What is air quality and how could we teach it in schools?

Using the Urban Observatory Schools portal and the Sense Explorers toolkit
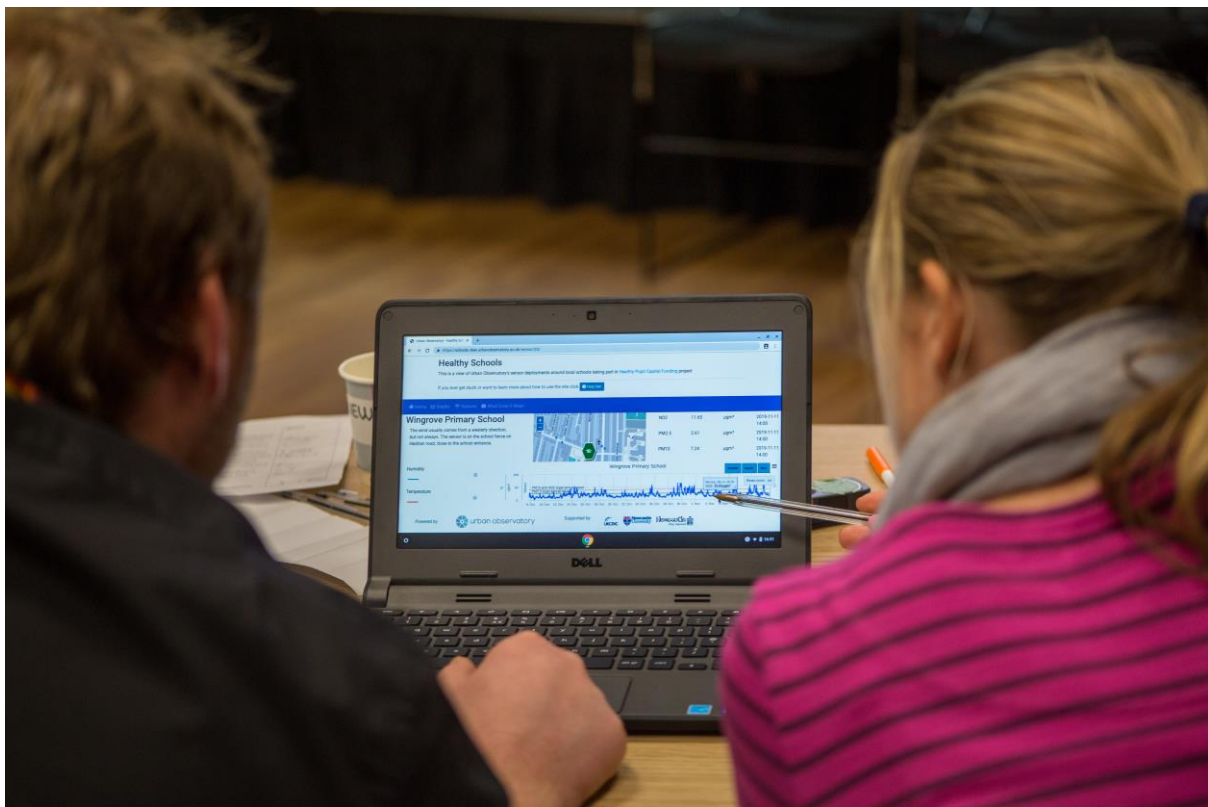

Photo credits: Daniel Parry and Dan Richardson

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Using the Urban Observatory Schools portal

The portal can be accessed by visiting: https://schools.view.urbanobservatory.ac.uk/

NB. You need to be on a computer with Google Chrome or Firefox. You may have issues if trying to access the portal using an older browser like Internet Explorer.

