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Teaching the EduStationLive Demo Logger G2 V1.3+, Particle

The EduStationLive classroom demo logger is web connected and suitable for environments with WIFI or tethered connectivity. It is designed for classroom use and has no enclosure or housing.

BUILD > FLASH FIRMWARE > DEPLOY IN CLASSROOM > SWITCH ON > YOUR DATA IS ONLINE

You should be able to build this FreeStation from the step by step instructions given here, without assistance. **If you deviate from this design your station may not work as expected.**

Citation: Mulligan, M., Burke, S.M and Brittain, A. (2022) Teaching the EduStationLive Demo Logger V1.x. Available online: http://www.freestation.org/building

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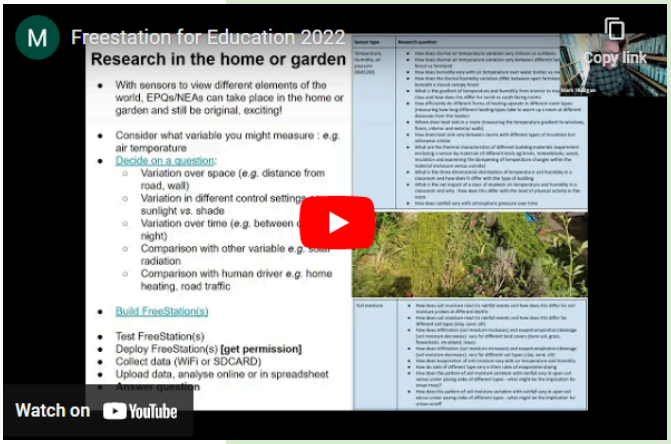
A video Introduction to FreeStation for Educators



Practical considerations for environmental monitoring in schools

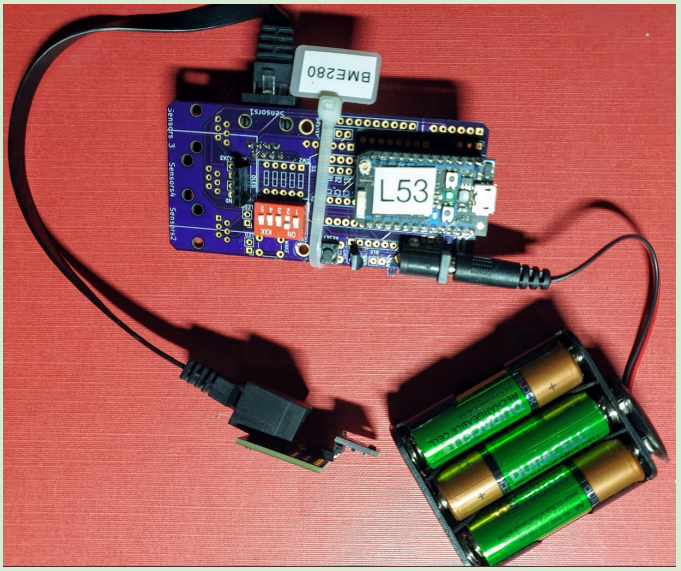
Please consider:

- What kind of monitoring would you like to undertake? What do you want to achieve? What aspects of the environment are your main concern?.
- Where would you install the sensor(s), whose permission is needed to do so, do you need installation support by ground staff?
- Are senior staff happy with the position from a practical and aesthetic perspective, is there adequate access to sunlight for solar power, will the device be connected directly to the internet (WIFI or SIM) or be periodically tethered to a mobile phone - or will data be collected by swapping SDCARDS.
- Will the FreeStation be visible enough to engage/interest the whole school. Will students be able to access the device to download data on their own? Consider whether the location is safe. Consider the height of the students. Do they need to be able to reach the reset switch?
- Who will be responsible for ordering the equipment? Teachers, technicians, students? If this is a cross curricular project, which budget will be used? How will the administration of this research be handed on to new students?
- How will the activity be communicated to the school and wider community? Twitter, Instagram, newsletters, school website?

