

## Indoor Air Quality in Schools – a practical guide

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### Introduction

We spend almost all our lives indoors, with most people being indoors about 90% of the time. Unlike outdoor air, indoor air is continuously recycled, trapping and building the pollutants. Even if we keep indoor surfaces clean, air pollutants may still be present in large quantities.

This brief will outline the importance of good indoor air; lessons learned from the COVID-19 pandemic, and outline our recommendations for tackling this issue, as we move into the autumn/winter season.

### Why is indoor air quality so important?

#### Indoor air quality and disease transmission

The COVID-19 pandemic brought home the importance of IAQ and underlined the role buildings and transport play in the transmission of disease. Transmission has been observed more widely in poorly ventilated or crowded indoor settings.

## Wider health issues

Indoor air pollution can cause a number of health issues, some of which can be severe. More mild health impacts include irritation to the eyes and respiratory systems, but prolonged exposure to poor air quality can result in developing chronic cardiovascular and respiratory diseases.

Research also shows links between indoor pollution and children's respiratory health and evidence of links to other conditions, which included eczema, dermatitis, greater hyperactivity, skin and eye irritations and difficulty sleeping.

## Indoor air quality and cognitive function

The build-up of carbon dioxide and other indoor air pollutants affects concentration. Children may be affected more by higher CO<sub>2</sub> concentrations than an adult, due to their smaller body size.

Declines in cognitive function scores may be found when CO<sub>2</sub> concentrations are elevated at levels commonly found in indoor spaces.

## Common indoor air pollutants

Poorly ventilated spaces not only increase the risk of disease transmission, but also risk the build-up of harmful pollutants. It's important that we acknowledge these pollutants we discuss the use of CO<sub>2</sub> monitors as a proxy indicator for other *un*-clean air.

**Carbon dioxide (CO<sub>2</sub>):** sources include exhaled air, inadequate ventilation, combustion processes. Health effects include dizziness, headache, fatigue, and confusion.

**Carbon monoxide (CO):** sources include faulty, incorrectly installed, poorly maintained or poorly ventilated cooking or heating appliances which use fossil fuels. Low levels of exposure can cause headaches, dizziness, disorientation, nausea and fatigue.

**Particulate matter:** this is made up of tiny particles and liquid droplets that can include chemicals, metals, dust and mould spores. Health effects include respiratory symptoms, skin and eye irritations, asthma, Cardiovascular Obstructive Pulmonary Disorder (COPD).

**VOC's:** Volatile organic compounds sources include solvents, glues, cleaning agents, pesticides, paints, air fresheners, printers and copiers, and some building materials. Short-term exposure to volatile organic compounds can cause eye and respiratory tract irritation, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reactions, nausea, and memory impairment.

## Tackling the issue

Take a holistic approach starting with reviewing the building as a whole.

*How does the building smell?* Smelling stuffy room air is a sign that carbon dioxide concentration is high, and the ventilation is poor.

Consider areas where pollutants are produced in significant quantities – can they be extracted before they spread through the rest of the building? Examples could be kitchen and bathroom areas, or design and technology areas. Consider any occasional activities, which might generate extra pollutants - for example fumes from painting or building maintenance works.

## Practical controls

### Ventilation

Ventilation can be 'natural' (opening windows) or mechanical (using systems of ducts and fans to provide air to the building, usually 'plumbed in' to the building) or a combination of the two, for example an extract fan such as in a bathroom to remove 'waste' air with fresh air coming from openings in the building. (Most schools rely on this method).

### Filtration

If you cannot get enough outside air in, or the outside air is not good/clean, the air can be run through a HEPA filter. There is an online calculator available (see link under additional resources) to tell you how much clean air is needed, based on the size of the space and the number of occupants (based recommendations from Unison and HSE). We appreciate that there are cost and resource implications to using filters – the message is if you can consider filtration then do, and if it is not possible to meet the recommended HEPA filtration, any filtration is better than none.

