Datalogging Activities for the Busy Teacher

What is datalogging?

Datalogging is the process of collecting information for later analysis. Datalogging can best be described through a series of different examples.

Environmental

Datalogging has enabled the accurate measurement of the movement and change in glaciers. Typically a hole is drilled in the ice, into which the dataloggers, laden with electronic sensors are lowered. The sensors can measure the location (via GPS signals) as well as temperature and other important glacial characteristics. This particular type of datalogger is known as a remote datalogger as it generally store data for a pre-defined length of time after which they are collected for data analysis. New versions of these devices are solar powered and capable of transmitting the data back to a base station, which prevents the need for researchers to constantly go out into the field to download data.

Biological

Radio tags have been a popular way of tracking animals. A wild animal is captured and given a special tag that emits a radio signal. Once released, researchers can then keep track of where the animal is heading by following the radio signals. Travel patterns of the animals can be mapped which gives a clearer picture of the migratory habits. Researchers are also able to keep track of, and identify specific animals to discover how fast they grow etc. In marine animals, in addition to tracking migratory behaviour, researchers have also been able to observe how deep they dive.

Technological

Dataloggers are used extensively in technological settings to measure performance. Rockets are often equipped with sensors to measure the acceleration and speed as the launch from the ground.

Weather balloons are equipped with sensors for measuring air pressure, temperature, wind speed amongst other properties. This data is then sent to ground based researchers who use the information to make predictions about the future weather.

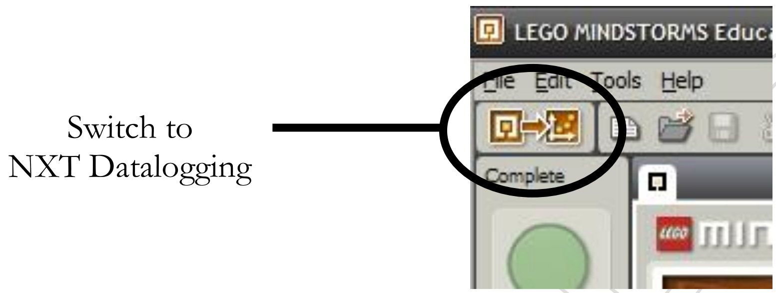
Racing car drivers often use datalogging technology to track the speed of their car. Additional information such as engine temperature, fuel levels, etc can give the pit crew a better understanding of how the car is performing.

Using the NXT-G software

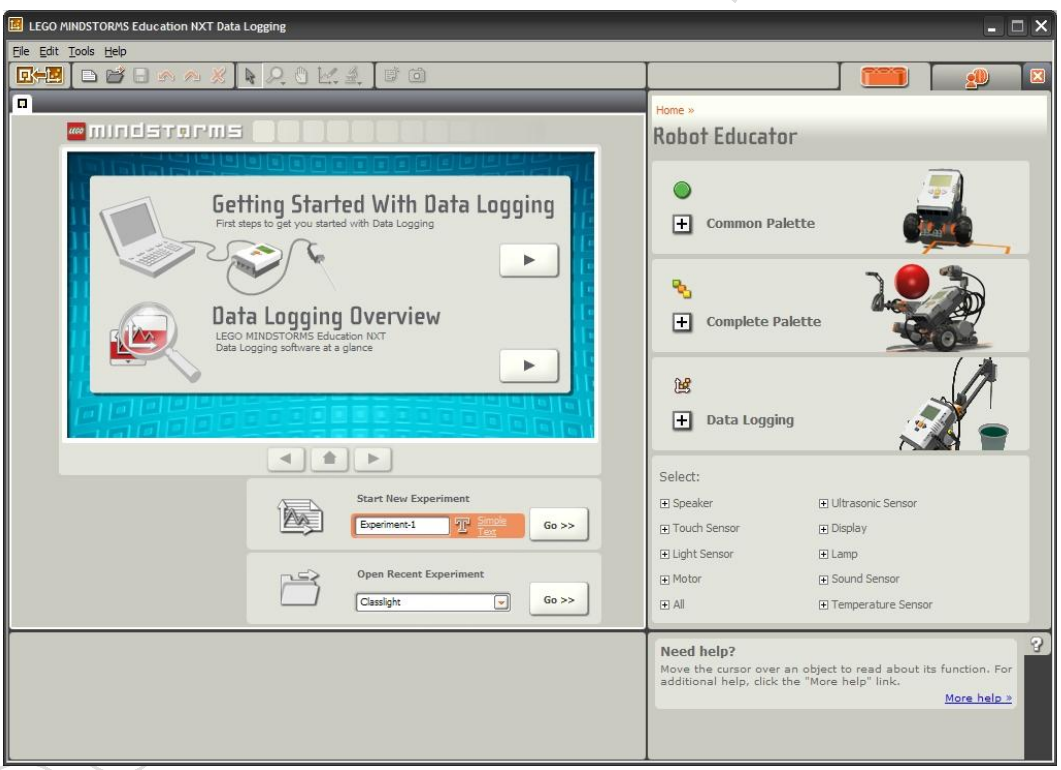
NXT-G version 2.0, enables experiments to be quickly configured and implemented. Whilst it is still possible to do very effective datalogging with version 1.1 and 1.0, it requires a slightly different approach which is outlined later in the chapter.

NXT-G 2.0

Open the datalogging software by either double clicking the 'NXT Datalogging' shortcut icon or opening up the main NXT-G software and selecting the 'Switch to NXT Datalogging' button in the top right-hand corner.



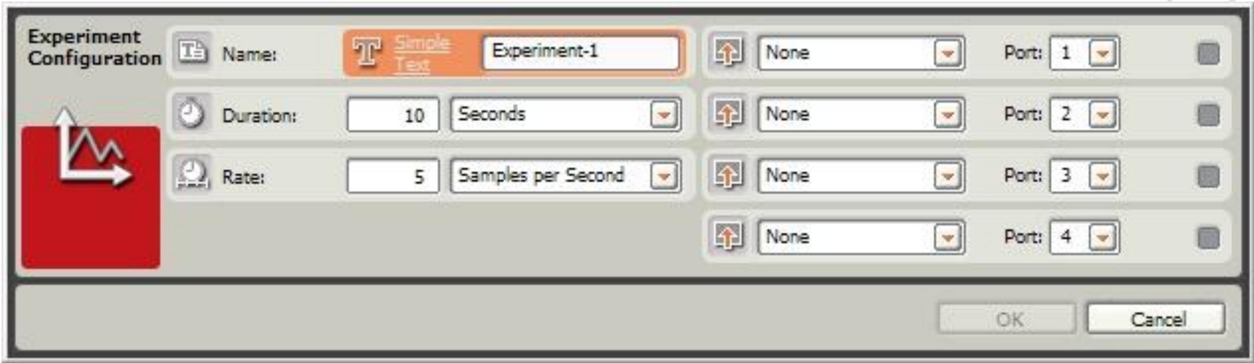
This will open the main Datalogging window



The tutorials in the Robot Educator panel are an excellent resource which teachers are strongly encouraged to go through.

