



Cleaner Air 4 Schools

KS2 Science and Geography

Welcome!

This toolkit has been designed by London Sustainability Exchange to help you teach your Primary School class about Air Quality. We'll help you and your pupils find out the answers to the following questions:

- What is Air Quality?
- How does it affect us?
- How do we measure it?
- Can we make a difference?

We've divided up this toolkit into four sections: explore, experiment, analyse and take action. All four sections go together as a full unit of work but we've left room for you to be flexible if you just have time for a lesson or two.

Part one: explore

In part one of the Cleaner Air 4 Schools toolkit, your pupils start by learning the Great Smog of 1952. Your pupils will then learn about the basic make up of air, different types of pollutants, what causes them and what they do to human and environmental health. This will help them come up with imaginative best case and worst case scenarios for poor air quality.

Your pupils also will become "Air Quality Detectives", creating a baseline of attitudes at school and at home that they will attempt to influence over the course of this project.

Part two: experiment

In this part of the Cleaner Air 4 Schools toolkit, your pupils will build on their learning from part one, moving from understanding what air quality is to finding out how to measure it. We have prepared a set of three experiments using NO₂ diffusion tubes, lichen mapping or Air Quality wipe testing that work together or separately.

Part three: analyse

In part three of the Cleaner Air 4 Schools toolkit, your pupils will take all the information they've gathered in from the experiments in part two and analyse the results. They will see examples of data journalism and infographics to inspire them to present their results in an attractive, easy to understand manner. Your class will discuss the results and think about their predictions from part two: are the results as they expected?

Part four: take action

In the final part of the Cleaner Air 4 Schools toolkit, your class will think about communication, campaigning and encouraging behaviour change in their own lives, in the school and in their community.

Your pupils will learn about the ways in which messages are communicated and analyse them for content, style and emotion. Your class will use this learning to think about how to communicate the importance of good air quality. They will assess a number of suggestions and select class, group or individual projects to take forward.

Links to learning

The Cleaner Air 4 Schools toolkit has been designed to deliver key learning objectives and curricular aims for Science and Geography at KS2. Part four also contains activities that build comprehension and composition skills required for English at KS2.

Additionally, this toolkit is ideal for use if your school is taking part in the Healthy Schools, Silver Crest or TFL Stars programmes.



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Part one: explore

In this part of the Cleaner Air 4 Schools toolkit, your pupils start by learning about a historical case of poor air quality: Great Smog of 1952. Next, they will find out just how dangerous modern air quality is compared to other hazards with an interactive “higher or lower” activity.

Your pupils will then learn about the basic make up of air, different types of pollutants, what causes them and what they do to human and environmental health. This will help them come up with imaginative best case and worst case scenarios for poor air quality.

Next, your class will start to create a baseline of attitudes and behaviours around travelling to school by completing a simple survey about their own attitudes to travelling to school.

Finally, your pupils will become “Air Quality Detectives” and take home a survey for the adults in their lives, creating a baseline of information that they will attempt to influence over the course of this project.

Before you start: assembly notes

Before teaching your class using the lesson plan in part one, give a school assembly on air quality. London Sustainability Exchange has prepared a Power Point presentation you can use during the assembly (www.tinyurl.com/lxassembly), or you can prepare your own slideshow of images.

In the assembly, you should tell your pupils that pollution from traffic outside the school grounds could be making the air in their classrooms and playgrounds dangerous to breathe.

Do any of your pupils have asthma? A study has found that 30% of all new asthma cases in children are caused by exposure to pollution.

Do any of your pupils play sports? Studies have found that pollutants from traffic reduces children’s lung capacity by almost 20% - and we need our lungs for running, jumping and

Curriculum links

- Science: undertaking scientific enquiries to answer questions about our world and human behaviour
- Science: exploring the impact of our environment on how our bodies function, including learning how pollutants can be harmful to the human body
- Geography: use fieldwork and observational skills to study the key human and physical features of their school, home and local environment

Materials requirement

- printed copies of worksheets one, two and three
- pens or pencils
- whiteboard and marker
- internet access (for viewing images)

Time requirement

One assembly to introduce the subject to the whole school, then one session of 50 minutes plus fifteen minutes of homework. There is an optional stretch activity that will take around half an hour.

being healthy both now and in the future.

Tell your school that one of your classes will be doing a special investigation into air quality in the local area, and that they need everyone’s help! Use the “hands up” travel survey on the next page to get information about how your pupils and staff travel to and from school. Alternatively, you can complete the “hands up” travel survey with each class separately as part of registration.



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Assembly: school survey

Conduct a “hands up” travel survey during your school assembly, recording the responses in the tables below. This will give a baseline of data, letting you see your progress as your Air Quality projects go on.

Survey date:	Number of pupils present:
School year(s) surveyed:	Class(es) surveyed:

How do you usually travel to school?

Type of transport	Count
Walk (including scooter, rollerskates, skateboard, etc)	
Cycle	
Car or van to the school entrance (not sharing)	
Car or van to the school entrance (travelling with others)	
Park and walk (not sharing)	
Park and walk (travelling with others)	
Bus	
Rail	
Other	
Total	

How would you most like to travel to school?

Type of transport	Count
Walk (including scooter, rollerskates, skateboard, etc)	
Cycle	
Car or van to the school entrance (not sharing)	
Car or van to the school entrance (travelling with others)	
Park and walk (not sharing)	
Park and walk (travelling with others)	
Bus	
Rail	
Other	
Total	



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Lesson one

➤ Opener: Great Smog of 1952 5 minutes

To start the lesson, display a gallery of images from the Great Smog of 1952. The Guardian has a good collection: www.tinyurl.com/smog1952.

Explain that smog is a kind of dirty fog. In 1952, the weather was very foggy. The fog mixed with lots of dirty smoke from people's coal fires and pollution coming out of factory chimneys.

This mixture of weather and pollution created a very poisonous blend. The smog was so dirty and thick that it stopped traffic and gave lots of people serious breathing problems. Sadly, the Great Smog of 1952 killed over 4,000 people.

The terrible conditions and the deaths of people and farm animals made everyone very angry. The government responded by passing a new law that banned the dirtiest types of smoke and stopped factories and families using coal and smoky wood burners in the city.

➤ Class activity: higher or lower? 10 minutes

Tell your class that you are going to play a dangerous guessing game. Write "Air Quality" in the middle of your whiteboard with a vertical line and big arrows above it and below it. Using *Teacher notes 1.1: Higher or Lower?* as a guide, ask your class to raise their hands if they think each of the different hazards is more dangerous (higher!) or less dangerous (lower!) than poor air quality or the other hazards already listed.

Order students' responses on the whiteboard. You may wish to group responses agreed table by table or take a note of the majority's answer. Once you have ordered all eight hazards you can reveal the real answers.

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➤ Group work: the air that we breathe 20 minutes

Use the results of the previous activity to prompt a short discussion. If necessary, use the following prompts to guide the discussion.

- Did they get the order right?
- Were there any surprises?
- Did your class expect poor air quality to be this dangerous?
- Does the air your class are breathing now look as polluted as it did in the Great Smog?
- What do they think modern pollution is?

Ask your class to take a deep breath and think about what is going into their lungs. Air is a mixture of gases that we breathe in thousands of times a day. The mixture changes depending on where we are and what we (or others) are doing. Can the class think of anything we do that might change the quality of the air around us?