Glossary of terms

Precision station	Explanation
µ	is a Greek letter mu. It means one millionth
µg (micro gram)	As the particles are small, we have to use small units, this is called a microgram (µg) which is one million times smaller than a gram.
µm or micrometre	A micrometre is 1000 times smaller than a mm. Human hair is 50-70 µm thick and a grain of sand is 90 µm wide.
m^3 or cubic metre	A cubic metre is a volume of a 3D cuboid. Think of a box 1m by 1m by 1m; that is a cubic metre.
µgm³	Amount of particles in micrograms inside a cubic metre. (particles inside the 1m by 1m by 1m box)
Particulate matter (or PM for short)	Are the particles suspended in the air- they can be very small, almost invisible to our eyes. PM can be from natural sources such as pollen and dust but can also contain more harmful tiny particles. These can be made from different materials like metals or plastics, for example, from car brakes and tyres.
PM2.5	Is a measure of the amount of particles smaller than 2.5 micrometres. Measured in µgm³ (the amount of particles that were inside 1m by 1m by 1 m box that are smaller than 2.5 micrometres)
PM10	Is a measure of the amount of particles smaller than 10 micrometres. Measured in µgm³ (the amount of particles that were inside a 1m by 1m by 1m box that are smaller than 10 micrometres)
Nitrogen dioxide (or NO2 for short)	Is a poisonous gas and can be produced naturally by lightning and some plants. 80% of it is from burning diesel and petrol in our cars.
Temperature	Air temperature measured in degrees Celsius.

| Precision station	Explanation
Humidity	Amount of moisture in the air. Humidity is high when air is damp, especially when it's raining.
Annual average	The average over the whole year. If we took one measurement every day we would add them all up and divide by the number of days.
	(We take a measurement every 15 minutes so we get 4 measurements every hour, which gives us (24 x 4) 96 measurements every day. Over a whole year, we can have up to (96 x 365) 35040 measurements. We could add these all up and divide by the number of days to find the annual average.)
Legal limit for NO2	Below 40 µg/m^3 **over a whole year** (called annual average)
	NO2 should not be more than 200 µg/m3 **in any hour** but it's allowed to break this rule 18 times in a year.* (So that's 18 hrs in a year. A year has 8760 hours in total (24 x 365).
Legal limit for PM10	Below 40 µg/m^3 **over a whole year** (called annual average)
	PM 10 should not be more than 50 µg/m3 **in a day** but it's allowed to break this rule 35 times in a year.*
	(So, it's allowed to be broken on 35 days a year)
Legal Limit for PM2.5	Below 25 µg/m^3 **over a whole year** for PM2.5

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* Why can the rules be broken occasionally?

The government recognise that there might be instances beyond anyone's control such as; bonfire night or emergencies (for example; a big fire or road traffic accident causing very bad road blockages) which will increase air pollution, so they have accounted for that when setting the legal limits.

Instructions for using the portal

1. Paste the weblink https://schools.view.urbanobservatory.ac.uk/ into your browser and click to **open.**

   This takes you to the home page of the new schools dedicated view. Only air quality pods associated with **schools (green)** are shown on this portal, alongside some **precision stations (purple)** and a **weather station (yellow)** to give an indication of wind direction.
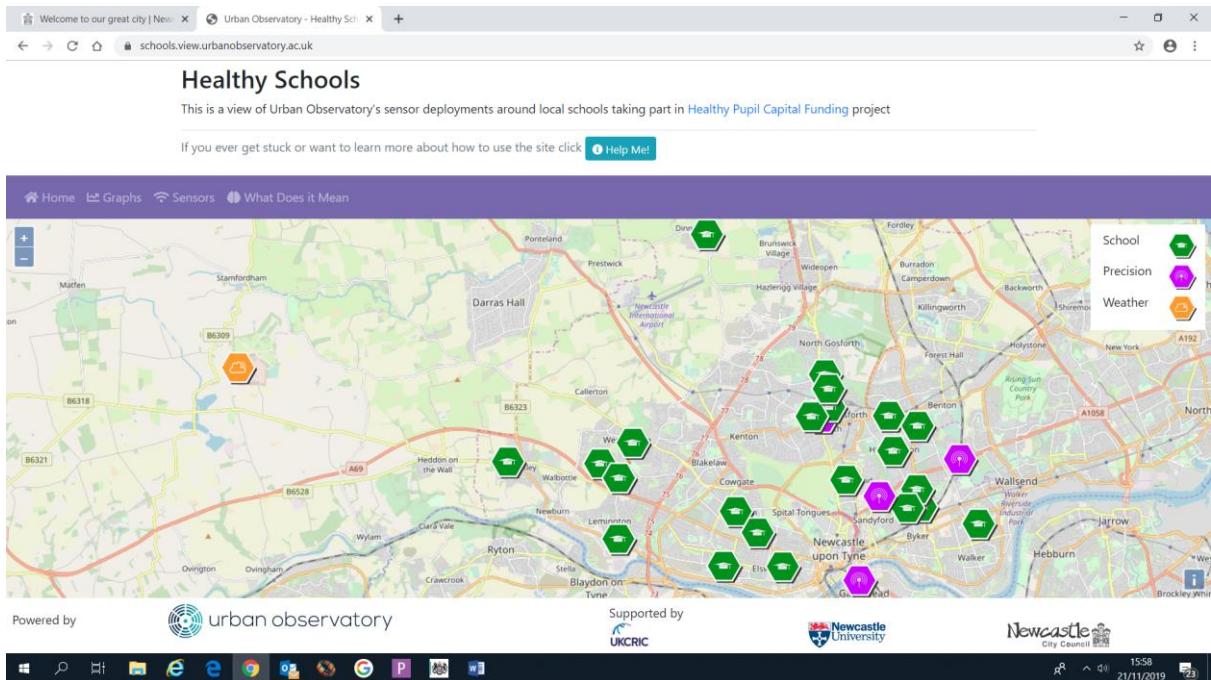
2. At the top of this home page, there is a '**help me** 'button which will give you a little tour of features on this page. **Press it** now and click next to see the 6 different buttons and what they do. Click **'done'**, when you are finished.