EduStation Data Logger

The EduStation G2 is a small, *Particle Photon microcontroller (MCU)* based data logger with Internet of Things (IoT) connectivity that can be used to record a digital channel (*e.g.* rainfall, fog), sensors using I2C communication (*e.g.* temperature, humidity) and analogue sensors (*e.g.* soil moisture, wind speed and direction). The EduStation logger is designed for **cheap, quick build for classroom demonstration and deployment.** The logger by default, reads instruments every 10 minutes, averages every hour and sends them to the web where the data may be retrieved. The logger can also be set to read and send data continuously, every minute, every 10 minutes or hourly.

Note that, although still available from some outlets, Particle has discontinued production of the Photon without a clear replacement. Generation 3 FreeStation devices are built on the Raspberry Pi Pico and ESP32 and replace Generation 2 devices, see the FreeStation website.



Bill of Materials

The bill of materials lists the components that need to be purchased, with images and links to vendors. You will need to purchase from each tab. Total cost approximately: approx **USD 40 per logger. Please order all components together and leave plenty of time for delivery so you are not held up waiting for a single component.**

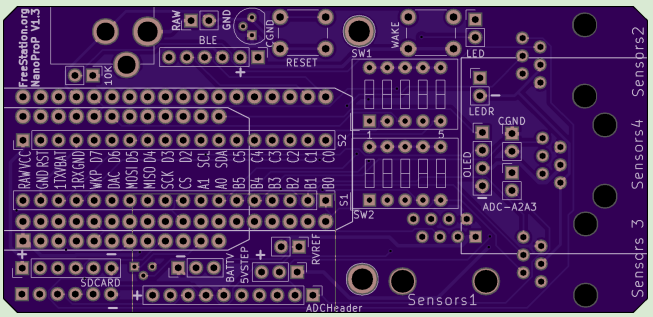
Printed circuit board (PCB) Order

The NanoProP1.3 printed circuit board (shown on the bill of materials) can be ordered from OSHPark only[1]. Only one is required per station, but the minimum order is three. OSHPark is based in the USA. Total cost approximately: $40 (**$10.4 per station, 2020 prices**). Delivery time is 2-3 weeks for free delivery.

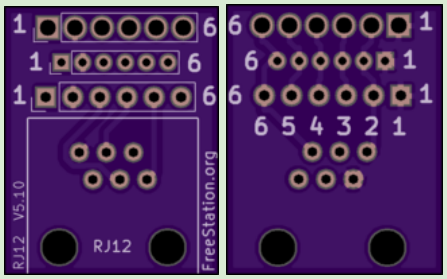
Other Generation 2 PCBs that may be required (depending on instruments) are listed below and those needed are indicated for each instrument on the relevant section of the bill of materials .

The NanoProP1.3 is suitable only for Particle Photon and Electron based data loggers and has four sockets:

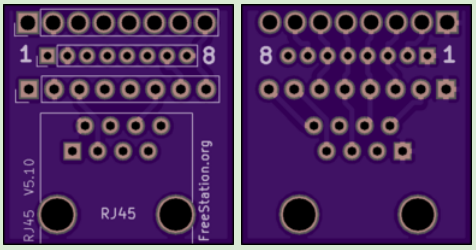
- **Sensors1** connect to sensors via RJ45
- **Sensors2**: connect to sensors via RJ12
- **Sensors3**: connect to sensors via RJ12
- **Sensors4**: connect to sensors via RJ12



FreeStation NanoProP1.3 printed circuit board



RJ12Narrow - for connecting wired or male-pin digital and analogue sensors to RJ12 Sensor ports. Both sides of the PCB are shown.



RJ45Narrow - for connecting wired or male-pin I2C and ADS sensors to RJ45 Sensor ports. Both sides of the PCB are shown.

[1] FreeStation has no commercial link with OSHPark, and obtains no commission from this order, and cannot help with enquiries on any order you may have made with them.

Tools required

Only a soldering iron and solder (plus safety equipment) are required to build the demo unit since it is for indoor use and has no enclosure or housing. Units for deployment outdoors are described elsewhere at www.freestation.org/building

Safety

You are responsible for your safety and those working with you. Building FreeStations requires the use of soldering irons. Always wear protective goggles and take care that all equipment is safe and functioning properly and that you have an appropriate working space that is well ventilated. Adhere to the workshop policies of your school and ensure that there is appropriate teacher supervision.