Hand out *Worksheet 1.1: the air that we breathe* and talk your students through the basic make up of air and the pollution that might be in it. Ask your students to work in pairs or small groups to complete the activity on the worksheet. When encouraging them to imagine the very worst place and the very best place for air quality, encourage them to think both realistically (a bus station) and fantastically (a bus station on top of a volcano).

Draw a line down the centre of your whiteboard, labeling one half "worst" and one half "best". Ask each group in turn to describe their worst place from the last activity, noting key attributes on the "worst" half of your whiteboard. If



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needed, prompt them to provide explanations for their decisions. After each group has described their places, ask the rest of the class if they can think of local places with those key attributes. They may not find any active volcanoes but there may be places with lots of idling traffic, industrial areas or power stations. Add any locations your class think of to your whiteboard.

Next, ask each group to describe and explain their best places, noting key attributes on the “best” half of your whiteboard. Again, after each group has finished, ask the rest of the class if they can think of local places with similarities to their ideal Air Quality locations, adding any locations to your whiteboard.

Finally, take a picture of your whiteboard or make a note of the responses - you’ll need this for a later lesson.

➤ **Worksheet: routes to school** **10 minutes**

Hand out *Worksheet 1.2: routes to school* and ask each of your pupils to fill in the survey. Explain that the answers to this survey will combine with the school’s assembly answers to help them find evidence of people changing their habits in ways that will help improve local Air Quality. Once your pupils have filled in the survey, collect the sheets and put them away until next lesson.

➤ **Close: Air Quality Detectives** **5 minutes**

Tell your class that their homework is to become an “Air Quality Detective”. Each of them will be exploring their school route, investigating the local area and questioning their family. Hand out *Worksheet 1.3: air quality detectives* and walk them through it. Explain that next time you have an Air Quality lesson they will report back on their investigations!

Air Quality Champions

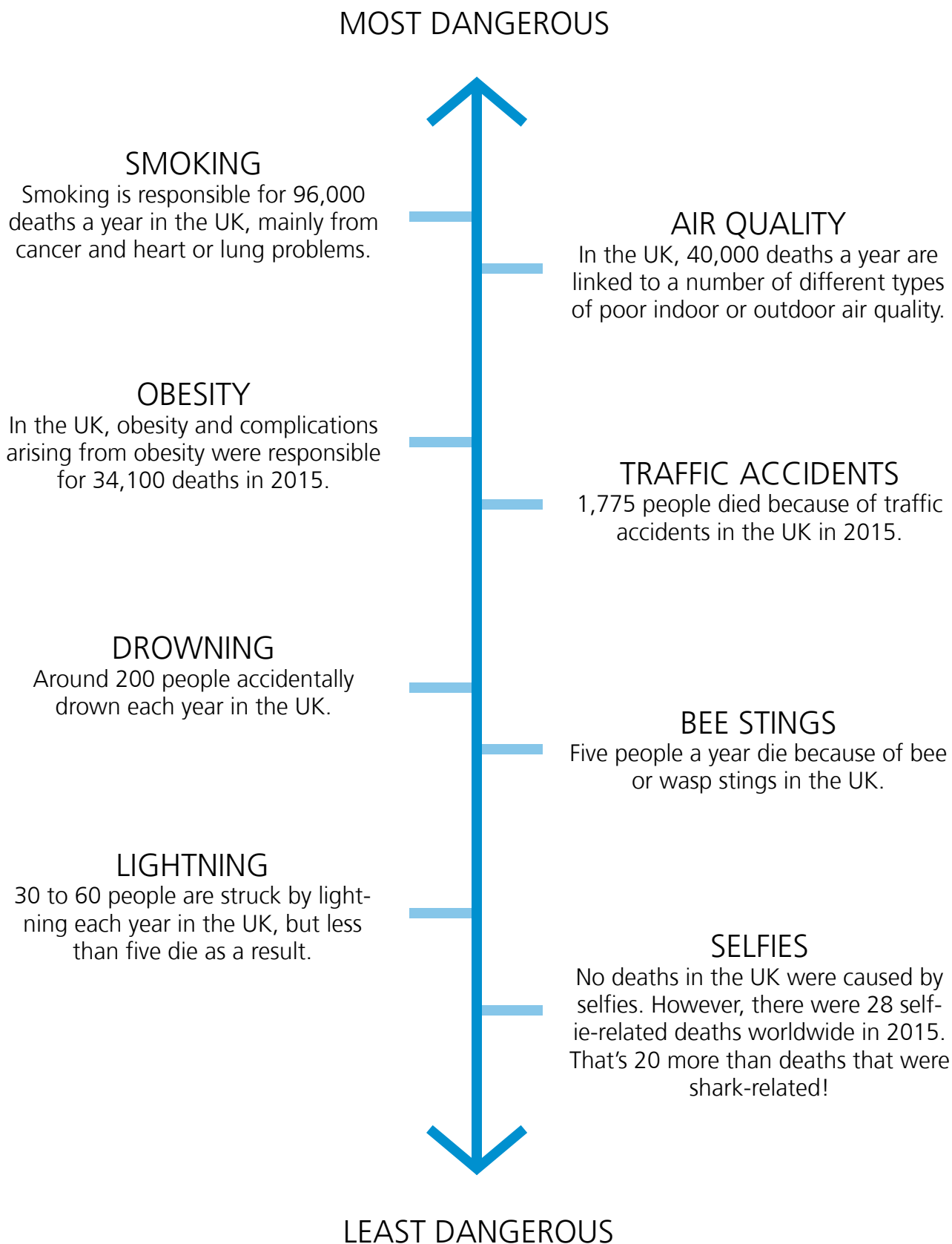
If you have time to set stretch activities as part of this lesson, or a group of pupils who are particularly engaged, you can start an Air Quality Champion programme.

Throughout this unit of work, we have suggested some supplementary activities that your Air Quality Champions can take a lead in.

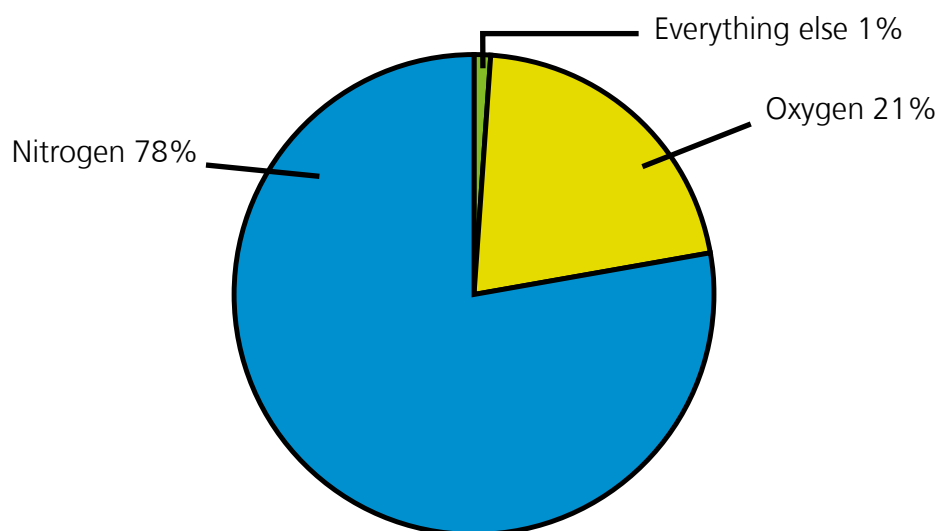
They can choose to undertake extra experiments and data analysis activities in parts two and three, and run campaigns to raise awareness or create positive behaviour change in part four.

