



Indoor Air Quality in Schools Guide

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Introduction

As the nation continues to battle the COVID pandemic, institutions across the country, including schools, are working hard to ensure a safe reopening. According to the guidance issued by the Centers for Disease Control and Prevention (CDC), ensuring safe operations in schools requires maintaining healthy facilities - this includes adequate ventilation for good indoor air quality.ⁱ

Unfortunately, schools around the country have long been met with the challenge of balancing tight budgets and multiple priorities, which can lead to delayed maintenance of their facilities. A 2020 study from the U.S. Government Accountability Office shows 41 percent of schools need to update or replace their ventilation systems.ⁱⁱ

The goal of this Guide is to:

- Provide a useful overview of indoor air quality
- Share tools that schools can use to improve air quality
- Offer guidance for navigating CARES/CRSSA funding to improve air quality in schools





The Basics

What is Indoor Air Quality (IAQ)?

The air you breathe is filled with lots of things including gases and particles – most are too small to see with the naked eye. What you breathe in can travel to your lungs and may cause harm. Some of the particles are so small that they can reach deep into your lungs, cross into the bloodstream, and be carried throughout the rest of your body. That is why ensuring your indoor air is clean – free of harmful gases and particles – is important. This is called indoor air quality.

Children’s bodies and lungs are still developing — children breathe 2-3 times more often than adults.ⁱⁱⁱ Because of this, their lungs may be more at risk to environmental exposures than those of adults. It is estimated that pollutants are up to five times higher indoors than outdoors. This is important as children (and adults) spend up to 90% of their time indoors.^{iv}

Contaminants in the environment can negatively impact children’s development. Indoor air pollutants can cause long and short-term health problems such as: coughing, eye irritation, headaches, allergic reactions, worsened asthma and/or other respiratory illnesses, and in rare cases contribute to life-threatening conditions such as radon-induced lung cancer or carbon monoxide poisoning.

Schools should ideally serve as optimal learning environments for students, but poor air quality in a school’s building can actually have negative effects. High carbon dioxide levels and poor ventilation, which plague many buildings, can adversely affect concentration, cognitive ability and test scores. Furthermore, too high or low temperature and humidity can enable viral transmission which can be detrimental to the body’s immune system, causing drowsiness, increased risk of cold and flu. Poor air quality also affects teachers and staff, resulting in reduced focus, fatigue and increased sick leave.^v