Environment and Ethics

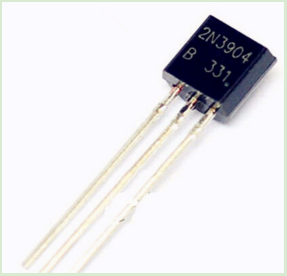
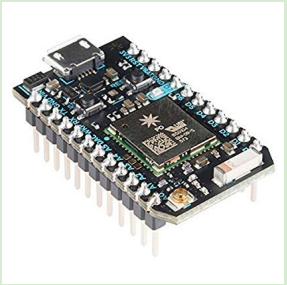
FreeStation loggers are designed with a low environmental footprint in mind but you must also do your part. Dispose of electronic components properly when they are no longer needed. Ensure you have the necessary landowner permission to deploy data loggers and that the relevant authorities are aware. Deployed FreeStations should always carry a notice indicating what they are and contact details for the owner.

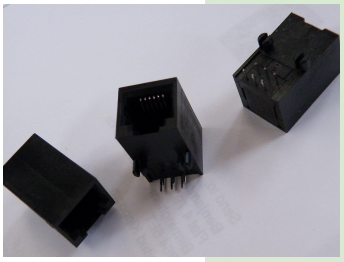
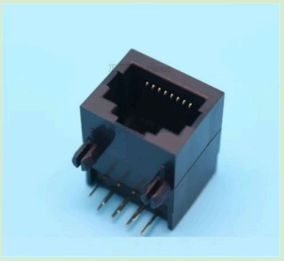
Build instructions

EduStation demo logger

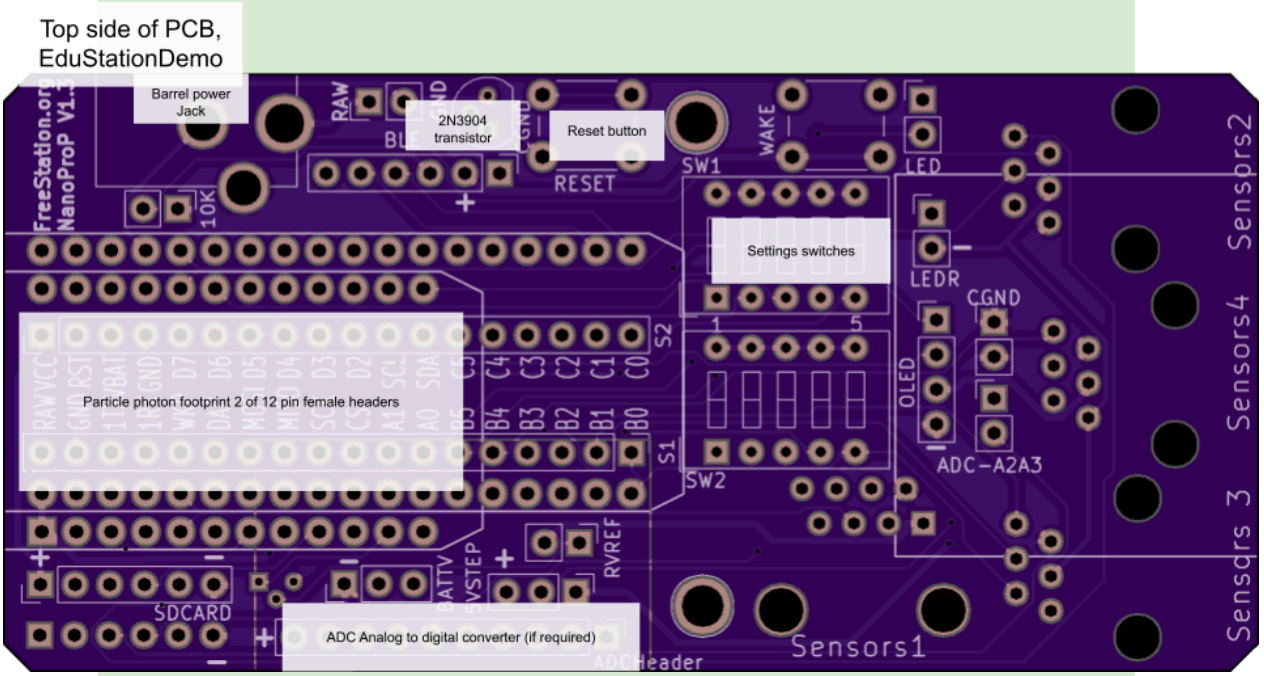
The FreeStationLive logger that is used in the EduStation demo uses the Particle **Photon**. The FreeStation can use either an OLED text display or a multicolour LED to communicate its status. By default the OLED is used for instruments that deliver an immediate measurement (FreeSensors) and a multicolour LED only is used for logging (recording) sensors.