These activities can also be done as classroom or fieldwork activity involving all your pupils if you have extra time to spend on air quality in your school.

Teacher notes 1.1: higher or lower?



Worksheet 1.1: the air that we breathe



99% of our air is made up of nitrogen and oxygen, gases that are friendly to humans. However, an increasing amount of the remaining 1% of air is made up of harmful substances called pollutants. Too many of these pollutants create poor air quality. Air quality is a measure of the healthiness of our air.

We pollute our air in lots of different ways. When cars, vans or buses burn fuel in their engines, polluting fumes come out of the exhaust pipe. Some houses use coal, wood or gas fires to keep warm or cook, which produces polluting smoke. Most electricity is made in power stations that burn coal, oil and gas. These examples are all caused by humans. However, pollution can also come from natural sources, such as volcanoes or pollen.

Read the descriptions of five types of pollution below. The first two types of pollution on the list (nitrogen dioxide and particulates) are the most concerning in London.

- Nitrogen dioxide comes from car exhausts, burning fuel in power plants, cigarettes and thunderstorms. You can find lots of it in cities during rush-hour traffic. It is dangerous for humans, especially people with asthma.
- Particulates aren't gases but lots of bits floating around in our air, including aerosols, smoke, fumes, dust, ash and pollen. Particulates get into our lungs, contributing to asthma and lung disease.
- Carbon monoxide comes from burning fossil fuels. You'll find it wherever there are cars, taxis, buses, or fires. It causes headaches, fainting and eventually suffocation.
- Carbon dioxide comes from humans (and other animals) breathing out. At high enough doses it has the same toxic result as carbon monoxide - and it's also very bad for the planet. Increased carbon dioxide is the reason a room filled with people feels stuffy (besides temperature). Other sources of CO₂ are fires, volcanoes, cars and aeroplanes.
- Sulphur dioxide is a smelly but colourless gas that come from power stations and volcanoes. It combines with water in the air to produce acid rain.

Where might you find poor air quality? Imagine the very worst and very best places and describe them here.

Worksheet 1.2: routes to school

Name: _____

Year group: _____

Class: _____

School: _____

Please circle: Girl Boy Age: 5-6 7-8 9-10 11+

What is important to you on your route to school?

Reason	Rank 1 to 6 1 = most 6 = least Use each number once
Being safe	
Being on time	
Being with friends/family	
Good exercise/healthy	
Having fun	
Saving money	

What is worrying about your route to school?

Reason	Rank 1 to 6 1 = most 6 = least Use each number once
It's too slow	
It makes me late	
It's dangerous	
It's boring	
It's expensive	
It's too polluted	

What do you like about your route to school?

1.

2.

3.

What don't you like about your route to school?

1.

2.

3.

Worksheet 1.2 (continued): routes to school

How do you usually travel to school?

Type of transport	Tick one
Walk (including scooter, rollerskates, skateboard, etc)	
Cycle	
Car or van to the school entrance (not sharing)	
Car or van to the school entrance (travelling with others)	
Park and walk (not sharing)	
Park and walk (travelling with others)	
Bus	
Rail	
Other	

How would you most like to travel to school?

Type of transport	Tick one
Walk (including scooter, rollerskates, skateboard, etc)	
Cycle	
Car or van to the school entrance (not sharing)	
Car or van to the school entrance (travelling with others)	
Park and walk (not sharing)	
Park and walk (travelling with others)	
Bus	
Rail	
Other	

Thank you very much for completing our survey!

Thank you for taking part in this survey! We will keep your information safe and will not share it with anyone. It will only be used for the purposes of this project.

Worksheet 1.3: air quality detective

Hello! Please help your local air quality detective complete their investigation. The detective's school is working on the "Cleaner Air 4 for Schools" project. We are learning about pollution, measuring local air quality and taking steps to reduce health risks.

Q1. How do you feel about the following statement? Circle one answer.

I know a lot about pollution and air quality in London.

Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree Don't know

Q2. Do you have a bike? Circle one. Yes No

Q3. Do you have a car? Circle one. Yes No

Q4. How often do you leave your engine running for longer than 1 minute while your car is parked?

Always Often Sometimes Infrequently Never No car

Q5. How far do you live from school? Circle one answer.

Within 0.5 miles 0.5-1 miles 1-1.5 miles Over 1.5 miles Don't know

Q6. How do you usually travel to school, to work or in your leisure time? Tick one per column.

Type of transport	School	Work	Leisure time
Walk			
Cycle			
Bus			
Rail, tube or DLR			
Car or van (not sharing)			
Car or van (with others)			
Park and walk (not sharing)			
Park and walk (with others)			
Other (please specify)			

Q7. Why do you travel to school using the type of transport above?

Q8. What is most important to you when travelling to school? [rank 1-6, 1 being most important]

Being safe	Being on time	Money	Being healthy	Family time

Q9. What are you most concerned about when travelling to school? [rank 1-6, 1 being most important]

It's dangerous	It's too slow	It's expensive	It's too polluted	It's boring

Worksheet 1.3 (continued): air quality detective

Q10. How would you prefer to travel to school, to work or in your leisure time? Tick one per column.

Type of transport	School	Work	Leisure time
Walk			
Cycle			
Bus			
Rail, tube or DLR			
Car or van (not sharing)			
Car or van (with others)			
Park and walk (not sharing)			
Park and walk (with others)			
Other (please specify)			

Q11. Why would you prefer to travel using the types of transport above? What is stopping you?

Q12. What is your role in the school? Circle all that apply.

Parent or carer Educator Non-teaching staff School governor

Q13. Which year groups do you have children in? Circle all that apply.

Reception Year 2 Year 3 Year 4 Year 5 Year 6

Q14. What is your gender? Circle one.

Female Male Prefer not to say

Q15. Which race/ethnicity best describes you? Circle one.

Asian or British Asian Pakistani	Mixed White / Black Caribbean
Asian or British Asian Indian	Mixed White / Black African
Asian or British Asian Bangladeshi	Mixed White / Asian
Asian or British Asian Other	Mixed Other
Chinese	White British
Black / Black British Caribbean	White Irish
Black / Black British African	White Other
Black / Black British Other	Other (please specify) _____

Want to find out more or get involved? Write your name and preferred method of contact below.

Thank you for taking part in this survey! We will keep your information safe and will not share it with anyone. It will only be used for the purposes of this project.



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Part two: experiment

In this part of the Cleaner Air 4 Schools toolkit, your pupils will build on their learning from part one, moving from understanding what air quality is to finding out how to measure it. We have prepared a set of three experiments that work together or separately.



Experiment option one NO₂ diffusion tubes

Class time required: 50 minutes
Fieldwork time required: 50 minutes
Time until results: six weeks
Cost: around £6 per tube



Experiment option two Lichen mapping

Class time required: 15 minutes
Fieldwork time required: 40 minutes
Time until results: immediate
Cost: none



Experiment option three Air quality wipes

Time required: 20 minutes
Time until results: two weeks
Cost: around £5

Curriculum links

- Science: planning scientific enquiries of different types to answer questions
- Science: recognise when and how to set up comparative and fair tests and explain which variables need to be controlled and why
- Science: taking measurements using a range of scientific equipment
- Geography: use fieldwork and observational skills to study the key human and physical features of their school, home and local environment

Materials requirement

- printed copies of the worksheets and guides named in each experiment
- pens or pencils
- whiteboard and marker
- NO₂ diffusion tubes for experiment one
- internet access and a tape measure for experiment two
- laminator, wet wipes and sandwich bags for the stretch activity
- risk assessments for fieldwork

Time requirement

Each experiment takes between one and two lessons of 50 minutes, including work in class and out in the field. Experiments take between two and six weeks to complete and return results.