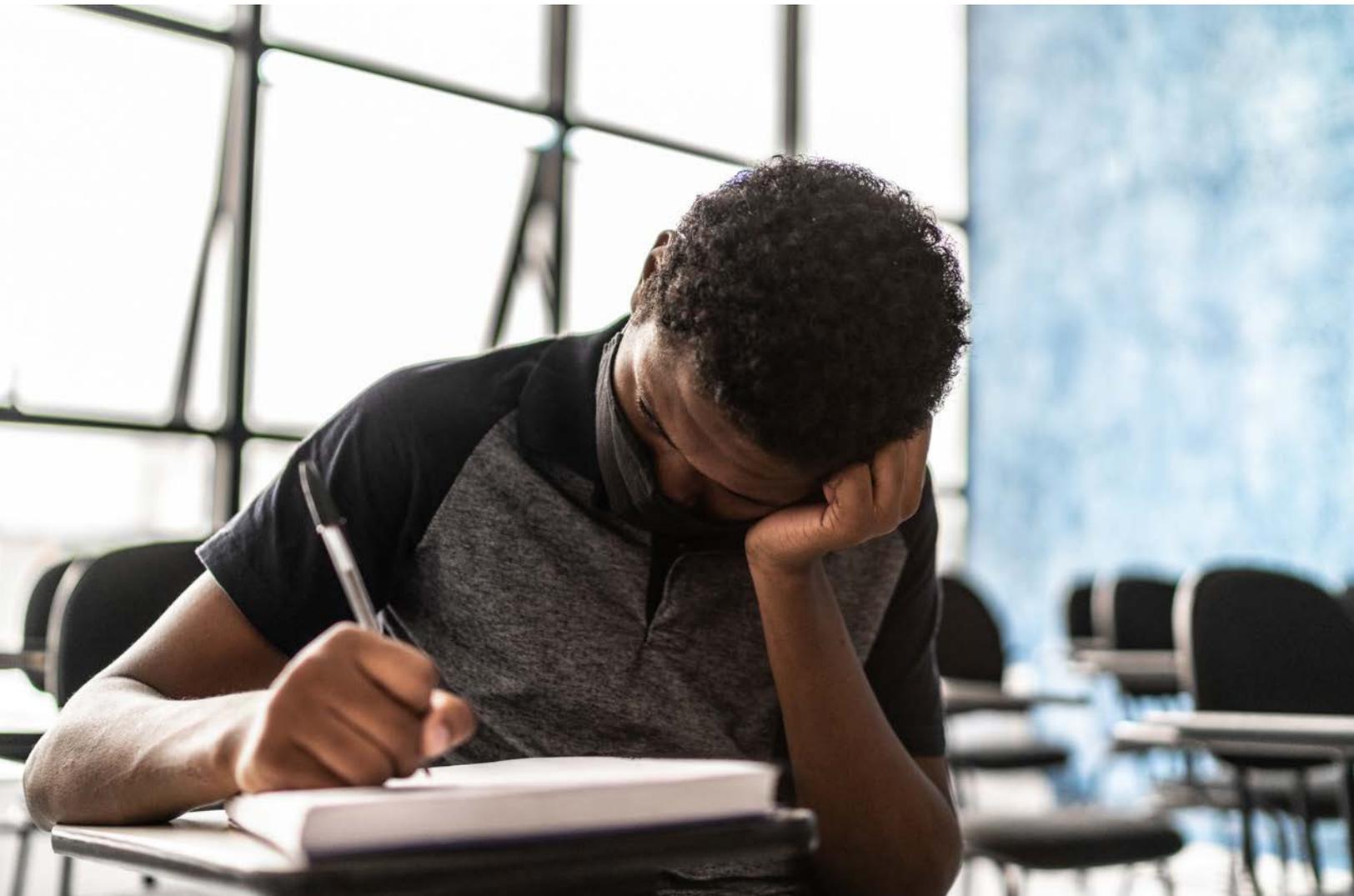
The Basics

How does indoor air quality impact learning?

It would be difficult for any student to focus on learning with those symptoms. In fact, research has shown indoor air quality can be quite detrimental to student performance and attendance. Here are a few points to consider:

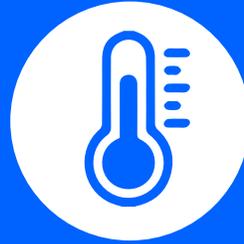
Improving IAQ has been shown to:

- Improve student performance including addition skills, number comparison, and reading and comprehension.^{vii}
- Reduce absenteeism due to lung diseases such as asthma.^{vi} Asthma is one of the leading causes of school absenteeism causing an estimated 13.8 million lost school days in children ages 5-17.^{viii} Children with asthma are especially vulnerable to environmental asthma triggers found indoors in many school buildings.^{ix} Take the Lung Association's [Asthma Basics](#) online module to learn more.
- Reduce radon exposure, which is responsible for 21,000 lung cancer deaths in the US each year. Take the Lung Association's [Radon Basics](#) online module to learn more.





What causes poor indoor air quality in schools?