### Using CO<sub>2</sub> Monitors

CO<sub>2</sub> measurements should be used as a broad guide/proxy measure for the quality of air within a space, rather than treating them as 'safe thresholds' as CO<sub>2</sub> monitors do not specifically measure levels of other pollutants. However, they do help check there is enough fresh air getting into the room (providing the room is occupied, as you need people breathing to generate the CO<sub>2</sub> being measured). If the monitor shows consistently high levels, indicating stale air accumulation, then look at other measures to bring it down.

## Balancing the need for good indoor air quality with thermal comfort

This is a complex challenge with potential trade off requirements, however, there are things that can be done to make the most of ventilation for comfort and infection risk.

- Bear in mind that in winter when it's cold and windy it is easier to ventilate as you can get away with smaller openings or opening occasionally (bigger temperature differences between indoors and outdoors creates more airflow).
- Open windows and doors at key times (i.e. after certain activities, between classes, or for 10 minutes a few times a day). Be strategic, i.e. if near a busy road, don't open at busy times.
- Opening high up windows can help reduce cold draughts. If any windows are painted shut, get them unstuck.
- Ensure existing ventilation such as vents fans, ducts, air bricks etc. are maintained, cleaned and unblocked.
- Ensure existing ventilation systems are maintained and everyone knows how to use them - keep instructions displayed.
- Keep everything under review, especially if the occupancy or use of the building changes in any way.

## Implementation

**Start** by measuring the air

Through a CO2 monitor, think about placement of monitors and any existing barriers you have to using them

Or,  
passive through *smell/feel* i.e. *does the room smell bad or feel stuffy?*

Where areas are identified as needing improved ventilation...

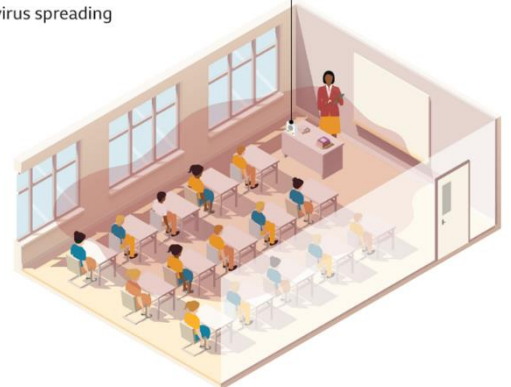
1. *Reduce the source of air pollution*
  - ✓ Consider areas where pollutants are produced in significant quantities
  - ✓ Consider any occasional activities, which might generate extra pollutants
  
2. *Improve ventilation*
  - ✓ Trickle Ventilation
    - Trickle vents on windows, small window opening, keeping doors ajar
  - ✓ Purge Ventilation
    - Opening windows and/or doors fully for a short period of time i.e. brief but sudden changeover of air

### Simple steps to improve classroom ventilation

Without ventilation, air is trapped in a classroom

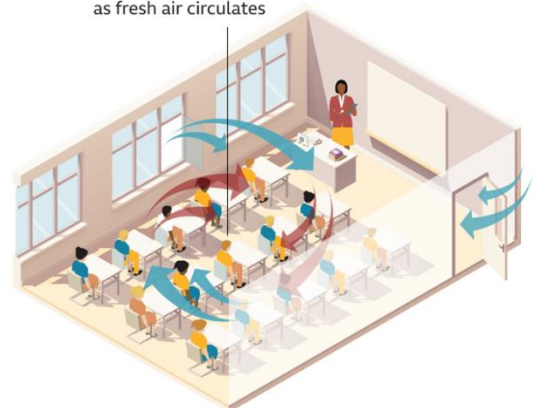
Build-up of CO2 can indicate need for better airflow to reduce risk of virus spreading

Teacher monitors CO2 levels



Opening a window and door allows better airflow

CO2 levels are reduced as fresh air circulates



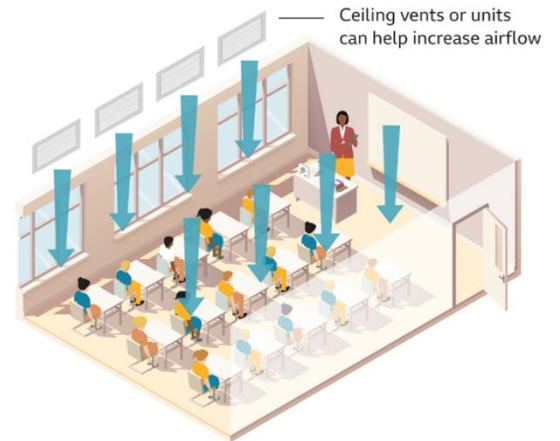
If it's cold outside, opening high windows lets fresh air in and prevents drafts