There is an optional stretch activity that will take around 40 minutes.



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Lesson two



Experiment option one NO₂ diffusion tubes

Class time required: 50 minutes

Fieldwork time required: 50 minutes

Time until results: six weeks

Cost: around £6 per tube

You will need NO₂ diffusion tubes and clips for this experiment. You can purchase them from Gradko (www.gradko.co.uk). Price includes analysis.

Additional help from teaching assistants or volunteer parents/carers is useful for the fieldwork.

Opener: nitrogen dioxide 10 minutes

What do the class remember about the air we breathe? Can they remember any of the types of pollution? Remind them about nitrogen dioxide, which comes from car exhausts, burning fuel in power plants and thunderstorms. We find lots of it in cities, especially during rush-hour traffic. It is dangerous to humans, especially asthmatic people.

Remind your class that the level of nitrogen dioxide (NO₂) in our air is supposed to be 40 micrograms per cubic meter, which is about 0.000003%. However, NO₂ levels in cities are often way above this legal limit. Show your class some NO₂ diffusion tubes and explain that they will be using them to measure levels of this pollutant in their local area. Using *Teacher notes 2.1: NO₂ diffusion tubes* as a guide, explain that it is a device that determines NO₂ levels.

Group activity: mapping 10 minutes

Ask your students to get into groups and distribute maps of your school grounds and the surrounding area. Give them each nine coloured stickers and ask them to place them in areas that they expect to show high or low levels of different types of air pollution. Where might be the best places to put their NO₂ tubes? Ask them to think about their route to school and where they spend time, for example bus stops and parks.

Group activity: fair experiments 20 minutes

Explain that the NO₂ tube activity the class will be doing is an experiment. We have to think very carefully about how we do experiments because there are a number of things that can change or influence results. Hand out *Worksheet 2.1: fair experiment checklist*.

Your students should make sure that the location of the NO₂ tubes is the only thing that changes (the independent variable). How will they make sure everything else stays the same? Scientists call this process "controlling for other factors". How are they going to be the best scientists they can be?

Ask your pupils to fill in the worksheets in groups. If needed, tell your class that the independent variable (the thing that changes) should be the location of the tube. Prompt your students to think about the other things that might change that they can control for, such as the height of the tube and how exposed it is to wind, rain or interference from people or animals.

Encourage your pupils to think like scientists and come up with ways of making the experiment fairer. If they had more time or money, is there anything they'd do differently?



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➤ **Classwork: final experiment preparation** 10 mins

Go over the group responses to *Worksheet 2.1: fair experiment checklist*, making sure that your pupils have carefully thought about controlling their variables. Make a final version of the checklist that everyone will use for the experiment.

Next, go back to the mapping activity your pupils worked on earlier in the session and work with your class to decide the best locations for the NO₂ tubes. Create a final version of the map of your local area that pinpoints where your pupils will be placing the tubes.

Finally, hand out *Worksheet 2.2: air quality tube record* with the NO₂ tubes and fittings.

➤ **Fieldwork: installing NO₂ diffusion tubes** 50 mins

If you have enough classroom assistants or volunteer parents/carers you can work in groups for the fieldwork, or you can choose to work as a full class. In either case, ensure your pupils document the installation correctly using *Worksheet 2.2: air quality tube record*. Pupils should label the tubes and make good notes about each of the chosen locations (in the format suggested in the teachers notes), including geographic data, photography and/or annotated sketches, and site use (e.g. car park, bus stop, open field). Make sure you know where the tubes are located as you'll need them to prepare for session three.

The diffusion tubes must be collected two weeks after this lesson. Send the labeled tubes and monitoring sheets to your supplier. You should receive your diffusion tube results as a CSV file within two weeks.



Experiment option two Lichen mapping

Class time required: 15 minutes

Fieldwork time required: 40 minutes

Time until results: immediate

Cost: none

➤ **Opener: nitrogen dioxide and lichen** 5 minutes

Ask your class to think back to the first lesson. What do they remember about the air we breathe and pollutants? Can they remember any of the types of pollution? Remind them about nitrogen dioxide, which comes from car exhausts, burning fuel in power plants, cigarettes and thunderstorms. We find lots of it in cities during rush-hour traffic. It is poisonous for humans, especially people with asthma.

Tell your class that, in Europe, the amount of nitrogen dioxide (NO₂) in our air is supposed to be very small: just 40 micrograms per cubic meter, which is about 0.000003%. However, NO₂ levels in cities are often way above the legal limit.

There are lots of different ways of measuring this type of pollution, such as special tubes or digital sensors. However, there is another, natural way of finding clues about nitrogen dioxide levels: looking for lichen.

➤ **Fieldwork: looking for lichen** 35 minutes

Have any of your pupils heard of lichens? They are a type of organism that can be found on trees. Lichen is made up of fungus and algae living in



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close partnership - a relationship that scientists call symbiosis. Lichens can tell us a lot about the environments they live in. Certain types of lichen are easily harmed by pollution, some thrive in a polluted environment, and some are happiest in the middle. By identifying and mapping different species we can find out about local pollution.

Tell your class that they will be going out into the school grounds to search trees and twigs for lichens that will give us clues about pollution. Opal Explore Nature have an excellent lichen guide for your fieldwork here: www.tinyurl.com/LichenAir. Using the booklet, lichen guide, tree guide and a tape measure, your pupils can explore the school ground and record examples of lichens they find on different types of trees and twigs.

➤ Close: lichen mapping 10 mins

Once your class have found and recorded four examples of lichen on trees and four examples of lichen on twigs, head back into the classroom. Enter the results onto the Opal Explore Nature website www.tinyurl.com/LichenResults.

Once you have entered your results you will be able to explore the results of other communities and compare pollution levels locally and at sites across the UK. If you wish, you can encourage your pupils to carry out this survey at home with their families as homework. This works well in conjunction with the Air Quality Wipe Test in the next column.



Experiment option three Air quality wipes

Time required: 20 minutes

Time until results: two weeks

Cost: around £5

This experiment works well as an Air Quality Champions activity, classroom stretch activity or as homework, giving visual evidence of “dirty” air quality areas. You’ll need to laminate copies of *Worksheet 2.3: air quality signs* and cut out the central “window” after lamination. You’ll also need to provide wet wipes and sandwich bags.

Ask your pupils to stick the laminated copies of *Worksheet 2.3: air quality signs* on four external windows. Encourage your pupils to choose a variety of places: at home, at the bus stop, at schools or at a tube station. The test sheet must be left in place for two weeks.

After two weeks, clean the inside of the “window” with a wet wipe in an up and down direction. Record the location and start/end dates of the experiment, then place the wipe in a labelled sandwich bag.

Once all the sites have been “cleaned”, your pupils should make a visual display of the wipes. See the data analysis section in part three for guidance and worksheets.

Teachers notes 2.1: using NO₂ diffusion tubes

What is an air quality tube?