There are several variables that can cause poor indoor air quality:

- Outdoor air pollutants (pollution that comes from outdoors)
- Indoor air pollutants (including chemicals, fumes and biological contaminants such as mold, pests, bacteria and viruses)
- Poor air filtration
- Poor air flow
- Improper room pressurization/ventilation
- Temperature (either too hot or too cold)
- High or low humidity

Air pollutants can be gases or particles. Carbon dioxide and carbon monoxide are the most common gas contaminants and there are many misconceptions around both. Carbon monoxide may come from improperly vented furnaces, exhausted fumes returning into the building, or worn/poorly adjusted boilers or furnaces. Carbon monoxide is deadly at higher concentrations, whereas carbon dioxide mostly comes from exhaled air from students and teachers in the classroom and can be compounded with poor ventilation. While carbon dioxide is not deadly, it is key in understanding ventilation and air quality and is a much more common problem.

Particulate matter — often written as PM — are small particles that are suspended in the air. Particulate matter can be organic or synthetic. Some examples of particulates found in schools include smoke from cooking, pollen, mold spores, bacteria, viruses, chalk dust, tobacco smoke, e-cigarette smoke, construction dust, or wildfire smoke.^x

VOCs, or volatile organic compounds, are solids that vaporize (or off-gas) at room temperature. They come from both natural and chemical sources. VOCs can irritate the lining of the nose, throat, and lungs. Some harmful sources of off-gassing include new furniture, fabrics, paint, and more.



What You Can Do

How can I assess/monitor IAQ in my school?

Five indoor air quality measurements are important for schools.

1. Temperature
2. Relative humidity
3. Air movement
4. Airflow volume
5. Carbon dioxide (CO₂) (a monitor is useful for indicating when outdoor air ventilation may be inadequate)

These five measures are readily available, do not require expensive equipment or special training, and are straightforward to interpret. There are various devices that measure indoor air quality. Some measure single contaminants, while others measure multiple contaminants using a single device. Some devices measure over a short period of time, while other devices offer continuous monitoring in order to identify longer term and fluctuating trends in air quality. If your school's budget does not allow the purchase of some, or all, of the equipment, you can borrow equipment from an EPA Regional Office. You can find EPA Regional Offices here: <https://www.epa.gov/aboutepa/regional-and-geographic-offices>

If you cannot obtain the recommended equipment due to lack of resources, prioritize your equipment purchases as follows:^{xi}

1. Temperature, relative humidity and chemical smoke device for indicating air movement.
2. Airflow volume measuring devices; and CO₂ monitor.





What are simple, low-cost solutions to improve IAQ in my school?



The healthiest and most sustainable approach to improving indoor air quality in your school is to:

1. Assess the indoor air quality to establish a baseline and understand where improvements are needed.
2. Improve ventilation to increase circulation of fresh air.
3. Improve filtration of circulating air.

There are low-cost, low-tech options to improve ventilation and filtration, including:

- Opening windows and doors when weather and safety conditions allow to increase outdoor air flow.
 - Know what is happening outside as well — opening windows is a great way to ventilate, however, if there is construction, a road, or any other pollution source nearby (i.e. wildfires), it may not be safe to open windows (even if you are not facing the source).
- Using fans to exhaust room air to the outdoors and to get a cross-wind.
- Using wireless, battery-operated indoor air quality devices that can monitor a wide array of air quality issues (e.g. temperature, humidity, CO₂, radon).
- Opening outdoor air dampers.
- Setting thermostat fans to the “on” position instead of “auto”.
- Creating clean-to-less-clean air movement.
- Running the HVAC system at maximum outside airflow for 2 hours before and after the building is occupied.
- Using portable high-efficiency particulate air (HEPA) fan/filtration system for each classroom. There are online tools to calculate the size of the portable air cleaner to use – this is measured in cubic feet. It is important that the HEPA filter fits the room it will be used in so it has the correct rate of air exchange – cleaning or replacing old air with fresh air at a rate fast enough to get rid of any virus people might be breathing out before someone else can breathe it in. These HEPA filters are “plug and play”.
- Educate! Students today care so much about their health and the planet around them. Educating about air quality both indoors and outdoors will help everyone be safer and more productive.



What You Can Do

How do I select the right products to improve IAQ in my school?