PCB components

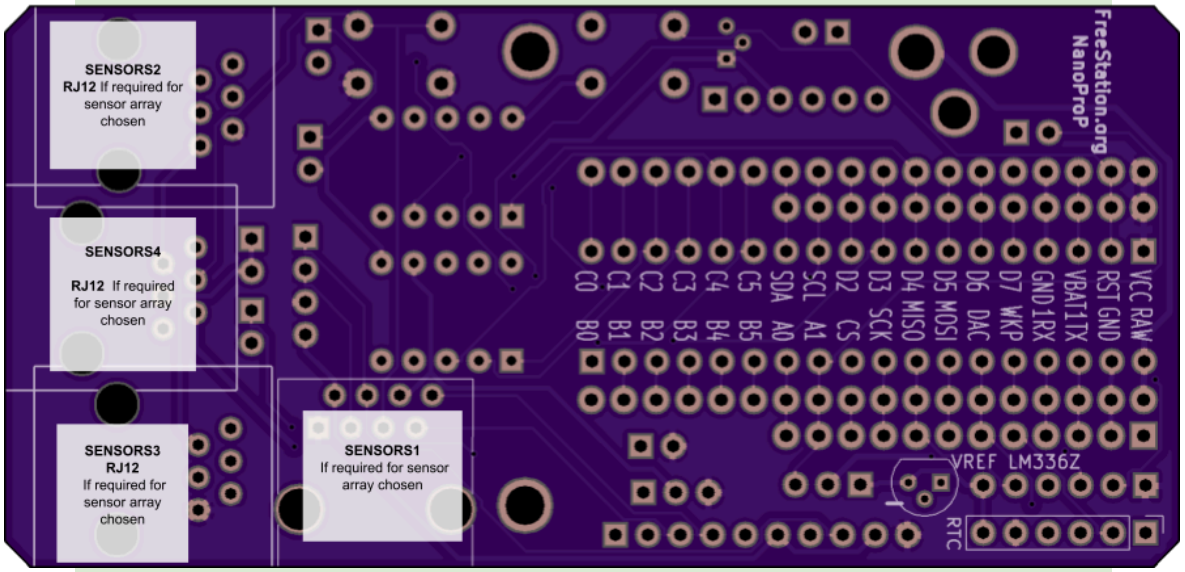
Female headers 	2N3904 transistor 	Particle photon 	PCB feet 	Reset (momentary) switch JST male JST connector 
RJ12 socket	Settings switch	RJ45 socket	Female (barrel) power jack	

Placement of components



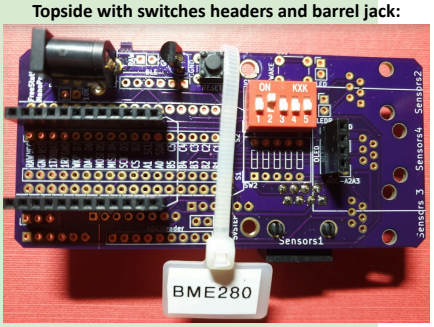
Bottom side of PCB, EduStationDemo



- Parts are listed in the bill of materials, linked above
- The PCB is populated as shown here. Different RJ (registered jack) sockets will be needed for different sensors (each sensor in the bill of material includes the required socket.
- It is critical to avoid solder bridges (adjacent pins joined by solder, creating a short-circuit) and to check the board fully for these before powering on.
- All major components with male header pins are connected via female header sockets on the FreeStation PCB so that components can be easily replaced.
- Components are attached to the PCB as indicated by the labels (RESET etc) and on the side indicated by the outline in white
- Ensure that components are soldered to the correct side of the board and in the right way around