NO₂ diffusion tubes are used to measure the how much nitrogen dioxide is in the air. The tube has a steel mesh inside, which is coated with a chemical and hidden under the grey or coloured (not white) cap. When air passes over this mesh nitrogen dioxide reacts with this chemical. Scientists can analyse the amount of chemical change and tell us the average concentration of nitrogen dioxide in the air. NO₂ diffusion tubes have $\pm 15\%$ accuracy, so their results are considered to be indicative rather than conclusive.

Why should you use NO₂ diffusion tubes?

The measurements are suitable for citizen science as they can indicate where pollution is highest, and where further study is needed. You could carry measurements out to:

- Compare routes to school and recommend quieter/less polluted routes
- Demonstrate where traffic calming or anti-idling measures are needed
- Examine the potential need for structural interventions, such as moving the school entrance, or placing green barriers around the playground
- Compare pollution levels between term time and holiday time

How to use an air quality tube

By following these guidelines you will create a data set that can not only engage your local community, but, if you send LSx the data, can also contribute to our London-wide data set. This allows us to make wider comparisons between schools and push for policy change at a local and GLA level.

Deployment guidance

1. Choose a site

- Minimise the risk of the tubes going missing by using locations that you know (i.e. your house or your neighbours' wall) or by placing them up to two meters high.
- Place your tubes in locations with good air flow: do not choose a doorway or hole in a wall because air will not be flowing freely enough. Make sure the site is not covered by trees, bushes or other plants.
- Consider what you are trying to demonstrate first so you collect the right evidence.
- Ensure you collect comparative measurements (i.e. one tube on a quiet road, one on a busy street).
- Consider pollutant sources, for example make sure you place them on the roadside of the pavement not by the shops.
- Consider where people are affected by pollution, and focus data collection in those areas.
- Safety should be an important consideration when siting tubes at height or near to roads.

Recommended locations to include in your experiment:

- At the entrance to the school
- At the school gate
- In the school playground
- At the nearest crossing to the school
- At a bus stop or train station children use to get to school
- On the most commonly used side streets (ask children which roads they commonly use)

- At traffic lights where children will stand waiting by busy roads
- In a local park the children pass on their way to school

2. Deploy the tubes

- Add a barcode label to the tube (not the grip)
- Add the corresponding label onto the monitoring sheet
- Add information to the monitoring sheet about location, start time and any other useful local information (e.g. close to building works).
- The location should be recorded carefully to make the maps accurate. The location you record should be unmistakable, such as “corner of Long Lane and Tabard Street”, “bus stop Q on Battersea Bridge”, “64 Long Lane” or “Exit 1, Borough Tube Station”.
- Remove the white cap and put it into your sampling bag. Don’t lose the white cap: keep it safe! You need to replace it at the end of experiment.
- Fix the tube to the wall: insert the tube into black plastic wall mounts, peel off the red patch and stick to the wall surface. If needed, you can use additional string or ties.

Other useful information your class could record:

- Distance to nearest main road
- Percent of perimeter bounded by roads
- Percent of perimeter bounded by green space
- Nature of surrounding roads
- Extent of idling problem around the school perimeter
- Traffic flow around the school perimeter

3. Collect the tube after two weeks

- Put the white cap back on the tube and place it back into the bag.
- Record the date and time that the cap is replaced.
- Record details of tube condition (Dirt? Insects? Dislodged?).
- Has anything changed in the area?

4. Send tubes to laboratory for analysis

- It typically takes 10 working days for results to be returned.

Other experiments

Your air quality tube measurements should be backed up with other experiments or surveys. You can add in the lichen or wipe experiments from part two, or include the traffic and idling surveys on *Worksheet 2.4* and *2.5*. These additional observations help to understand readings, and provide a stronger evidence base for intervention.

These experiments could be an Air Quality Champions activity, classroom stretch activity or set as homework.

Worksheet 2.1: fair experiment checklist

Anyone can design an experiment, but designing a good one is tricky. You should have a clear idea of what you want to find out, what you think you'll find and a good plan of action. When scientists design experiments, they have to make sure that they are fair. For an experiment to be fair, you should only change one thing at a time. This is called the independent variable. When you have decided on your independent variable, you must think carefully about how to control for other variables.

➤ Experiment details:

(overview of the experiment, where it will be and how long it will run for)

➤ Hypothesis:

(what you think will happen)

➤ Method:

(what you will do)

➤ Independent variable:

(what you will change)

➤ Controlled variables:

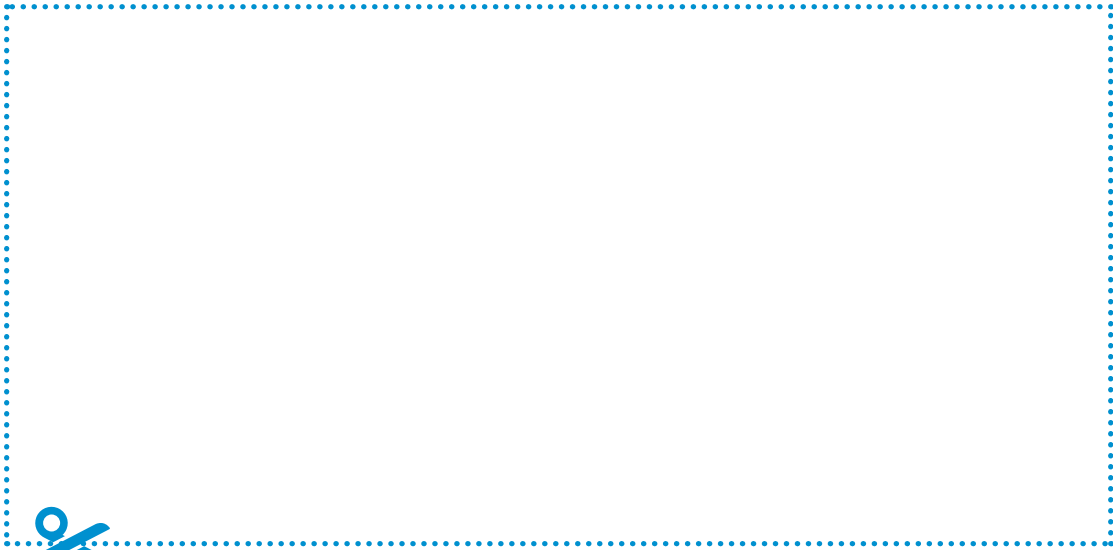
(what needs to stay the same)

Worksheet 2.2: air quality tube record

Date and Time	Tube Code	Location Data	Site Information and Other Notes

Worksheet 2.3: air quality signs

This bit of window is used for testing air quality.