3. **Zoom** into the map, using either your mouse or the **+ -** buttons in the LHS top corner, to find your school. Click on the **green icon** at your school location.

4. A **white pop down box** will appear showing you the latest readings from your sensor. Use the glossary above to understand what the parameters mean and the units of measurement.
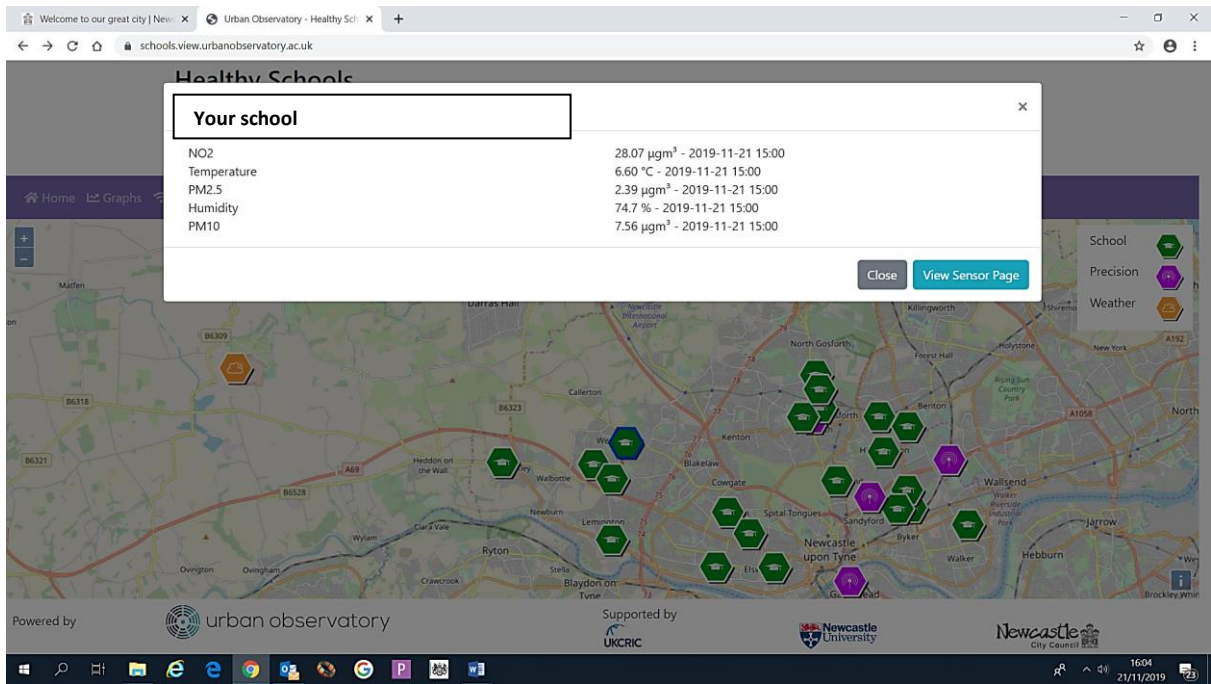
5. If you want to look at more data from this sensor (not just latest reading,) click on **'View sensor page'**. This opens up a new page, showing data from this sensor.