To start a new experiment, type an appropriate name in the 'Start New Experiment' section and press the Go button.

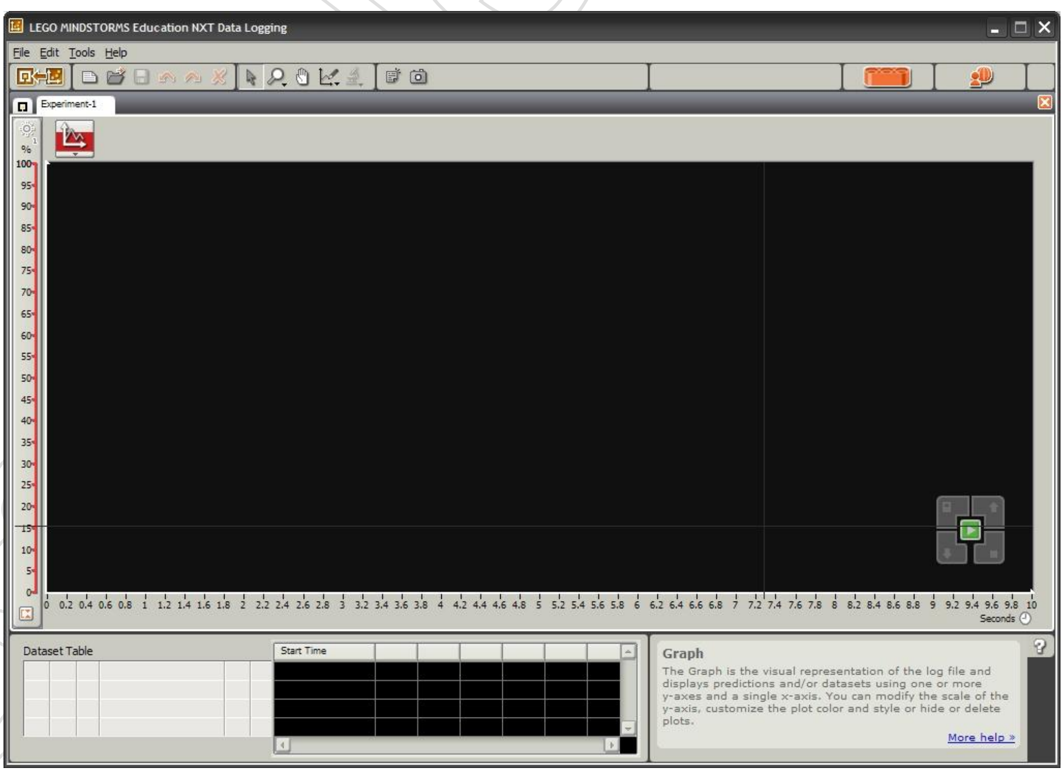
You will then be prompted to configure the various properties of the experiment.



Duration: How long do you want the experiment to run for? Seconds? Minutes? Hours?

Rate: How much time is there between each measurement? Using this configuration panel, the maximum sampling rate is 25 times per second. It is possible to get faster sampling rates using a 'constant' blocks wired into a data hub, but that procedure is not covered in this book.

Using the drop down lists on the right hand side, the NXT can sample up to 4 different sensors at a time. Once configured, press the 'OK' button to move to the graph screen.

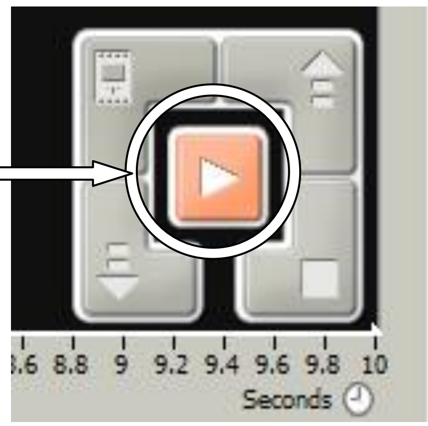


The NXT device can be operated in two different ways, Real Time or Remote.

Real Time Operation

Real Time experiments maintain the connection between the computer and the NXT (either USB or Bluetooth) throughout the length of the experiment. As the sensor values change, the graph will also change in real time to reflect the moving values of the sensor. To enable Real Time operation, configure your experiment and press the 'Download and Run' button. The program will go through the series of Initialising → Compiling → Downloading and will then immediately start running.

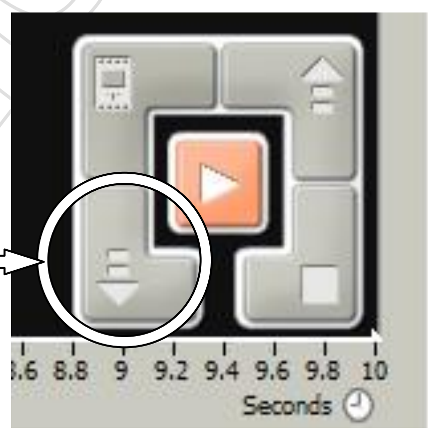
Download and Run



Remote Operation

The NXT can also be used in Remote operation, where it is possible to disconnect the device, move it to another location and start the experiment running only when required. Press the 'Download' button to transfer the experiment program to the NXT device.

Download for
Remote operation



Treasure Hunt - Sound

Sensor: Sound Sensor

Overview: Go on a treasure hunt to find out the volume of various *things*.

Setup: Show the students how to view the sound sensor readings on the NXT brick. Ask them to measure the sounds of various events and record them on the worksheet found at the back of the book.

As the 'view' screen only updates a few times a second, look for sounds that are fairly constant. Short, sharp sounds (such as hand claps) *may* be too quick for the NXT to observe when just using the 'view' screen.