Cold air sinks and mixes with rising warmer air



Mechanical ventilation needs to be set to push fresh air into the room

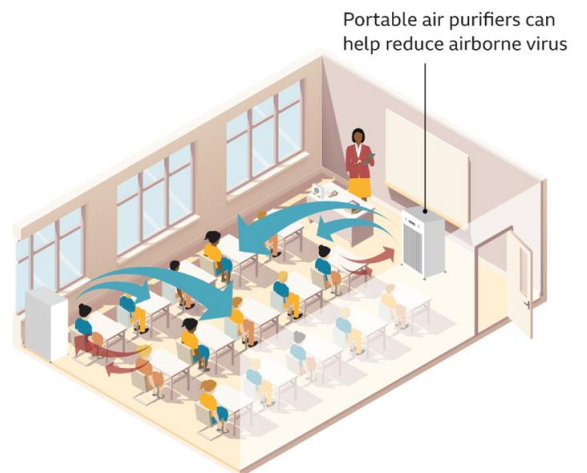
**IF** you have mechanical ventilation units **already** installed



*Following the steps outlined above and not seeing an improvement in CO2?*

Air filtration units help clean the air in the room

You may need to consider using alternative filtration options to improve the indoor air i.e. a HEPA filter. See further resources for information and support.



### Train your workforce in the use of CO2 monitors and IAQ improvement

This needs to be everyone's responsibility and the teaching staff within your school, plus other staff groups, should be taught how to use this information as part of their normal activities.

There are some useful training resources available at <https://www.coschools.org.uk/> and copied below for ease.

## CO2 level guidelines

CO <sub>2</sub> level	Description	Actions	Outcomes
<b>&gt; 1500 ppm.</b>	Indicative of inadequate ventilation.	Keep checking ventilation provision (e.g. windows and doors are open) and the CO <sub>2</sub> levels. If consistent, notify school leadership.	There are quite high levels of shared/rebreathed air in your classroom which, if maintained, might lead to poorer learning and health outcomes.
<b>800 ppm to 1500 ppm.</b>	Potential for stuffy/stale air and lethargic learners.	Open windows and/or doors – higher-level openings first and then lower-level openings.	Potential to improve ventilation in your classroom should be considered for better health and learning outcomes.
<b>&lt; 800 ppm.</b>	Indicative of good ventilation.	If CO <sub>2</sub> levels are not rising, and if the classroom is cold then you can consider slightly closing your window opening extents. Do so slowly and steadily.	Ventilation should be acting to help reduce the risk of airborne transmission but only as part of a fuller range of mitigation measures ( <a href="https://www.gov.uk/government/collections/guidance-for-schools-coronavirus-covid-19">https://www.gov.uk/government/collections/guidance-for-schools-coronavirus-covid-19</a> ).
<b>Close to, or just above, 400 ppm.</b>	Typical outdoor reading.	No actions required, but if your classroom is cold then the windows can be slightly closed.	Your classroom might be overventilated – this might not be of direct concern, but if your classroom is cold then you might be wasting energy and affect the learning experience.

Figure 1 Image taken from <https://www.coschools.org.uk/> March 2023

## Guidance on CO2 monitor display

You may find it helpful to print this image below to display alongside CO2 monitors in your setting.

### This environmental display monitor shows temperature and carbon dioxide (CO<sub>2</sub>)

- CO<sub>2</sub> helps indicate if a room is appropriately ventilated outdoors air
- You can increase the ventilation by opening the windows more widely
- Opening more windows and doors will increase the ventilation but might make the room uncomfortably cold
- Use this display monitor to help you to strike a balance

**Your CO<sub>2</sub> Levels are above 1,500 ppm.**


*Do NOT worry:* CO<sub>2</sub> is a proxy for ventilation and does not inherently indicate any risk.