6. Click the '**help me**' button again and get the tour of 8 features this new page.

7. You can look at each variable by itself or put more than one on the graph by ticking the appropriate boxes. Use the glossary to remind yourself what each variable is.

8. You can see that the graph shows two dotted lines – one shows **the legal limit for Nitrogen Dioxide (NO2) and PM10,** and the other shows the **legal limit for PM2.5.**

9. The legal limit values are annual averages – but we've put this line on the graph to help identify when the numbers are high or low.
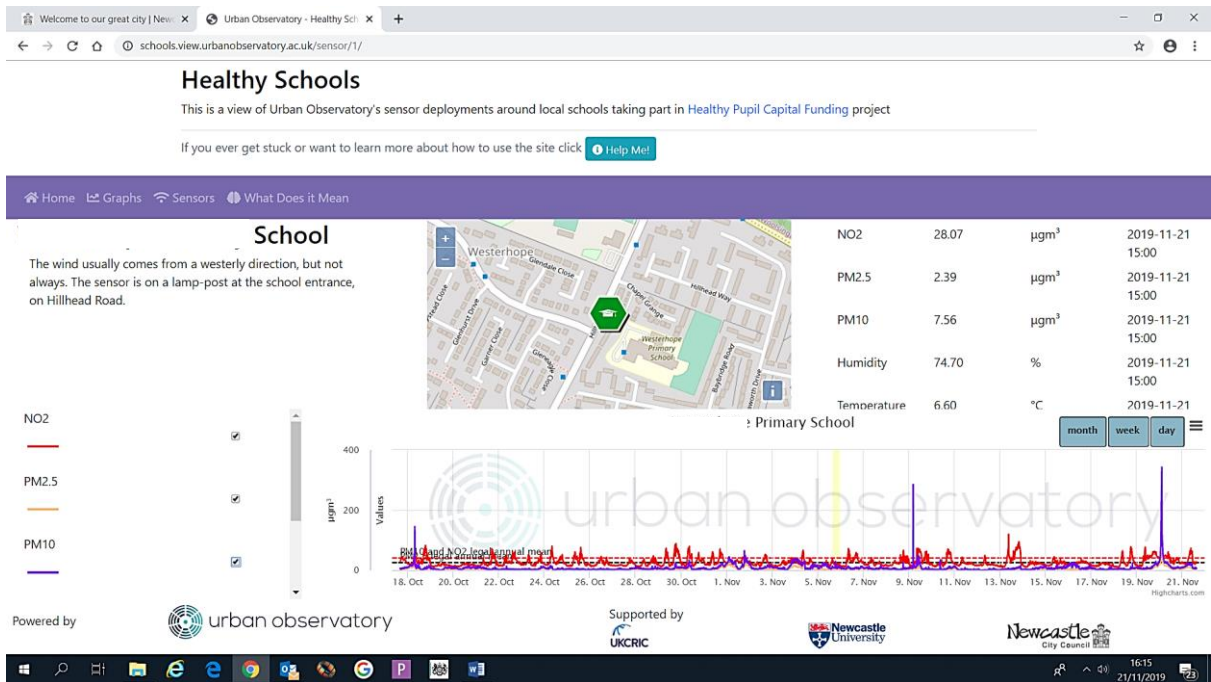
10. You can change how much data is shown on the graph by clicking on the **'Month'** **'Week'** or **'Day'** tab, on the RHS of the graph or by using your mouse to highlight the bit you are interested in. You can reset the zoom by clicking the '**Reset zoom'** button.

11. Spend some time zooming into peaks and seeing if you can think of an activity that may have caused the increase in air pollution. You might need to think like a detective, as it's not always straight-forward.

For example;

- Do you get more pollution at drop off/pick up times?
- Look at bonfire night; we would expect to see an increase in PM 10 and 2.5.
- Maybe you don't see a peak when you would expect to? If this happens; look at the weather sensor - look to see if the wind direction or strength has changed or whether it was raining a lot?

12. If you want to print your graph out – go to the menu bar on RHS of the **'Month'** **'Week'** or **'Day'** tab (three lines underneath each other). You can **download** the graph in different formats including as an image (JPEG, PNG) or a pdf.

Comparing Data

13. Now you are more familiar with your own sensor pod, you can look to compare your data either with the accurate data from the precision data or another sensor outside a different school. Click on 'Graphs' in the **purple box** towards the LHS of the screen.