Some events that might be good sounds to measure include;

- General classroom noise
- Playground noise
- School Bell
- Barking dogs
- Rain on a rooftop
- Lawn mower
- Traffic stopped at the traffic lights

Encourage the students to take several readings for each event. Have them compare values with other groups. As a class, rank in order all the events recorded, from the quietest to the loudest.

Q: Did they measure the same things as you?

Q: If 'yes' did they get the same readings as you? Why? Why not?

A: No, when we both measured how loud the school bell was, the other group found the reading much higher. This was because they placed their Sound Sensor closer to the bell. Our Sound Sensor was also pointing in the wrong direction which would also explain the lower reading. The directionality affected the reading

Can someone please turn down the volume?

Sensor: Sound Sensor

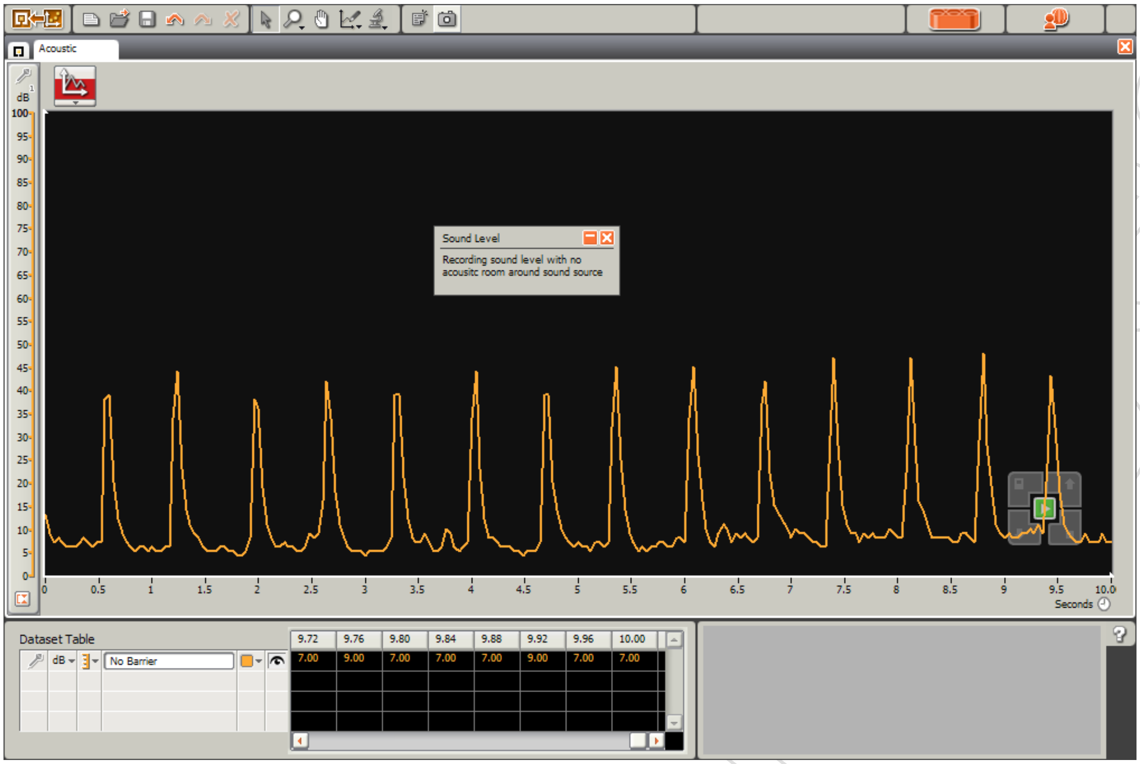
Overview: Use the sound sensor to investigate the acoustic properties of various materials.

Setup: Build a 'room' to house a sound source. Place a sound sensor a fixed distance away from the sound source.

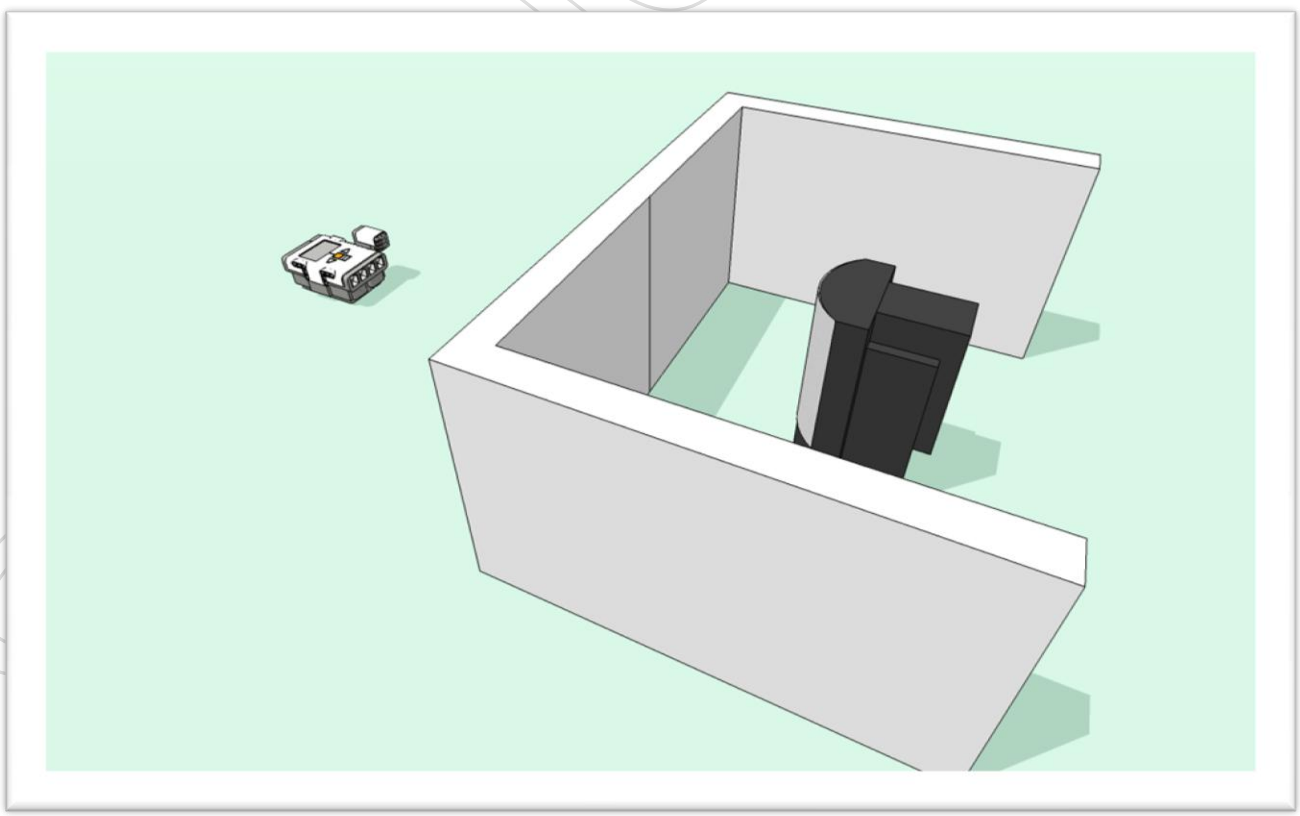
Procedure: Place the datalogger approximately 1 meter away from a sound source. Your sound source could be a speaker from a computer, a bell or any other device that creates a constant sound volume. It is important that this sound produces a similar sound each and every time, to ensure consistency of our experiment.