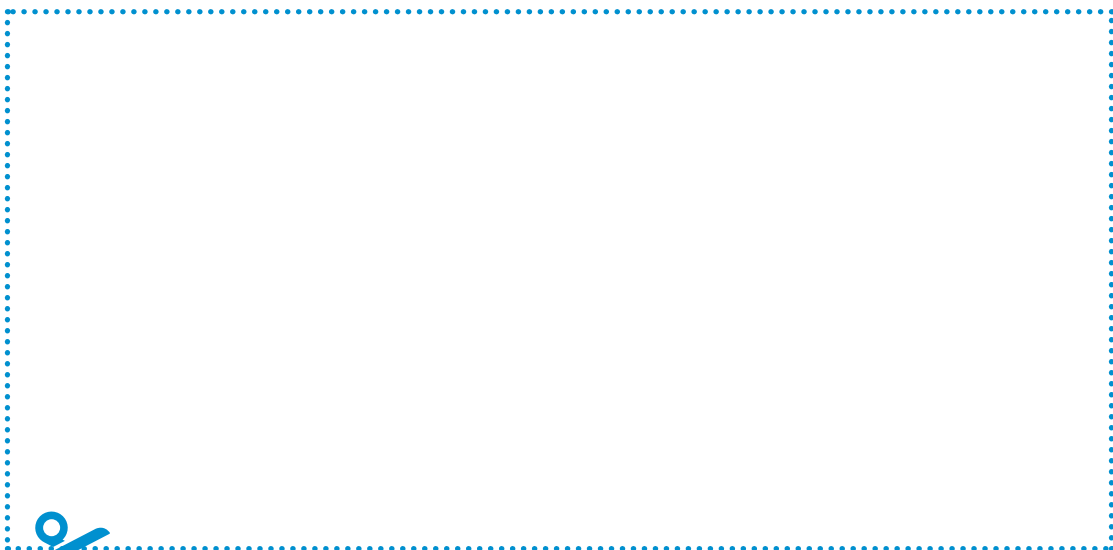


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Worksheet 2.4: idling survey

Is car idling contributing to air pollution around your school? Engine Idling is when car engines are left running for over one minute while not moving. Idling contributes to local pollution. You can monitor idling by counting the number of vehicles outside your school that are idling. Parents dropping off or picking up or children at the start or end of school could be once source of engine idling. You will be counting cars in two 15 minute blocks.

1. In a group of three, choose who you will be:
 - a. Observer: looks for parents' cars that are idling and not idling and tells the Timer.
 - b. Timer: uses a stop watch to time if cars have been idling for at least one minute.
 - c. Recorder: puts one dash in the column 'Number of cars idling' every time the Observer and the Timer find an idling car, and one dash in the column 'Number of cars not idling' every time the Observer spots a parked car that is not idling.
2. At the end of 15 minutes, the Timer tells the Observer to stop counting and the Recorder writes the finish time in the column 'End Time' (e.g. 8:45 am). Add up the number of cars idling and not idling and record this in the 'total' column.
3. After a 1 minute break, you can swap jobs. Repeat steps 1-6 and record your findings in the second row.
4. When you finish counting cars for the second time, add up all the cars idling and put this number in the 'total' column on the bottom row. Add up all the cars not idling and put this number in the 'total' column on the bottom row.
5. Steps 1-4 can be repeated again in the afternoon.



Idling Survey Record Form

School: _____ Date: _____ Location: _____

Supervisor: _____ Observer: _____ Timer: _____ Recorder: _____

Start time	End time	Number of cars idling	Total	Number of cars not idling	Total
Total number of		Cars idling		Cars not idling	

Worksheet 2.5: traffic survey

Time: _____ Date: _____ Location: _____

School: _____ Year and class: _____

Transport type	Tally of transport seen	Total
Car		
Bus		
Lorry		
Van		
Motorbike or scooter		
Bicycle		
Walking		



Cleaner Air 4 Schools

KS2 Science and Geography

Part three: analyse

In part three of the Cleaner Air 4 Schools toolkit, your pupils will take all the information they've gathered in from the experiments in part two and analyse the results. They will see examples of data journalism and infographics to inspire them to present their results in an attractive, easy to understand manner. Your class will discuss the results and think about their hypotheses from part two: are the results as they expected?

Finally, your class will start to think about planning a course of action based around their results. They will think about how to make a positive change in their local air quality, thinking in terms of both the big picture and small steps they can personally take. Your pupils will think about who they need to engage in order to make this change happen and what are the best ways of reaching those people.

Before you start

Make sure you have the results of each experiment that you chose to complete. If you did experiment one (air pollution tubes) the laboratory will send your results back you in a spreadsheet format approximately two weeks after you send the tubes off. If you did experiment two (lichen mapping) your class will have taken detailed notes and then filled in the online survey. In this lesson you will collate the notes and compare the online results to other areas. Finally, if you did experiment three (the wipe test) your students should bring the logged, labelled and packaged up wipes to the classroom for this lesson.

Curriculum links

- Science: planning scientific enquiries of different types to answer questions
- Science: recognise when and how to set up comparative and fair tests and explain which variables need to be controlled and why
- Science: taking measurements using a range of scientific equipment
- Geography: use fieldwork and observational skills to study the key human and physical features of their school, home and local environment

Materials requirement

- printed copies of the worksheets and guides named in each experiment
- pens or pencils
- whiteboard and marker
- A4 printed maps of the area
- one larger (at least A3) map of the area for a display version of the results.

Time requirement

One session of 50 minutes, plus an extra thirty minutes per additional experiment completed. Alternatively, you can choose to split your class into groups focussing on different experiments, condensing the time required into one hour.



Cleaner Air 4 Schools

KS2 Science and Geography

Lesson three

➤ Opener: information is beautiful 10 minutes

As the class comes in, display examples of infographics on your screen or interactive whiteboard. You may wish to display the Information is Beautiful website or any book by David McCandless (your school library may already have a copy).

Explain that infographics, made by people called data journalists, are creative ways to look at information like the data you have generated as part of your experiments. Do your class think it makes the data sets simpler to understand or do they think the graphics confuse things?

➤ Group activity: data analysis 30 minutes

Tell your class that one of the most important parts of an experiment is analysing the results and communicating your findings. Today, your class will become data journalists and create a number of reports that show the results of the last air quality lesson.

The approach your class takes for analysing and displaying your results will depend on which experiment(s) your class chose to do in part two. You may choose to display each data set in a number of ways. Our recommendations for each experiment are listed below, but your class can interpret their data as they wish! You may want to use the same method across the whole class, or you could split the class into groups with different outputs, for example with one group taking charge of making a map, one group creating a series of bar charts and one group making a display of the air quality wipe results.



Experiment option one NO₂ diffusion tubes

If you chose to complete the air quality tube experiment, the laboratory will have sent your results back to you in a spreadsheet. Ask your class to think back to the experiment locations. What do they think they're going to see?

Hand out *Worksheet 3.1: mapping air quality* and talk your class through this example map. Hand out maps of the experiment area along with the spreadsheet of results. You can photocopy a map with pre-drawn circles where the tubes were located, or, as an extra activity, ask the class to draw their own circles based on the geographic information on the log sheet. Ask your pupils to colour in the circles according to the colour bar on *Worksheet 3.1: mapping air quality*.

Ask your class to think about the results:

- Do the results vary across different locations?
- Can they identify any patterns?
- Are they surprised by any of these results?

Now the basic results are mapped, ask your class what else they can add to display their findings in the best way. They should think about how to display the data in a clear way and what kind of information about the experiment or the local area would be useful. Tell your class that the results are a snapshot of a 2-4 week period, and that the accuracy of the tubes ($\pm 15\%$) mean that the results can only be considered indicative rather than inclusive.

Your pupils should make sure they label both the data and the map itself with relevant information such as the date, location, key for any symbols used, notes on what the experiment measured and who did the experiment.



Cleaner Air 4 Schools

KS2 Science and Geography

The air quality tube results should be backed up with evidence from other experiments or surveys. How does adding in results from the lichen or wipe experiments help you understand the levels of air pollution in your local area?



Experiment option two Lichen mapping

At the end of the last lesson, your class should have entered the results that they found on the Opal Explore Nature website www.tinyurl.com/LichenResults.