14. Press the '**help me** 'button and take the **first TWO clicks** on the tour. (We'll come back to the last two steps on the tour later).

15. As shown on the tour; pick a theme – '**air quality' or 'weather'** and the variables will show on the RHS. Choose which one you want to compare.

> **For example;** If you choose theme; Air quality, you will click on PM 10. (or could click on NO2 or PM2.5)

16. This opens up a new window, with a graph in the middle and the locations that can be compared. These are all the schools and precision stations.

17. Click the '**help me**' button again and take the **first TWO clicks** on the tour on this new page.

18. You can change how much data is shown on the graph by clicking on the **'Month'** **'Week'** or **'Day'** tab, on the RHS of the graph or by using your mouse to highlight the bit you are interested in. You can reset the zoom by clicking the '**Reset zoom**' button (as before).

19. The **two dotted lines** are shown again; one shows the **legal limit for Nitrogen Dioxide (NO2) and PM10**, and the other shows the **legal limit for PM2.5.**

> **Remember;** the legal limit values are annual averages, but we've put this line on the graph to help identify when the numbers are high or low.

20. Spend some time looking at the data from **your school compared to a precision station.** We recommend choosing the precision station closest to your school. (Some new precisions will be added to this map in November 2019; one at Four Lane Ends and one on St James Boulevard). We would expect air pollution from the precision stations to be higher than by school.

   Also compare your school against another school or maybe 3 at a time, by ticking the boxes.

Recording Your School Activity

21. Now click on 'Sensors' on the **purple bar** at the top and click on the '**help me** 'button and take the whole tour.

22. From this page, you can either go back to sensor page, view notes or add notes.

23. We would like you **to add notes to your sensor page**, so you can keep track of events you run at school. For example, a walk to school day or air pollution assembly, or bonfire night. When you've added a note, you can see it appear on your sensor page in a **pale yellow** box. If you click on the **yellow box**, the note pops up on your graph. We've added bonfire night to your notes already.

24. You need to use your **password** to add notes to your graph. (The password is to stop bots hacking your page and adding nonsense notes). if you have lost it - don't worry, please email us at urbanobservatory@ncl.ac.uk and we'll send it again.

25. We've added some notes under 'what does it mean' on the **purple bar** at the top of the page. It very briefly covers;

> - What is air pollution?
> - How does it affect us?
> - How do we measure it?
> - What do the numbers mean?
> - Legal limits and units of measurement
> - Other things to think about

Additional Top Tips for Teachers

We would recommend keeping the **glossary, ball park figures** (in text below) and the **table** in link below handy to remind you of AQ thresholds so you can determine when values are high.

https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf

[NB: these values will be indicative only and individual values should be used with caution.]

The Urban Observatory

The Urban Observatory (UO) is a research project, run from Newcastle University, that has created the densest sensor network in the UK, to understand the interactions and inter-dependencies between parameters and scale. We have the largest set of open real-time environmental monitoring data in the world.

All data from Urban Observatory is open and available to anyone and everyone and accessed via our website [http://www.urbanobservatory.ac.uk/] or directly via the data portal [http://newcastle.urbanobservatory.ac.uk/]. We have over 6000 sensors and lots of different types of data; from beehive activity from a network of instrumented urban hives, to rainfall data to air quality sensors.

Air Quality Sensors

There are over 200+ indicative air quality sensors, 66 of which are **AQmesh**, which is the type of AQ sensor used in healthy school project (see F1). These air quality sensors are classified as **indicative**, as they are electro-chemical sensors and use a different method to measure air pollution, to '**reference**' roadside cabinets. The reference stations use a standard method, approved by DEFRA (https://uk-air.defra.gov.uk/networks/network-info?view=aurn). There are several reference stations in and around the region, such as at Cradlewell, Salters Road, and Tyne Bridge and along Coast Road. (This data is also available on our data portal e.g. [http://newcastle.urbanobservatory.ac.uk/sensors/sensor/PER_AIRMON_MONITOR1048100_AIR/]).

The Urban Observatory co-locate the AQmesh at the reference stations and the readings closely follow the same patterns. We are relatively confident in their performance at representing air quality, but they do drift with time, and are affected by temperature and humidity.