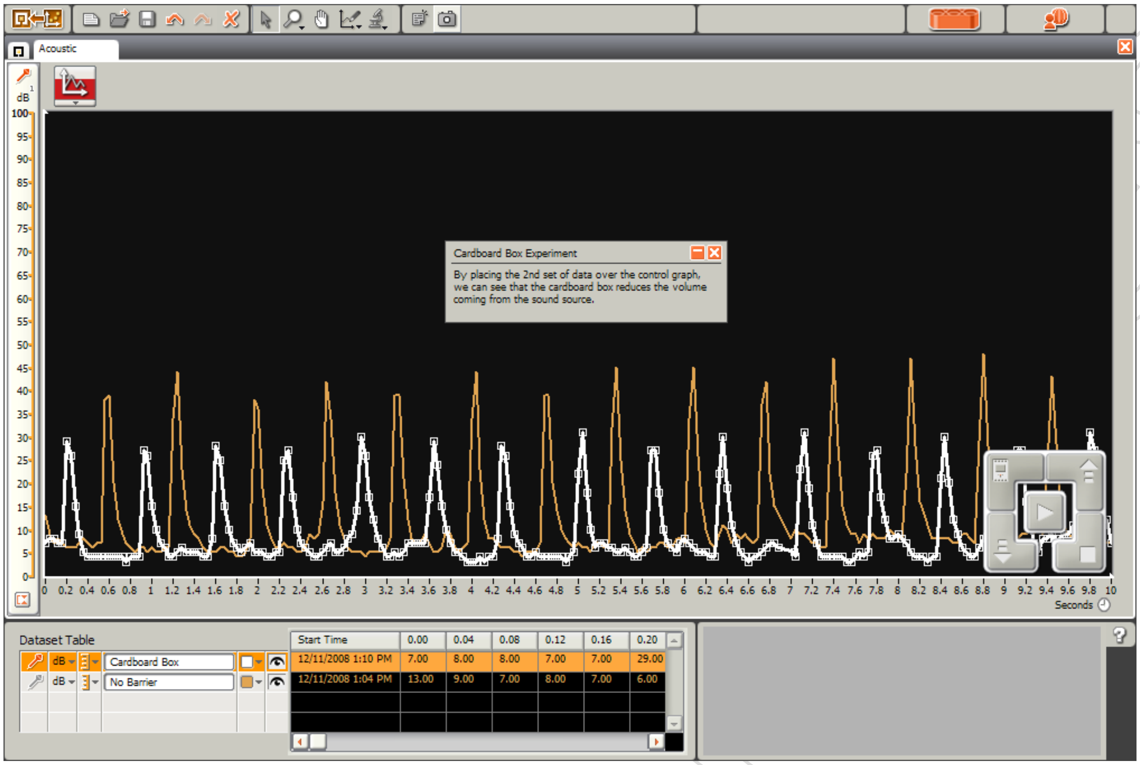
Start generating sounds and observe the graph of the sound level generated. This is what is commonly called the base line, or control experiment, as it indicates what range of values we expect to see with no additional constraints. You can download a 'hospital beeper' sound file from the resource page (www.domabotics.com/resources.php) or use your own method of generating a consistent sound sample.

The following graph show a sample of data collected as a control experiment with the hospital beeper as the sound source.



Now place your 'room' around the sound source and run the experiment again. Be careful not to change the distance between the NXT and the sound source. Feel free to experiment with the design. Compare your new set of data with your original results.





By overlaying the second set of data with our original control graph, we can see that the acoustic room we constructed reduces the volume measured by the Sound Sensor.

Extension: Run the experiment again, but this time, try some of the following materials

- Packing foam
- Sponge foam
- Cloth
- Wood
- Paper

Does the thickness of the material make a difference?

How bright is your classroom?