There are a lot of gimmicks marketed to improve air quality. The Lung Association is concerned about products that add chemicals to the air — foggers, electrostatic sprayers, spraying disinfectants and air fresheners. Many of these products end up polluting the indoor air further.

An indoor air quality monitor may be a good first step to getting an overview of the IAQ in your school. When selecting an IAQ monitoring system for your school, there are some key things to consider:

- Does the system monitor the most important contaminants? (CO₂, temperature, humidity)?
- Is the system easy to install and use for facility managers and teachers?
- Can the system provide reports over time to document IAQ levels?
- Is the system scalable? (i.e. – can a school start with 1-2 spaces and expand to additional rooms as budget/need becomes available?)

Some air cleaners generate ozone. Ozone is a caustic gas that irritates the lining of the nose, throat, and lungs. Ozone can also trigger asthma episodes and increase a person's susceptibility to respiratory infections. Be sure to select a HEPA air cleaner that does not produce ozone.

What about radon?

According to the EPA, a nationwide survey of radon levels in schools estimates that 19.3 percent of U.S. schools, nearly one in five, have at least one frequently occupied ground-contact room with short-term radon levels at or above the action level of 4 pCi/L (picocurie per Liter) -- the level at which EPA recommends mitigation. In schools with a radon problem, it is unlikely that every room will have an elevated radon level. Yet it is important to test all frequently occupied rooms that have contact with the ground.

We at the American Lung Association, along with EPA, recommend following the [Association of Scientist and Technologist Standards](#) for radon testing and mitigation for schools and large buildings. Often, a Qualified Measurement Professional is recommended for radon testing in school buildings. A continuous monitoring device will not replace a professionally administered radon test, but could provide useful data to make the decision to bring in a professional for testing.





Funds & Services

What are big picture ways to address IAQ in my school?

According to the Centers for Disease Control and Prevention (CDC), the essential elements for safe and healthy schools include adequate ventilation for good indoor air quality. Unfortunately, schools around the country have long struggled with tight budgets and deferred maintenance. A 2020 study from the U.S. Government Accountability Office found that 41% of school districts need to update or replace the ventilation system in over half of their schools, an estimated 36,000 schools nationwide.^{xiii}

Between the relief bill passed in December 2020 and the American Rescue Plan passed on March 11, 2021, the Federal government has approved \$176 billion in emergency COVID-19 relief aid for K-12 schools. Facility-related expenditures are among the allowable uses for these funds and are an excellent opportunity to invest in the indoor air quality of children and schools with no out-of-pocket expense.

Learn more about indoor air quality at school with the Lung Association's resources <https://www.lung.org/clean-air/at-school>





Funds & Services

What is the CARES Act?

The [Coronavirus Aid, Relief, and Economic Security Act \(CARES Act\)](#) authorized two programs that provide equitable services:

- **Elementary and Secondary School Emergency Relief Fund (ESSER)** – State Educational Agencies (SEAs) must allocate the ESSER funds to local educational agencies (LEAs), otherwise known as school districts. There are 12 uses of these funds, including repairing school facilities, especially ventilation systems, to improve air quality and reduce spread of the coronavirus.
- **Governor’s Emergency Education Relief Fund (GEER)** – Flexible block grants that each Governor will allocate. There are also 12 uses of these funds, including providing principals and other school leaders with the resources necessary to address the needs of their individual schools.

How can my school access CARES Act funding?

School districts must apply to State Education Agencies to access ESSER funds. Check with your State Department of Education about the application process and deadlines. Below is a list of specific points you should be prepared to address in your application.

1. Explain the purpose of the project or equipment.
2. Explain how the completed construction, remodeling, or equipment is necessary and a direct result of the COVID-19 public health emergency.
3. Describe where the remodeling or construction is to occur. If remodeling, include the specific building or space to be remodeled.
4. State whether the area is owned by the local educational agency (LEA) or if it is leased space.
5. Estimate start and finish date.
6. Name of the construction company or vendor for the equipment.
7. Itemize the estimate from the construction company.
8. Provide an estimate of the total cost of the project.