- **Solder the female headers**:
  - **For all configurations:** Particle Photon (2x12 pin, SDCARD 1x6 pin).
  - **For wind speed and direction:** 10kOhm resistor
  - **The RJ connectors that you solder** depend on the sensors that you want to use.
    - For analogue and digital channels (rain gauge, fog gauge, soil moisture, stage) solder the RJ12 connectors (to sensors 2,3,4).
    - For I2C channels (temperature, humidity, pressure), solder the RJ45 (to socket 1). Use the RJ12 and RJ45 sockets on the bill of materials. Others will not fit.
- **Solder the reset button**
- **Solder the 2N3904 transistor** to the component footprint labelled CGND (next to

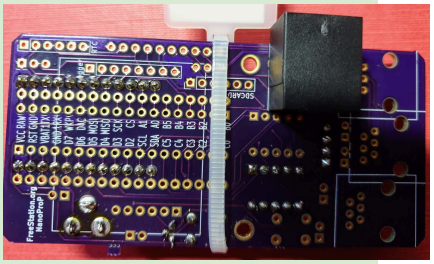
Topside with switches headers and barrel jack:



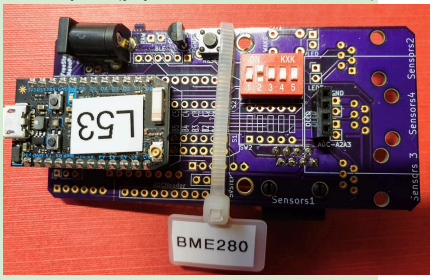
Underside with RJ45 socket:

the power jack).

- **Solder the red settings switch**
- **Solder the female barrel power jack**
- **Solder the particle photon headers** and place the Photon in the headers so that pin notation aligns with that on the FreeStation PCB



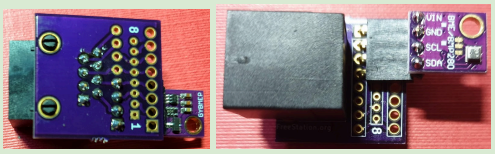
Topside (populated with Particle Photon):



Adding sensors is necessary to monitor the environment. Start with the BME280 temperature, humidity, air pressure sensor below. Others are outlined in [Building and Installing the FreeStation Sensors]().

Sensors

- The BME280 sensor measures air temperature, atmospheric humidity and barometric (air) pressure.
- What is air temperature? What is atmospheric humidity and what is barometric pressure?
- To connect it to the EduStationLive demo logger, first snap four pins from the **male** right angle pin headers and solder to the BME280 as shown.

• Solder the 4-pin right angle **female** header to pins 1-4 of the RJ45ShieldNarrow PCB in the row nearest the RJ45 socket as shown • Solder the RJ45 socket in place • Press the male pins of the BME280 into the female socket on the PCB • Finally connect the short RJ45 cable to **Sensors1** of the Demo Logger and to the BME280 PCB	

Connections

Sensor	**Notes for use with FreeStationLive**
Temperature, humidity, pressure sensor (BME280)	To **Sensors1** (RJ45)
For other sensor types	See Building and installing the FreeStation Sensors

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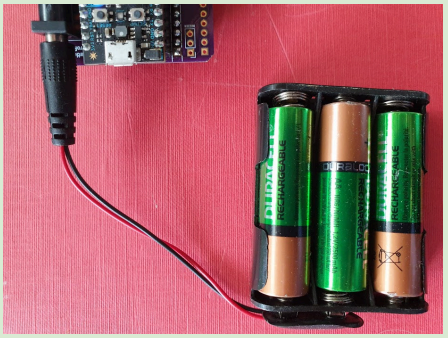
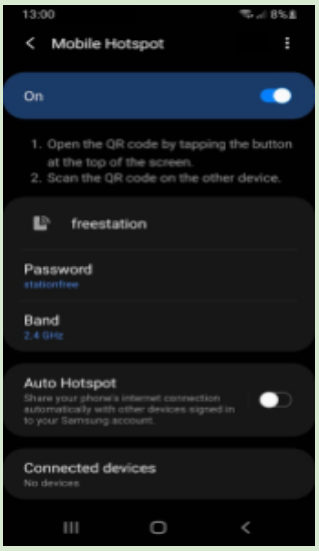
Firmware, power-up and testing