Sensor: Light Sensor

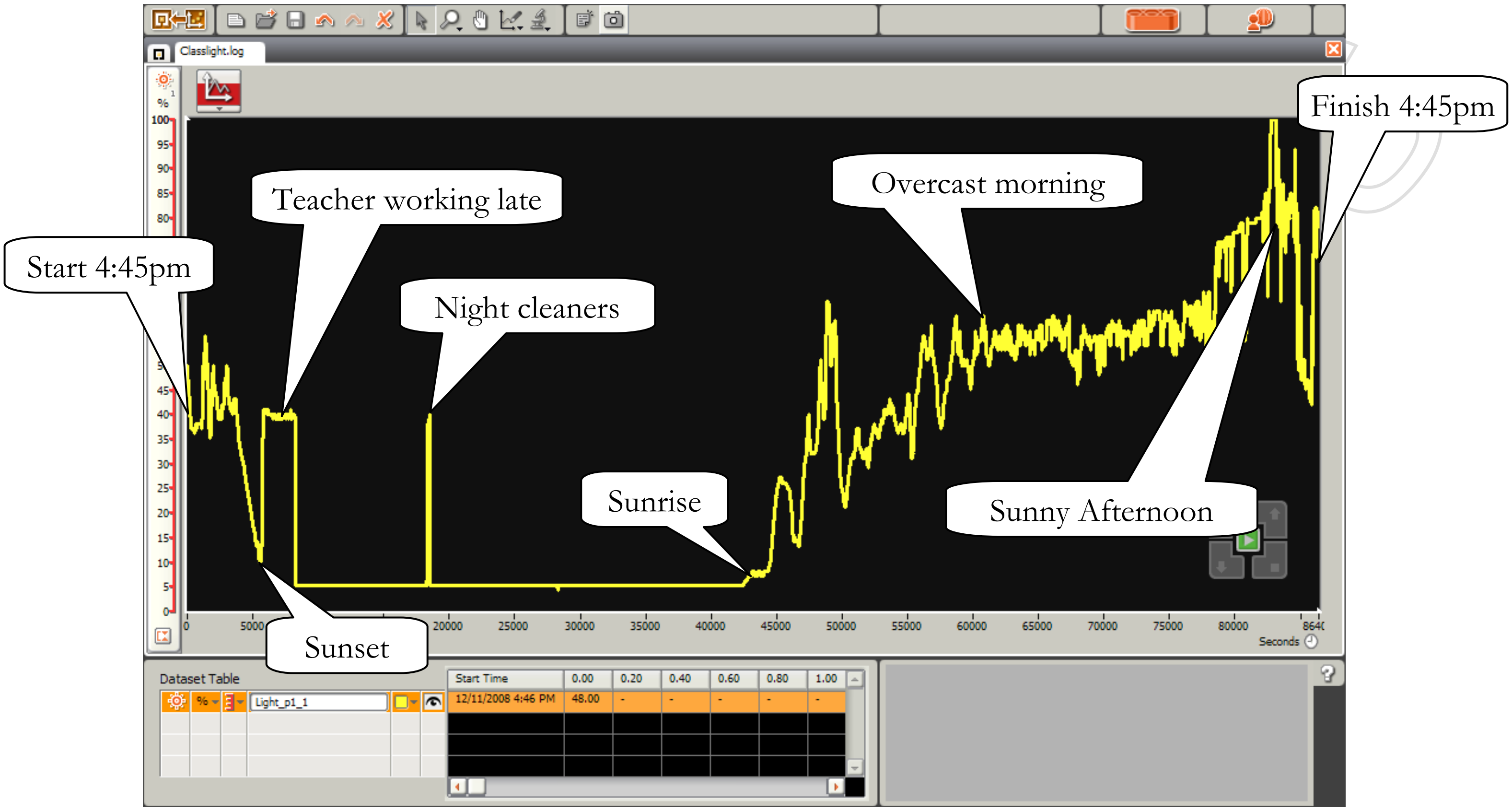
Overview: Use a datalogger to measure the light levels in your classroom.

Setup: Build a datalogger with a Light Sensor. Place it on a shelf pointing towards a window. Write a program that will record the light level at regular intervals throughout the day.

The above program will run for 1440 minutes (24 hours) taking a reading once every 30 seconds. This will result in 2880 data points in our sample. Also notice that the 'generate light' tickbox on the right-hand side is unchecked. We are only interested in the ambient light levels in the room.

Procedure: Place your datalogger on a window sill and start it running at a pre-defined time. Midday is a good choice for this particular experiment. Leave it running for 24 hours and at midday the following day, the program should stop. Have a look at the data and see if you can pick out significant events.

Look up the sunrise and sunset times for your area. Mark them on your graph.



Q: Are your light levels consistent during the daylight hours? If 'no' what situations might have occurred to cause any irregularities?

A: Events that change the level of the light in the room will have an effect on the readings of the Light Sensor. The following occurrences may have happened:

Clouds going across the sun, Curtains opening or closing, Lights being turned on or off

Q: Are your light levels consistent during the night? If 'no' what situations might have occurred to cause any irregularities?

A: Someone turning on the lights after sunset will cause the Light Sensor to read higher than normal. The following occurrences may have happened:

Teachers working late

Security patrol / Late night cleaners

Full moon rising

Burglar!!!

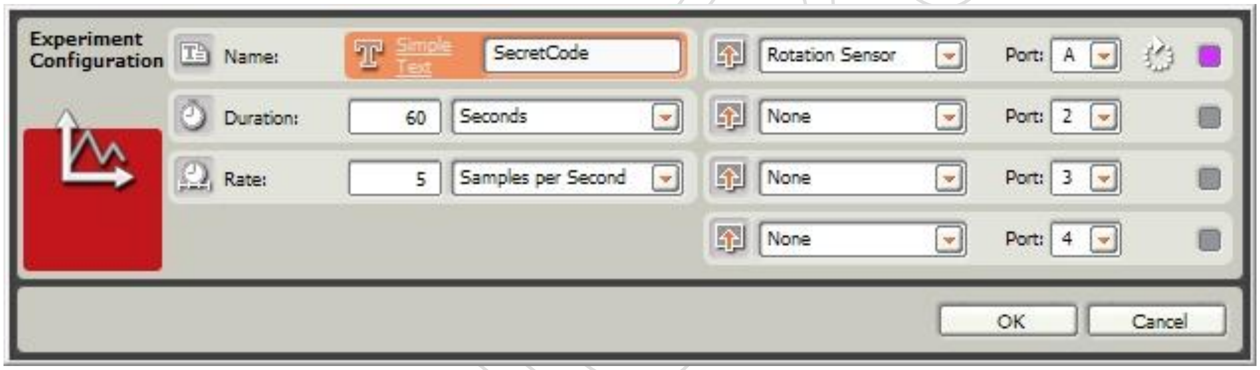
Secret Code

Sensor: Rotation Sensor

Overview: Can you break the code? By moving the pointer to each letter in turn, you will be able to generate a series of numbers that each represents a single letter.

Setup: Printout or construct your own decoder ring like the one shown. Build a pointer out of either LEGO or other materials and attach it to a motor. We will be using the inbuilt Rotation Sensor to determine what angle the pointer has moved to.