The absolute values from the AQmesh should therefore be used with caution, as they are only **indicative.** However, as the devices are much smaller, and cost a lot less than a reference station, they allow indicative measurements to be taken in many more places. This allows us to understand how our behaviour and decisions impacts air pollution. The observations also help us understand and think about how other factors such as wind, rainfall, form of a space (whether it's a wide-open space or enclosed) affects air pollution. All these factors are important to think about, when looking for ways to reduce air pollution.

Air Quality, health – concentrations of concern

The air pollutants that are considered to impact our health are **nitrogen dioxide (NO2)** and **particulate matter (PM).** PM10 is particulate matter with a diameter <10 micrometres (µm). We measure the number of particles of NO2 or PM in a cubic metre of air e.g. µg/m3. Long term exposure to high levels of NO2 and PM can increase our risk of heart and lung disease and asthma. Most of the NO2 and PM in our city centres comes from traffic. The Urban Observatory also measure PM 4, PM 2.5 and PM1 (particulate matter with a diameter <4, 2.5, 1 micrometres (µm) respectively). These measures are not shown on the schools' portal to reduce the complexity of information presented.

Air pollutant concentrations can vary widely for the same location depending on;

- the time of day,
- day of the week,
- weather conditions
- season.

Air quality limits use a mix of annual, daily and hourly averages to allow for this.

Figure 1. https://www.aqmesh.com/

Air Quality Limits

In the UK we want the annual average **PM10** concentration to be 40 µg/m3 or less. The 24hour average **PM10 concentration should be below 50 µg/m3** but can be exceeded 35 times.

We want the annual average of **NO2** to be 40 µg/m3 or less. **The hourly NO2 average should be below 200 µg/m3** but can be exceeded 18 times in a year.

More information on UK and EU air quality limits can be found at:

https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf

Using the Sense Explorers Toolkit:
project-based learning activities around air pollution

What is it?

Sense Explorers is a free toolkit developed by Newcastle University, which contains activities and digital resources to involve young people in transforming places and the environment.

The toolkit invites children to gather data about problems in their neighbourhood, such as; air pollution or speeding traffic and come up with ideas to make it a better place. Using their senses, and some interactive digital tools, young people learn that their neighbourhood is worth looking after and that they have the power to make it better.

The toolkit can be used by anyone who wants to involve young people in learning about the environment and making it better, including teachers, youth workers, planners, architects, charities and action groups. It's designed for anyone aged 8+ and completely **free to use** without any restrictions. The activities can be adapted for any project of your choosing.

Using the toolkit

Please visit http://sense-explorers.uk to get started with Sense Explorers.

Sense Explorers comes in four parts: *Explore, React, Design* **and** *Influence*. Pupils will;

- Collect data using their own senses and some digital technology; including a handheld, low-cost digital tool that detects air pollution, dust and noise.
- Think about what this data tells you about their neighbourhood.
- Come up with campaigns and solutions for these problems.
- Present their ideas to decision makers, to generate impact in their local area.

The toolkit overlaps with school curriculums, youth participation projects and activist agendas. The activities have been tried and tested in lots of different settings.

There are a few ways to use the toolkit;

- **Independent sessions** that each last 1-2 hours, based on the *Explore, React Design* **and** *Influence* elements of Sense Explorers. You can just pick one, or a couple together. Which ones would be most useful for your community?
- **A full day project**, where you explore each of the elements of Sense Explorers to uncover and respond to problems in your community.
- **A bitesize version** of the toolkit, which takes approximately 2 hours to run. This is a great way to have an impact in a short space of time.

For more information
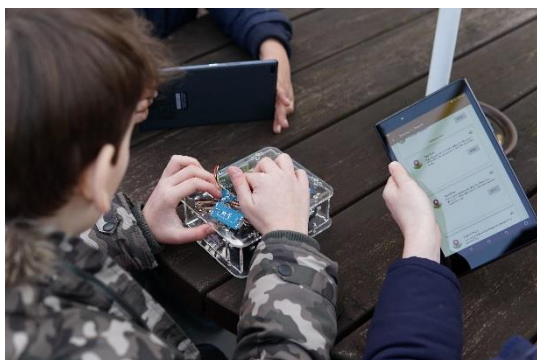
The toolkit comes from research being done by PhD students at Newcastle University. If you'd like to find out more, please get in touch with the lead researcher, **Sean Peacock** by emailing s.peacock@ncl.ac.uk