- **Install the firmware.** Details on installing firmware for FreeStation are found in the Building and installing FreeStation Sensors document. Use the firmware for the sensor of your choice:

	Demo mode (FreeStationLive). Will save to SDCARD when not connected.	**Without SDCARD (needs to be internet connected to work)**
EduStationLive Raingauge	Firmware 1.162	
EduStationLive Temperature, Humidity, Pressure (BME280)	Firmware 1.178	Firmware 1.178
EduStationLive Distance (river stage) sensor	Firmware 1.125	
EduStationLive Visible and Infrared light	Firmware 1.125	
EduStationLive Soil moisture	Firmware 1.125	
EduStationLive Temperature and Humidity (SHT21)	Firmware 1.125	
EduStationLive Object temperature	Firmware 1.125	
EduStationLive Wind speed and direction	Firmware 1.125	

• Place the batteries in the battery holder, connect the PP3 9V battery end of the power connector to the battery holder and connect the barrel jack to the EduStation. Troubleshooting details on power-up and testing are in the FreeStationLive/Local install doc.	
• The red **settings switches** allow the logging interval to be changed. The most useful for class demonstrations is to have **switch 2 on** and all other switches off. This will have the logger wake up and send a reading **once per minute.**	
• Setup your phone as a WIFI hotspot (personal hotspot or tethering) with username **freestation** and password **stationfree, with the hotspot band set at 2.4 GHz, not 5 GHz** • The FreeStations will look for this network (**the FreeStation network**) and connect via it either using your mobile data or using wifi sharing if your mobile is connected to a wifi network and is sharing that via the hotspot. • The FreeStation will wake up, connect (green LED), collect data (blue LED next to D7 lights up) and send the data (yellow LED) before going back to sleep (LED off).	

Settings switches: 

FreeStationLive and FreeStationLocal have a maximum of two banks of setting switches. Those marked SW1 control the timing of logging. Those marked SW2 are sensor specific.

The default logging frequency is hourly and the red settings switches 1 to 3 must be off on setup (or the switches not present) for this mode to operate. Other modes can be set using the switches as below. Pressing **reset** is

necessary for the switches to be read during the setup phase. If your station uses an OLED then the logging interval will be displayed.

FreeStation SW1 (O=off,I=on, switches from left): • **OOO = log hourly,** • **III = log every 10 mins,** • **OIO = log every minute.** • **IOO = log continuously without delay.** • **OOI = log on press of wake,** • **IOI = log daily,** • **OII = send on reset only** • **IIO = log every 30 mins** • **OOOIO = send once per day mode.**	**To use with permanent WIFI connection:** Choose your interval according to the switch settings and press **reset**. If not logging continuously the device will connect and send data at the requested timestep. If logging continuously data will only be sent on a reset. *Note that logging continuously generates a lot of very similar data!* **To use without permanent WIFI connection:** Set only setting switch 2 and 3 on and reset. The device will then need to be WIFI connected on reset so that it can get the correct time. It will wake up every 10m, take a reading and attempt to send an average every hour. If there is no connection it will write to SDCARD and only send when reset is pressed (if the device can connect to the network then). **Your FreeStation must have an SDCARD and running SDCARD code for this mode to work**

Getting your data

FreeStationLive devices register automatically to the FreeStation.org system on first use. Your device configuration and data are available using the 24 digit device ID associated with your Particle. This can be found using the particle Command Line Interface (CLI) as below.

Getting your FreeStation ID (FID):

On first connection your device will be assigned a unique FreeStation ID (FID) that is easier to remember and should be added as a label on the device. Discover the FID for your device using the device ID here or by looking at the last registered FreeStation here.