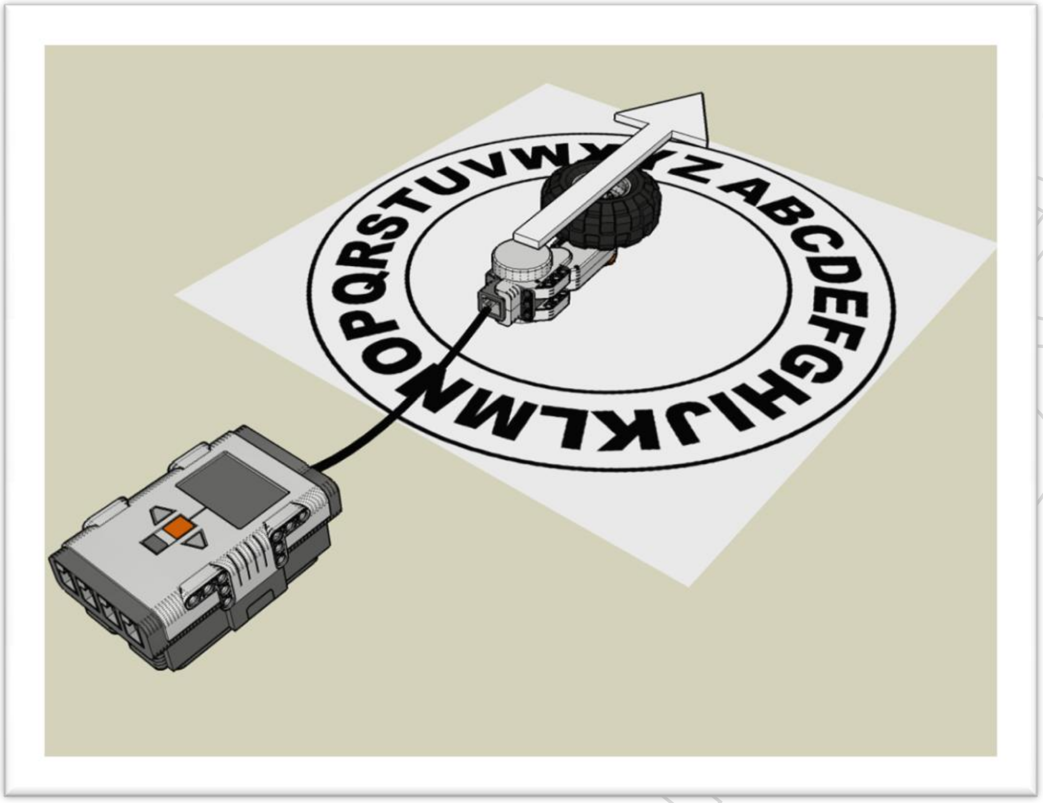
Program: We need to sample the Rotation Sensor at a reasonable sampling rate as we do not want to miss information if the person creating the code moves too fast. Notice too that we have changed the 'units' to measure degrees, and not rotations.

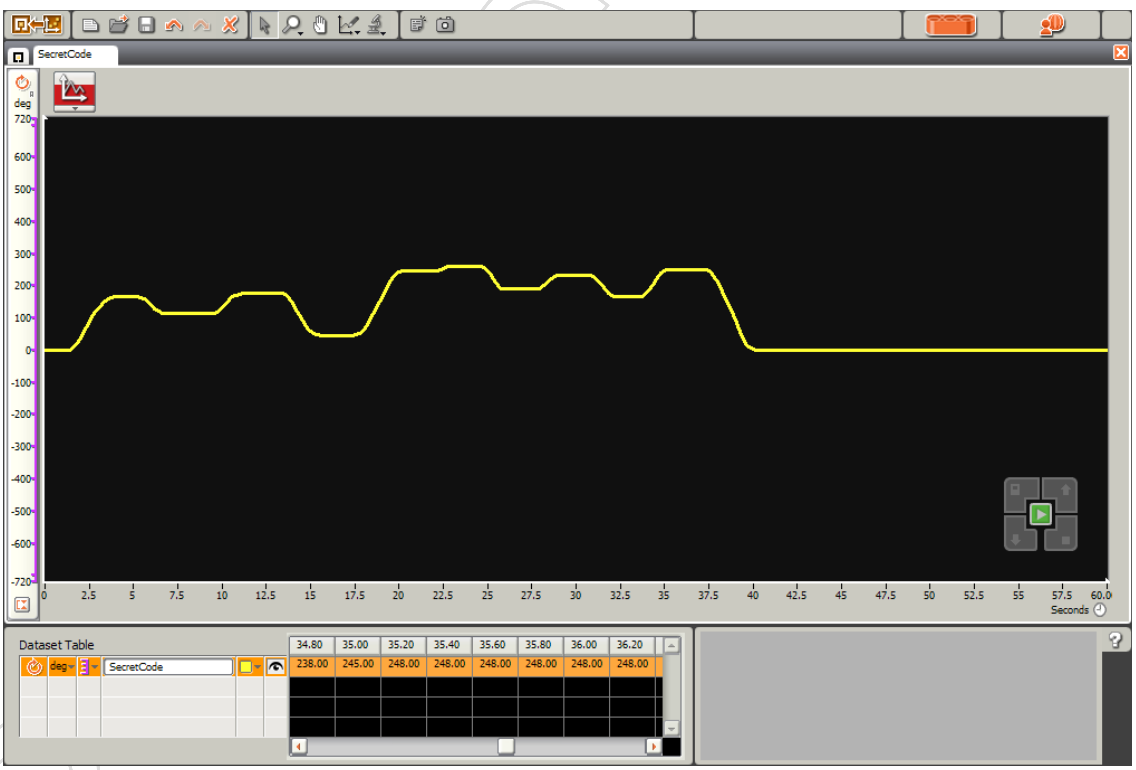


Procedure: The first group will decide on their message. A code circle can be found at the back of this book. Alternatively you can construct your own. Place the device in the middle of the circle, with the arrow pointing to the letter 'A'. This will be our starting point. Move the indicator arrow to each of the letters for at least 2 seconds in turn before moving to the next letter.

