

Why School Boards Need a Clean Indoor Air Quality Policy for Schools

*“Breathing clean air shouldn’t be a
luxury...”*

— Environmental Protection Agency
(EPA)



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Clean air is essential for children's health and well-being



Photo Credit: [Isaac Quesada](#)



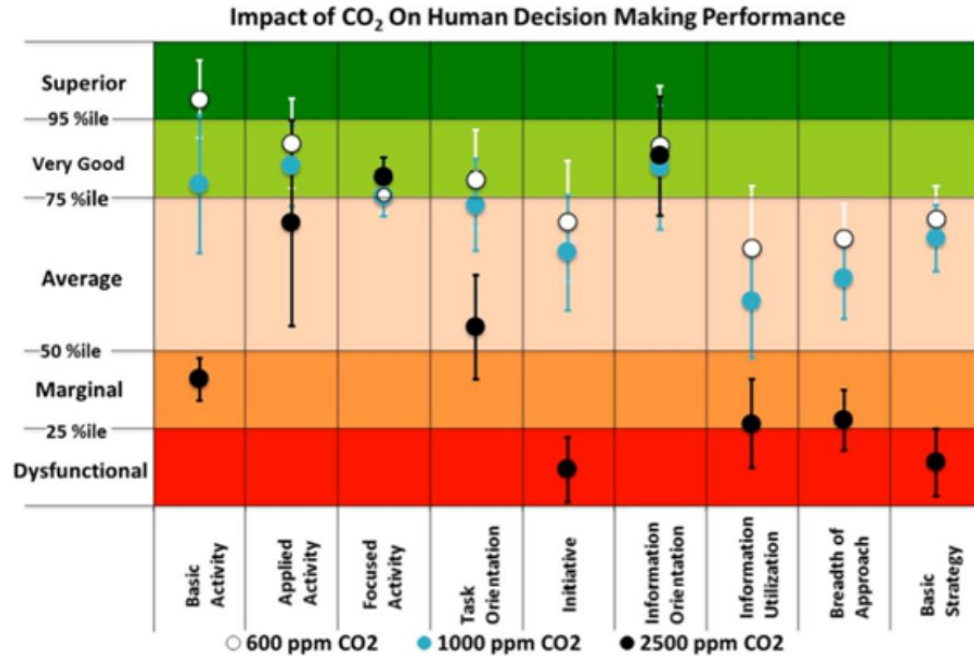
Improved indoor air quality (IAQ) boosts academic performance including math and reading test scores

- Cognition
- Literacy
- Math
- Problem-solving

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Poor IAQ impairs learning and cognition



Source: Is CO₂ an Indoor Pollutant? Direct Effects of Low-to-Moderate CO₂ Concentrations on Human Decision-Making Performance | <http://ehp.niehs.nih.gov/1104789/>

Source: <https://ehp.niehs.nih.gov/doi/10.1289/ehp.1104789>



The recent wildfire season taught us that we can't always just open a window to get clean air.

- “It is the fine particles (PM_{2.5}), not visible to the human eye, that [get deep into our lungs and bloodstream.](#)”¹
- “There is no evidence of a safe level of exposure for most of these pollutants. This means that smoke can impact your health even at very low levels. As smoke levels increase, your health risks increase. [Air quality may be decreased even if you can't see or smell smoke.](#)”²
- Young children are at higher risk than adults when exposed to PM_{2.5}.



Improved IAQ reduces:

- absences due to respiratory illnesses, and
- hospitalizations³ for children

Our past: Fall/Winter 2022

CTV News Calgary
Lines out the door, 17-hour waits: Alberta Children's Hospital crushed by respiratory infections
Staff at Alberta Children's Hospital say even seriously sick kids are waiting up to four hours to be triaged, with a packed emergency...
Nov 14, 2022



Canadian Red Cross to help CHEO amid surge in respiratory illnesses in children



Published Dec 04, 2022 • Last updated Dec 04, 2022 • 3 minute read

'Intense' flu season for Canadian kids needs solutions now and longer term, doctors say



Hospitals struggle to keep up with surge in cases

Amina Zafar - CBC News - Posted: Dec 05, 2022 3:10 PM MST | Last Updated: December 9, 2022

Busiest pediatric ER in B.C.: Surrey hospital 'overrun' as sick kids get hallway medicine

The surge in sick kids has B.C.'s Surrey Memorial Hospital seeing quadruple as many patients as their emergency department was designed for...

Nov 23, 2022

CityNews Toronto

'We're in an urgent situation': Health Canada looking at options to stock children's medications

By Tina Yazdani and Meredith Bond. Posted Nov 10, 2022, 5:08PM EST. Last Updated Nov 11, 2022, 1:18PM EST. As various respiratory illnesses spread in kids...