*Do:* Provide additional ventilation by fully opening windows and, wherever appropriate, doors

The concentration of carbon dioxide (CO<sub>2</sub>) is 1202 ppm (parts per million)

Particularly during colder weather, ventilation needs to strike a balance between these two factors

The room temperature is 19.5°C




Air Quality CO<sub>2</sub> Monitor

**Your CO<sub>2</sub> Levels are above 800 ppm but below 1,500 ppm.**

Provide additional ventilation by increasing the opening of windows and, if appropriate, doors

**Your CO<sub>2</sub> Levels are below 800 ppm.**

Continue to provide the current ventilation, if the space is cold then consider partially closing some windows – make changes stage-by-stage



## Additional resources and information

**Please contact us with any questions, concerns or comments at**

**[dph@northyorks.gov.uk](mailto:dph@northyorks.gov.uk)**

- Royal College of Paediatrics and Child Health (Jan 2020) The inside story: Health effects of indoor air quality on children and young people  
[the-inside-story-report\\_january-2020.pdf \(rcpch.ac.uk\)](https://www.rcpch.ac.uk/resources/the-inside-story-report-january-2020.pdf)
- The PROTECT COVID-19 National Core Study on transmission and environment  
[PROTECT COVID-19 National Core Study | \(manchester.ac.uk\)](https://www.proTECT.ac.uk/)
- Building Bulletin 101: Ventilation, thermal comfort and indoor air quality 2018  
<https://www.gov.uk/government/publications/building-bulletin-101-ventilation-for-school-buildings>
- [Summary of CO2 monitors and air cleaning units survey findings and applications for DfE-funded air cleaning units \(publishing.service.gov.uk\)](https://www.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/644442/summary-co2-monitors-air-cleaning-units-survey-findings-applications.pdf)
- Clean air resources for schools  
<https://www.actionforcleanair.org.uk/schools>
- HEPA filter online calculator  
<https://cleanairstars.com/filters>
- GOV.UK guidance on Ventilation to reduce the spread of respiratory infections, including COVID-19 [Ventilation to reduce the spread of respiratory infections, including COVID-19 - GOV.UK \(www.gov.uk\)](https://www.gov.uk/guidance/ventilation-to-reduce-the-spread-of-respiratory-infections-including-covid-19)
- Health & Safety Executive (HSE) guidance on ventilation in the workplace  
[Ventilation in the workplace \(hse.gov.uk\)](https://www.hse.gov.uk/ventilation/)
- Harvard University research
- [Poor indoor air quality may dull cognitive abilities | News | Harvard T.H. Chan School of Public Health](https://www.harvard.edu/news/2020/05/poor-indoor-air-quality-may-dull-cognitive-abilities)
- Schools Week article 'School hopes fresh air will help clear exam minds'.  
[School plans to keep its windows open after CO2 levels soar \(schoolsweek.co.uk\)](https://www.schoolsweek.co.uk/news/school-plans-to-keep-its-windows-open-after-co2-levels-soar)
- The latest (sourced as of 28/Nov/2022) 'How to Use CO<sub>2</sub> monitors in education and childcare settings' guide from the Department for Education can be found here: [RP24.4 How to Use CO<sub>2</sub> monitors in education and childcare settings.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/111111/2022-11-28-how-to-use-co2-monitors-in-education-and-childcare-settings.pdf)
- Top tips to manage ventilation and use CO<sub>2</sub> monitors from the Department for Education can be found here: [RP206 Top Tips - managing ventilation.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/111111/2022-11-28-top-tips-managing-ventilation.pdf)
- [RP207 Top Tips - using CO<sub>2</sub> monitors in your setting.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/111111/2022-11-28-top-tips-using-co2-monitors-in-your-setting.pdf)
- A useful webinar on using CO<sub>2</sub> to help manage school ventilation can be found here: <https://www.youtube.com/watch?v=P5bPntB2hn0>
- Useful guidance on what to consider before deciding to use an air cleaning unit, and how to use them in your setting can be found here: [RP176.0 - Maroon - How to Use An Air Cleaning Unit.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/111111/2022-11-28-maroon-how-to-use-an-air-cleaning-unit.pdf)