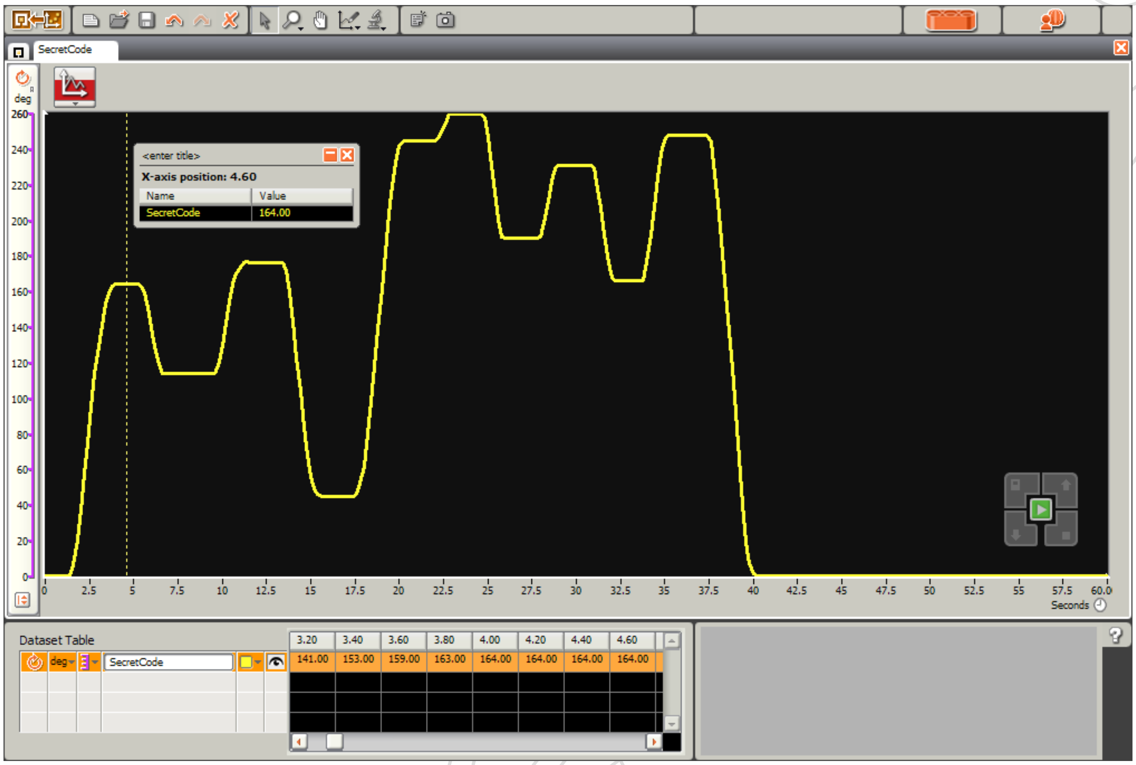
Our decoder ring has 26 letters equally spaced apart. (if you are creating your own decoder ring, ensure you are using a fixed width font. This forces thin letters like 'I' to take up as much space as larger letters such as 'M')

With 26 letters spaced evenly around a 360 degree circle, each letter will take up (360/26) 13.85 degrees. If we make the assumption that 'A' is at 0 degrees, it is possible to calculate the location of each letter in the alphabet.




SecretCode
deg
720
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-720
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50 52.5 55 57.5 60.0
Seconds
Dataset Table
deg
SecretCode
34.80 35.00 35.20 35.40 35.60 35.80 36.00 36.20
238.00 245.00 248.00 248.00 248.00 248.00 248.00 248.00

As the angles that the pointer moved to are quite small relative to the scale of the vertical axis, it is handy to press the ‘Scaling Mode Toggle’ button to expand the graph.



Using the ‘Point Analysis’ tool, we can drag the cursor over the plateau in the graph which represents the first letter at which our pointer was rotated. For this particular set of data, this was 164 degrees. Again by dragging the ‘Point Analysis’ tool to each subsequent plateau, it is possible to record the angle that the Rotation Sensor was moved to for each letter.

For this experiment, the following numbers were recorded:

164, 114, 176, 45, 245, 260, 190, 231, 166, 248

The following table shows the location of each letter, rounded to the nearest integer value, assuming the arrow is pointing at 'A' when the NXT is switched on. You may either encourage your students to calculate the values for themselves, or use the larger copy of this table located in the back of this book.

Letter	Degrees	Letter	Degrees
A	0	N	180
B	14	O	194
C	28	P	208
D	42	Q	222
E	55	R	235
F	69	S	249
G	83	T	263
H	97	U	277
I	111	V	291
J	125	W	305
K	138	X	318
L	152	Y	332
M	166	Z	346

Using the numbers that were recorded before, it is possible to find the closest matching number from the table above.

164	114	176	45	245	260	190	231	166	248
M	I	N	D	S	T	O	R	M	S

Extension: Do not use 'A' as the 0 degree letter. Choose another letter and include this 'key' letter with the graph. Students will need to calculate the offset to determine the correct letter.

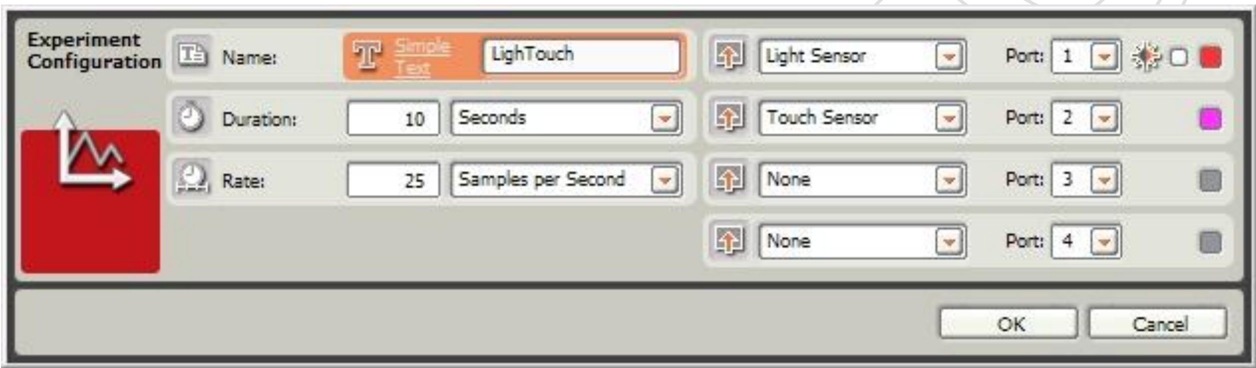
Visual Reaction tester - Just how fast do you think you are?

Sensors: Touch Sensor and Light Sensor

Overview: How quickly can you press the button after seeing a light turn on?