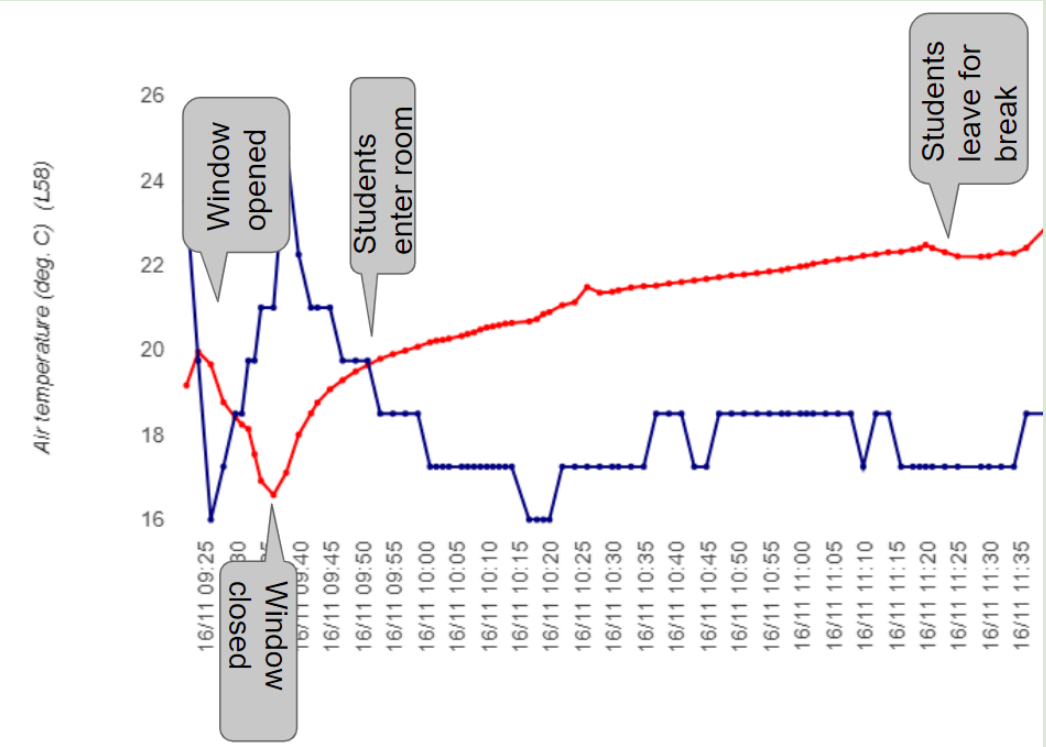
Your FreeStation data can be accessed by anyone with your device ID or FreeStation ID because FreeStation is an open-data project and by default your data will form part of our global database and will be accessible to all. Use the //Smart: console generator to access everything to do with your station including data, visualisations, configuration, analyses and device management. Simply add the device ID for FID and any details of how you would like to present the data. Then click **Check and Submit (Console). Copy the URL generated as your link to the results from that FreeStation Logger**

Lesson ideas

- **Practical: using a variety of sensors:** In computing/IT class, build and register a number of EduStationLive demo units, each with a different sensor and associated firmware. Label the FreeStations with their FID and record which sensor goes with which FID. Generate the //Smart: console for each device and keep a copy of the relevant URL for each device ID. In geography class, set these up for students, connect sensors, power up and enable the FreeStation hotspot and have the students take measurements in

various parts of the classroom and examine the results using the online links provided. After 10 minutes allow students to move to another device and check the data coming in from that device. At the end go through the device data on screen examining the variables and discussing what they mean and how they relate

- **Demonstration:** Build a single FreeStation demo device (using BME280). Power this up in class before the lesson and connect to your FreeStation network. Leave recording every minute throughout half the class. On the projector show how temperature and humidity changed during the class, indicating the impact of opening the window, closing the window, student coming in and their body heat warming the room etc



- **Project work:** In between classes have students deploy a number of devices at different heights and distances from an external wall in the class, collect data and map the differences in mean temperature and humidity in transects from the external wall inwards and from the ground upwards. How does temperature and humidity vary along these gradients? How do these gradients change when the classroom is full *vs* empty.
- See www.freestation.org/edustation for comprehensive teaching resources