After entering their results your class will be able to explore the results of other communities and compare pollution levels locally and at sites across the UK. If you asked your pupils to carry out this survey at home with their families, now would be a good time to discuss the results.

Lichen mapping completed across a community - school, park, high street, homes - can be a very interesting visual guide to air quality hotspots. If your class have done the air quality tube experiment as well, a larger display map that combines both experiments could be a powerful and interesting display for your school. Use the maps to spark a discussion on the local pollution hotspots.



Experiment option three Air quality wipes

If your class did this experiment, ask your students to present the results of their wipe tests in a visual format, using *Worksheet 3.2: air quality wipe results* as a guide. Ask the pupils who did

each wipe test to feed back to the rest of your class. Do the results from the wipes match their expectations or the results from the other experiments?



Close: what now? 10 minutes

Once your class have finished analysing their data, making their maps and discussing the results, move the conversation towards communication and action. Write the following starter questions on the whiteboard, and ask your pupils to brainstorm responses to each:

- What can we do?
- Who should we tell?
- What should our school do *next*?

Prompt them to think about bigger societal or futuristic changes for the first question (electric vehicles, banning idling). For the second question, they should think about people in positions of power and the wider community. For the final question, ask your class to come up with achievable suggestions, including behaviour change goals (car sharing, walking to school) and campaigning actions (writing an article for the local paper or hosting a pollution booth at the school's summer fair).

As homework, ask your pupils to be extra observant and make notes of a message that catches their eye over the next few days. That could mean cutting out an article in a magazine or newspaper that they liked, taking a picture of a bus stop advert that was visually appealing, copying a bit of graffiti with an interesting message or describing a poster for an event that they wanted to go to. Ask them to bring one or two examples into your next air quality lesson, and be prepared to talk about why they chose it and what it is about the message that makes it effective.

Worksheet 3.1: mapping air quality

This map was produced by Notre Dame RC Secondary Girls' School, an all-girls' Roman Catholic comprehensive school situated in Elephant and Castle. They have displayed the results of their air quality tube experiment in a very clever way. Firstly, they show the location of all their tubes on the map using circles. Secondly, they colour in those circles with a visual representation of the results, showing the key to the colours they use on the right hand side. Thirdly, they add context to the results by including pictures of four sites with diverse results. Finally, they include a title that lets us know what the map is telling us and when the results were collected.



1. Does this map tell you everything you want to know? How would you improve it?

2. Who do you think this kind of map would be useful for? How would they use it?

3. Using this map as an example, create your own map using the results of your experiments.

Worksheet 3.2: air quality wipe results





Cleaner Air 4 Schools

KS2 Science and Geography

Part four: take action

In part four of the Cleaner Air 4 Schools toolkit, your class will think about communication, campaigning and encouraging behaviour change in their own lives and in the community.

Your class will start this session by learning about an example of a successful citizen campaign about poor air quality that led to action being taken by city authorities.

Using the article, advert, poster or image they found for homework, your pupils will then think about the styles in which messages are communicated. They will analyse their chosen message for content, style and their emotional reactions.

Next, your class will use this learning to think about how to spread the message about the importance of good air quality. They will assess a number of suggestions and select class, group or individual projects to take forward.

We have provided an additional activity that can be done as a class or assigned to a group of Air Quality Champions as a stretch activity. This final activity builds on the previous learning and asks pupils to analyse their routes to school, then map cleaner walking routes as alternatives.

Tell your story

London Sustainability Exchange would love to know how your project went.

A case study template is provided in the appendices.

Email it over to info@lsx.org.uk or tweet [@LSx_News](https://twitter.com/LSx_News)

Curriculum links

- Science: reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations
- Science: showing results in oral and written forms such as displays and other presentations
- Geography: use fieldwork and observational skills to study the key human and physical features of their school, home and local environment using maps and plans
- English: (comprehension) discuss and evaluate how writers use language
- English: (composition) identify an audience for and purpose of the writing

Materials requirement

- printed copies of the worksheets
- newspapers or magazines
- computer with internet access
- pens or pencils
- scissors
- whiteboard and marker

Time requirement

This lesson takes 50 minutes, but you may wish to extend the activities started in it over another lesson. You could also continue the activity as part of an Air Quality Champions club or at a school event such as a summer fete or a presentation at a PTA meeting.

A fact sheet about air quality and some communication suggestions are provided in the appendices. These can be adapted and sent to parents, uploaded on the school site or used as a jumping-off point for lesson four.



Cleaner Air 4 Schools

KS2 Science and Geography

Lesson four

Opener: taking action 5 minutes

Show a short video or display images of Brazilian artist Alexandre Orion's work (available on www.alexandreorion.com under the project Ossario). He chose to protest his city's pollution levels using reverse graffiti: cleaning patterns in the residue the pollution left on the walls.

When the police came to investigate they listened to his arguments and ended up protecting the artist from traffic as he worked. The art sparked a big conversation about air quality and pollution, and as a result the city council cleaned up every tunnel in the city.

Do your class think that this was an effective way for the artist to get his message across?

Group activity: communicating with style 15 minutes

The homework assignment from the last lesson asked your pupils to make note of a message that caught their eye: an article in a magazine, a bus stop advert, graffiti or an event poster. You can also provide newspaper clippings, magazine adverts or images from the internet.

Hand out *Worksheet 4.1: communicating with style*. Tell your class that professionals like copywriters and designers spend a long time thinking about how they are going to get their message across using words, images or video. They often use specific ways of saying things to get into our minds and get a reaction.

Ask your class to get into groups and, using the worksheet as guidance, analyse the reasons each pupil chose the examples they did. They should carefully consider what makes that message effective or interesting.

Group activity: taking action 20 minutes

Ask your class to think back to the beginning of the lesson. Using the insight they've just gained on creating interesting messages, do they think they can positively impact their area as much as Alexandre Orion did?

What's their message? Explain how maintaining a healthy diet and exercising helps build physical resilience which makes you stronger against the effects of air pollution.

Hand out *Worksheet 4.2: taking action*. These are just some examples of actions they could take as a class, as groups or as individuals. Ask each group to cut up the worksheet and choose two actions: the one they would find the most fun and the one they think would make the most difference.

Ask them to also come up with one new suggestion. Remind them to think about their message, do they want to tell people to avoid pollution, drive less and walk more, maintain a healthy diet or something else?

After they have done this, ask each group to feed back to the class, then vote on the top three ideas to take forward.

Close: what next? 10 minutes

Your class have learned about air quality, carried out series of experiments, analysed the data and thought about what to do about it. The next steps are up to them.

Aside from the actions in *Worksheet 4.2: taking action*, you can also complete a routes to school activity. *Worksheet 4.3: living streets* provides a simple framework for analysing the local area. This can be used in conjunction with *Work-*

Worksheet 4.1: communicating with style

First impression

Why did you choose this message?

Image analysis

What kind of visuals does it have? What colours is it using?

Text analysis

What kind of words does it use? Positive, negative, persuasive, bossy or something else?

Emotional response

How does this message make you feel?

Effectiveness

Does this message do what it sets out to do? What could it do differently?

WRITE TO YOUR MP

Write to your MP with your evidence. Attach your report and tell them what action you want them to take.

CLEANER WALKING ROUTES

Carry out a 'healthy street check', then design a cleaner walking route map. Worksheets three and four will help you to take this action.

HOLD AN ASSEMBLY

Present your findings to the rest of the school at an assembly and ask for help and advice about making changes.

