button bar of the Logger Lite software, click on **Examine**. Choose all data to examine.
11. Move the slider to the 30 second mark on the chart.

Did the same people have the warmest or coolest hands halfway through the experiment? Explain your answer.

12. Try modifying the temperature of your hand. Without hurting yourself, try warming or cooling your hand.
13. Hold the probe the same way and record the temperature for another 60 seconds.
14. Record the highest temperature and the new line color in the Attempt 2 box in the chart above.

How did the adjustment you made to the temperature of your hand change the highest temperature?

Was this what you expected? Explain your answer.

Motion Sensor- Drawing With Motion

SC Standards for Learning

5.P.5A.1 Use mathematical and computational thinking to describe and predict the motion of an object (including position, direction, and speed).

8.P.2A.6 Use mathematical and computational thinking to generate graphs that represent the motion of an object's position and speed as a function of time.

H.P.2A.1 Plan and conduct controlled scientific investigations on the straight-line motion of an object to include an interpretation of the object's displacement, time of motion, constant velocity, average velocity, and constant acceleration.

H.P.2B.10 Obtain information to communicate physical situations in which Newton's Second Law of Motion does not apply.

In this activity you will use motion to explore fast and slow movements and near or far movements to create lines.

1. Connect the Motion Sensor to the computer
2. Place the Motion Sensor on the edge of the table as shown in the illustration.
3. Check to be sure the switch is set to the Normal setting.
4. Open the Logger Lite software.
5. Have one person in your group stand .5 meters away from the motion sensor.
6. Click **Collect** in the Logger Lite software to begin collecting data
7. Have the person standing, slowly move back from the motion sensor to about 2 meters away, and then slowly move forward back to about .5 meters from the sensor.
8. Click **Stop** in the Logger Lite software.
9. In the menu bar at the top of the window, click **Experiment > Store Latest Run**. This will "flatten" the data to the chart and allow you to collect more data.
10. Repeat steps 5-9, but this time the person should quickly move back and forth in front of the sensor.
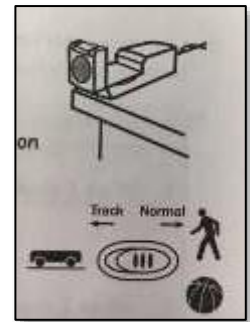
How did the speed of the movement change the data collected?

What happened to the line on the graph as you moved closer and further away from the sensor?

Challenge 1: Try to make a snake shaped line using just motion.
1. With your group, make a prediction about what movements need to be accomplished in order to make a snake shaped line in the graph. Think about how speed and direction would factor into the design.

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2. Erase the information on the graph by clicking the **New** icon in the button bar. Don't save the previous information.
3. On the new graph, use the **Predict** tool (looks like pencil) in the button bar to sketch what you think the snake should look like based on the motions you think need to be made.
4. Position a group member in front of the sensor and click **Collect**.
5. The group member should move in the speed/direction to try and replicate the predicted line of the snake shape.
6. Click **Stop** to finish recording the movement.

How successful was the movement of the group member at recreating the shape of the line?

How could the group member have changed his/her movement to make a shape more closely resembling the predicted line?

7. Click **Collect** again (don't save previous attempt) to try again.
8. Allow the group member to try one more time, taking into consideration the recommended changes suggested by the group.
9. Repeat this process with any other group members who would like to try this activity.

Challenge 2: Try to make different letters using just motion.
Following the same principles from challenge 1, try to use just motion to create letters in the graph. Try M, W, N, L, or any other letters you can think of.

Record your observations and thoughts below:

# Magnetic Field Sensor- Mapping a Magnetic Field

SC Standards of Learning

2.P.3B.1 Conduct structured investigations to answer questions about how the poles of magnets attract and repel each other.

6.P.3A.4 Develop and use models to exemplify how magnetic fields produced by electrical energy flow in a circuit is interrelated in electromagnets, generators, and simple electrical motors.

H.P.2D.5 Construct explanations for how the non-contact forces of gravity, electricity, and magnetism can be modeled as fields by sketching field diagrams for two given charges, two massive objects, or a bar magnet and use these diagrams to qualitatively interpret the direction and magnitude of the force at a particular location in the field.

This activity will show how magnetic fields change as the polarity of the magnet shifts.

1. Set the switch on the Magnetic field sensor to LOWx10
2. Connect the Magnetic Sensor to the USB port of the computer.
3. Use tape to tape a ruler to the table in order to keep it in place.
4. Place a bar magnet beside the ruler and position the S pole end of the magnet at the 3 cm mark as shown in the illustration.
5. Zero the magnetic field sensor.
   a. Hold the sensor far away from the magnet
   b. Hold the sensor so the silver spot near the name of the sensor is facing the ceiling
   c. Click the **Zero** button in the button bar
6. Place the sensor on the 1 centimeter mark of the ruler, making sure that the silver spot is facing the ceiling.
7. Click **Collect** to begin collecting data.
8. At even intervals every 5 seconds, move the magnetic field sensor one centimeter to the right.
9. Continue moving the sensor until you have reached 3 cm beyond the length of the magnet.
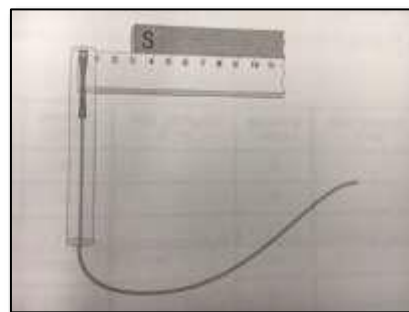
Where on the magnet was the largest positive magnetic field reading observed?

Where on the magnet was the most negative magnetic field reading observed?

Was there ever a zero value of the magnetic field? If so, where?

Why do you think the graph has both positive and negative values?

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