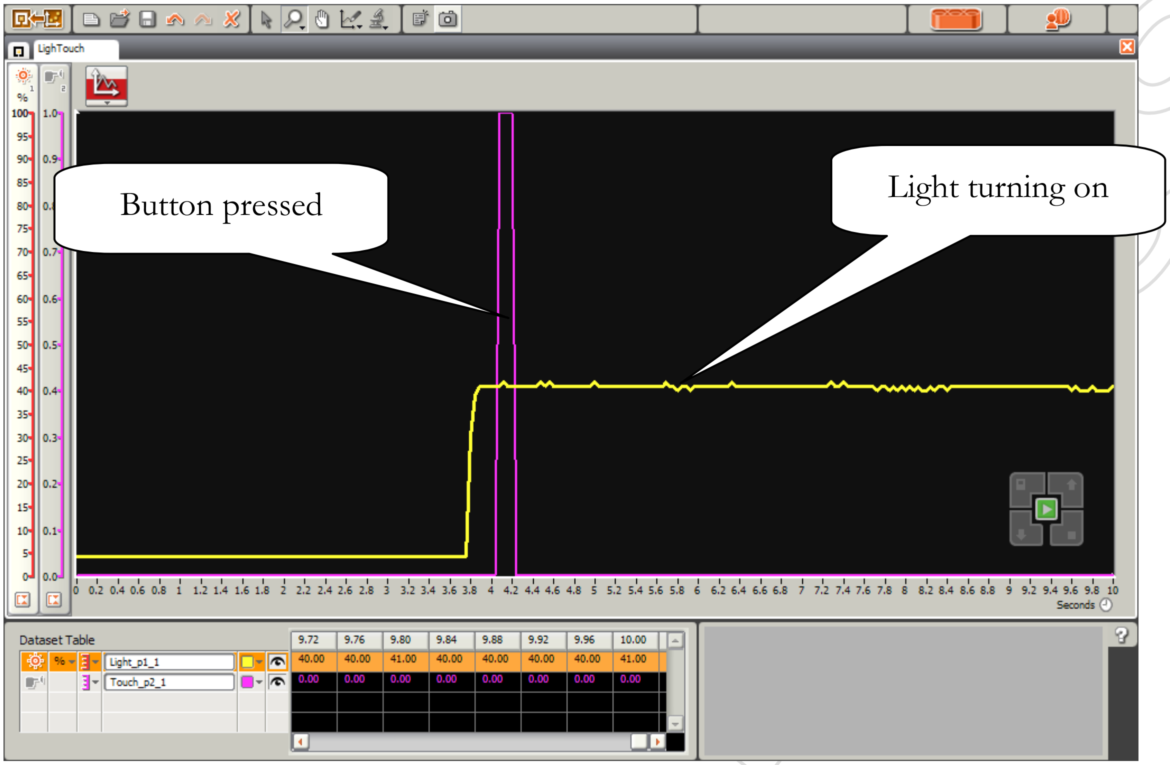
Setup: Build a device that has both a Touch Sensor and Light Sensor attached to the NXT.

Program: Similar to the previous experiment, we will need to log data for 10 seconds at 25 samples per second.

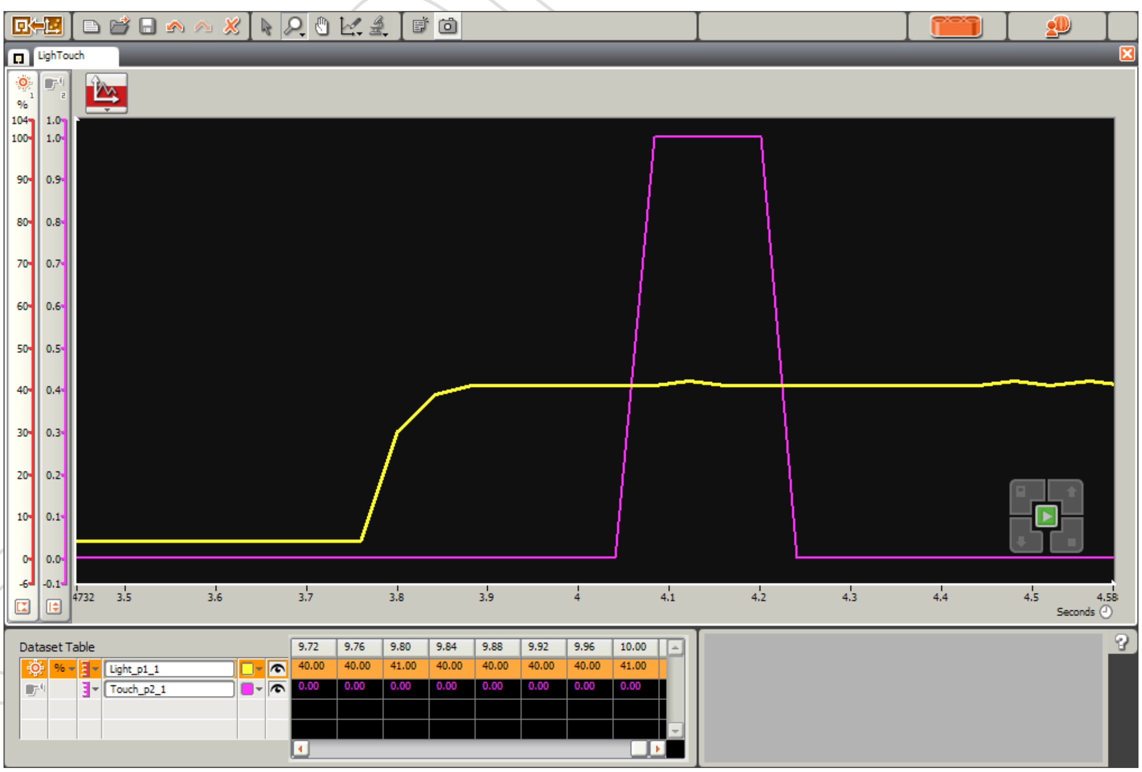


Procedure: Start your dataloggers and watch very closely a light. The task is to press the button as soon as the light is observed turning on. Make sure students cannot observe you turning on the light as they may try and anticipate the action.

Have a look at the graph that is created.



The lighter coloured graph is the Light Sensor. The darker coloured graph following this is the Touch Sensor data. Zoom in on the important part of the graph and read off the horizontal axis the times at which different events occurred.



Investigators Log

Name:

Experiment:

Sensors Used (circle appropriate)	Touch Sensor	Sound Sensor	Light Sensor	Ultrasonic Sensor	Rotation Sensor	Temperature Sensor
Port Used (1-4, A-C)						

Experiment Description
(what are you measuring)

Experiment Setup
(draw a picture of your experimental setup)

Are you sampling for	A short time Seconds	A medium time Minutes	A long time Hours
Do you need	Lots of samples every second	A few samples every second	A few samples every minute

Print out a graph of your experiment.

Label all the important points on the graph.

Treasure Hunt - Light

Sensor: Light Sensor

Overview: Go on a treasure hunt to find the brightness of various *things*.

Fill in the following table with the measurements that you take.

Object Description	Measurement 1	Measurement 2	Measurement 3

Compare your table with another group.

Q: Did they measure the same things as you?

Q: If 'yes' did they get the same readings as you? Why? Why not?