ADVERTISING CAMPAIGN

Plan, create and run an advertising campaign in your school, at the school gates, or in your local community. Make posters using persuasive writing.

SUMMER FAIR

Take your findings public and host a stall at your summer fair to spread the word about air quality.

REMIX THE BBC

Use Mozilla X-Ray Goggles to write your own news articles about air quality with photos of your local area. Make a screen grab and share it on social media.

GET PUBLISHED

Contact your local newspaper and local bloggers and send them a summary of your findings. Ask them to write a feature about your work!

WALKING BUS

Start a walking bus: where children and volunteers walk in a group, picking up or dropping off 'passengers' at specific 'bus stops' on their school route.

BIKE TO SCHOOL

Take part in the Sustrans Bike to School Week and encourage a healthy school run for all the family!

PTA PRESENTATION

Ask your Parent Teacher Association if you can give them a short presentation at their next meeting - can they help in your quest to improve air quality?

MAKE A SONG & DANCE

Raise awareness of air pollution by creating a song or dance which can be performed at a school assembly or uploaded to YouTube.

REVERSE GRAFFITI

Get permission to reverse graffiti a message about air quality. You can do this using a sturdy stencil, a wire brush and some eco-friendly detergent.



Worksheet 4.3: healthy streets

Think about your route to school. Mark it between 1 (very bad) and 5 (very good) for each of the five sections on the Healthy Streets wheel below.



Healthy Streets wheel by Lucy Saunders

What is the best thing about your route?

What is the worst thing about your route?

Worksheet 4.4: cleaner walking routes

Walking on a back street away from the main traffic route can reduce the pollution you breathe by up to 50%. Can you find a cleaner way to walk?



This map was created by a group of Air Quality Champions at a school in East London. Make your own cleaner walking routes map by filling out *Worksheet 4.3: healthy streets* for two different routes to school. Once you've scored each section of the Healthy Streets Wheel, add up the total score for each of your routes. Which is the best overall?

Think about each route: are there especially interesting places on your route? Are there places where the road is more dangerous?

How do your routes compare with each other? As a class, compare routes and make a final map together. Is anyone inspired to travel to school using a different route?

Communicating your message

The school has an important role in communicating the project. Newsletters, emails, twitter and blog posts are useful ways of getting the message out. Pupils can also get involved by helping to design and write these.

The most important messages to get across are:

1. Avoid pollution

- Go out earlier in the day when pollution levels are lower
- Consider wearing a pollution mask that filters out PM10, especially if you are a cyclist. Make sure it fits snugly so it works effectively.
- Avoid main roads and pollution sources; where you can and if safe to do so, walk through parks, on side and backstreets to reduce your exposure to air pollution.
- Try to use less busy bus stops and stand back from the road to avoid fumes.
- If you have asthma, COPD or another respiratory or cardiac disease, keep your reliever inhaler or angina spray with you at all times so you can quickly deal with symptoms if you get them.
- Check the air pollution reports before you go out. We recommend consulting <http://www.londonair.org.uk/LondonAir/> for current pollution levels and weather forecasts.

You can use this information to create your own project description:

About Cleaner Air 4 Schools

Cleaner Air 4 Schools is a fun and educational programme designed to teach students and parents about air pollution and to find ways to tackle the challenge. Our goal for this project is to educate the community in an interactive way. Working with Key Stage 2 students, alongside their parents and teachers, LSx is holding a series of activities, including citizen science experiments and making posters, to gain community support on health and the environment.

Parents/guardians are invited to attend any of the meetings or assemblies as a spectator or you can come for just a one-off session to have your say. Or, you can become an Air Quality Champion and get involved in the whole programme!

Cleaner Air 4 Schools was created by London Sustainability Exchange (LSx), a sustainability charity that works to improve Londoners' know-how, influence lifestyles and contribute to environmental policy and practice.

2. Maintain a healthy diet to boost physical resilience

Eating a well-balanced diet can help to reduce the risk of pollution related diseases such as diabetes, heart disease, stroke and cancer, as well as help you maintain a healthy weight. The National Eatwell Guideline suggests your daily diet should be made up of:

- 1/3 starchy foods, such as potatoes, bread, rice and pasta
- At least 10 portions of fruit and vegetables
- 1 portion of dairy and alternatives, such as milk or soya milk, cheese, and yogurt
- 1 portion of non-dairy protein, such as chick-peas, tuna, eggs, beans, and lentils
- A small amount (1% of your diet) of oils and spreads, such as butter.

3. Exercise to boost physical resilience

Aim to get at least 150 minutes of moderate exercise a week, by cycling or walking for example. Doing so reduces the risk of heart disease, stroke, diabetes, cancers, dementia and depression.

If you choose to exercise outside it is important to do so in relatively unpolluted areas, such as in parks, or on side and backstreets. Also try to exercise earlier in the day when pollution levels are lower to reduce risks of exposure.

How to write a case study

Tell us your story! You can share your project using the template below to help you write case study.

- **Project name:**
(e.g. name of community group/school group)
- **Background:**
(overview of project - how was it established, where it will be and how long it will run for)
- **Aim**
(what did you achieve at the end of this project and what do you still hope to achieve)
- **Outline of project:**
(further details of project, e.g. what did you do, step by step)
- **Hedline results:**
(what were the main lessons you learnt)
- **Findings**
(what did the results show)
- **Barriers Faced**
(what challenges did you face during the project)
- **Key Successes**
(what were the project's achievements, e.g reaching out and creating awareness in local community)
- **Summary**
(brief overview, what have you learnt, what would you change etc)
- **Next Steps**
(how will you use the information you learnt from the project & communicate your message)

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- all the teachers and pupils from the participating schools in each country Townsend Primary School (London), Milimani Primary School (Nairobi Kenya), Maharaja Agarsain Public School (New Delhi, India)
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- all the staff and volunteers who contributed their ideas and energy on this project
- Helen Steer of Do It Kits for all her hard work, research and creativity in bringing all this together.

About London Sustainability Exchange

LSx (www.lsx.org.uk) is a “think and do” charity which creates collaborations that address the complex barriers to a sustainable London. Our projects provide action-based community development and research to develop and share the lessons from our work across London, and most importantly, influence London’s policies for a sustainable future. LSx aims to:

- reduce London’s environmental footprint
- improve the lives of London’s disadvantaged communities
- improve the health of Londoners
- improve the knowledge and skills of our communities to achieve these goals

About Do It Kits

Do It Kits are a simple, engaging way to teach with new technologies in your Science, Geography, Computing, Design & Technology and STEAM classrooms. Do It Kits contributed to the content and the design of the Toolkit and provided links to the National Curriculum.



London Sustainability Exchange

About the FIA Foundation

The Foundation is a UK charity with an international reputation for innovative global road safety philanthropy; practical environmental research and interventions to improve air quality and tackle climate change; and high impact strategic advocacy in the areas of road traffic injury prevention and motor vehicle fuel efficiency.

The Foundation has established the Global Initiative for Child Health and Mobility to support implementation of the Sustainable Development Goals and the Habitat III New Urban Agenda, with a focus on the rights of children. The initiative brings together international partners for the objective of ensuring a safe and healthy journey to school for all children by 2030 through promotion of 'safe system' transportation design and urban planning; promoting safe footpaths, cycling lanes and lower vehicle speed limits; legislation and interventions for motorcycle helmet and seat belt use and safe and affordable public transport; and supporting policy and technical interventions to bring urban air quality within World Health Organisation levels.