There are many reputable indoor air quality and HVAC companies that offer free analysis of schools to evaluate current systems and identify proposed changes/upgrades to assist schools with improving indoor air quality.

Promotional support for the [Indoor Air Quality in Schools Guide](#) generously provided by [Airthings](#) and [Carrier Colorado](#).





- ⁱ Operational Strategy for K-12 Schools through Phased Prevention. Centers for Disease Control and Prevention. Updated May 15, 2021. Accessed at <https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/operation-strategy.html>.
- ⁱⁱ K-12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement. US Government Accountability Office. June 2020. Accessed at <https://www.gao.gov/assets/gao-20-494.pdf>.
- ⁱⁱⁱ <https://pubmed.ncbi.nlm.nih.gov/21411136/>
- ^{iv} <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>
- ^v <https://www.osha.gov/indoor-air-quality>
- ^{vi} Fisk, WJ. The ventilation problem in schools: literature review. *Indoor Air*. 2017; 27: 1039– 1051. <https://doi.org/10.1111/ina.12403>
- ^{vii} S, Jensen KL, Pedersen AL, Rasmussen HS. The effect of increased classroom ventilation rate indicated by reduced CO2 concentration on the performance of schoolwork by children. *Indoor Air*. 2016 Jun;26(3):366-79. doi: 10.1111/ina.12210. Epub 2015 Apr 27. PMID: 25866236.)
- ^{viii} Centers for Disease Control and Prevention. National Center for Health Statistics. National Health Interview Survey, 2015. Analysis by the American Lung Association Epidemiology and Statistics Unity using SPSS software.
- ^{ix} Moonie PhD, Sheniz, et al. The Relationship between school absence, academic performance, and asthma status. *Journal of School health* (2008). Vol. 78, No. 3.
- ^x https://www.epa.gov/iaq-schools/reference-guide-indoor-air-quality-schools#IAQRG_AppendixE_BiologicalContaminants
- ^{xi} https://www.epa.gov/iaq-schools/reference-guide-indoor-air-quality-schools#IAQRG_AppendixB
- ^{xii} Operational Strategy for K-12 Schools through Phased Prevention. Centers for Disease Control and Prevention. Updated May 15, 2021. Accessed at <https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/operation-strategy.html>
- ^{xiii} K-12 Education: School Districts Frequently Identified Multiple Building Systems Needing updates or Replacement. US Government Accountability Office. June 2020. Accessed at <https://www.gao.gov/assets/gao-20-494.pdf>.

About Airthings

Airthings is a global technology company and producer of award-winning radon and indoor air quality monitors for homeowners, businesses, and professionals. Founded in 2008, Airthings is on a mission to ensure that people around the world recognize the impact of indoor air quality and take control of their health through simple, affordable, and accurate technology solutions while optimizing energy consumption in buildings. Airthings' products have made radon detection and indoor air quality monitoring easy to deploy, accurate, and user friendly, and have received several accolades including the TIME's Best Inventions of 2019 award and CES Innovation Award Honors in 2019 and 2021. Headquartered in the heart of Oslo, and with offices in the US, Canada, and Sweden the company has over 140 employees from more than 30 nationalities—and counting. To find an expanded assortment of Airthings smart indoor air quality monitors and radon detectors or to learn more about the importance of continuous air quality monitoring, please visit airthings.com.

About Carrier Colorado

Carrier Colorado is a full service heating and air conditioning distribution center specializing in Carrier products. Founded in 1990, Carrier Colorado's passion is to dependably provide comfort to our community that improves people's lives. Carrier Colorado specializes in indoor air quality products and has a solution for any type of building with any type of budget. To be connected with an indoor air quality expert in your area, visit CarrierColorado.com.



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