Nov 10, 2022

Source: [Collaboration for a Clean Air Future - OHCOW](#)



We expect clean water. Shouldn't we also expect clean air?



Carbon Dioxide (CO₂) concentrations are a proxy for ventilation

Rebreathed CO₂

Breath approximately 40,000 ppm
Outdoors 400 ppm

**For every +400 ppm
rebreathed fraction +1%**

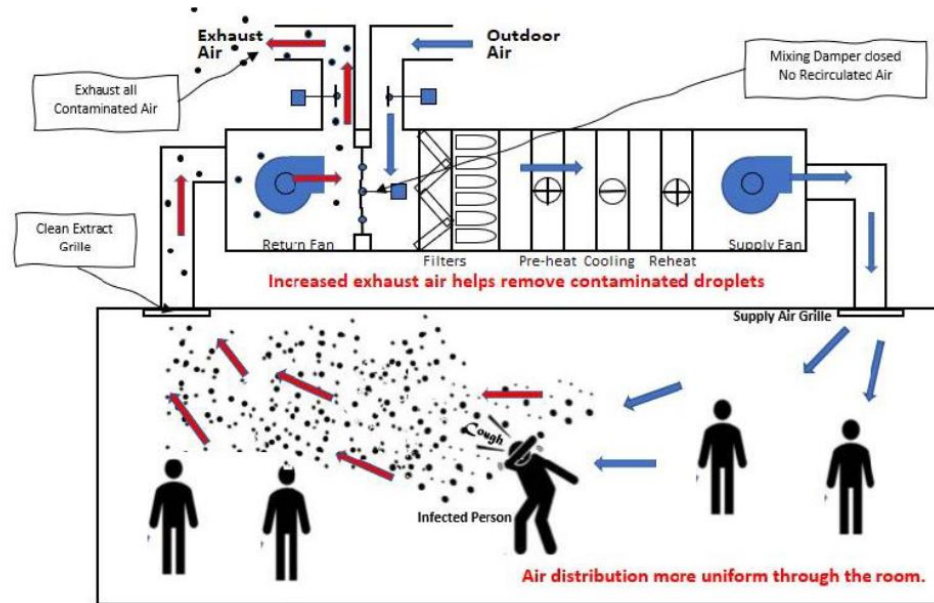
800 ppm = 1%	1 in 100 breaths
1200 ppm = 2%	1 in 50 breaths
2400 ppm = 5%	1 in 20 breaths
5000 ppm = 12%	1 in 8 breaths

Credit: David Elfstrom, P. Eng. Retrieved from <https://itsairborne.com/intro-to-monitoring-co2-20f191dd8f60>



Increasing ventilation reduces exposure⁴ to infectious aerosols (and other indoor pollutants)

Figure 19: How (mechanical) ventilation reduces risk of disease exposure




Notes: The benefit is from increased dilution at a higher ventilation rate rather than the distribution of air. The same concept applies for natural ventilation (e.g., open windows or trickle vents). Source: NAADUK (2022).

Right now, we don't know the air quality in schools, but what we do know is concerning

- Schools tend to have high levels of CO₂ and high concentration of particulate matter such as dust.
- CO₂ monitors can be a proxy for ventilation.
- CO₂ monitors are used in schools in Québec and elsewhere to monitor ventilation.
- Real-time reporting could help schools determine when to take steps to improve air quality.





Clean Air

In Classrooms Using

W.A.T.C.H.

W


indows

- Open windows as much as possible.
- If it's cold outside, even cracking windows slightly can help.
- Keeping the classroom door open helps circulate the air even more.
- Warm weather? Having 2 windows open while using a fan to blow air out of 1 of the windows is optimal.

A

ir Movement

Check to see if you feel air coming from the diffusers or air vents.




Although a flicker to the vent for an easy visual cue that it's working!

T

hermostat

Keep the **FAN** setting **ON** when the room is being occupied.



AUTO is ok to use when the room is going to be unoccupied.

C

O2 Levels

Use a CO2 monitor with a nondispersive infrared (NDIR) sensor

< 600 ppm	Very Good
600 - 800 ppm	Good
800 - 1000 ppm	Acceptable
1000 - 1500 ppm	Poor
> 1500 PPM	Very Poor

* HEPA filters do not change CO2 levels.

H


EPA Filter or Corsi-Rosenthal Box

Use the highest setting.

- Noise permitting.

Disable Features like:

- Ionization
- Plasma
- UV with Catalyst
- Auto



PLACEMENT IS IMPORTANT

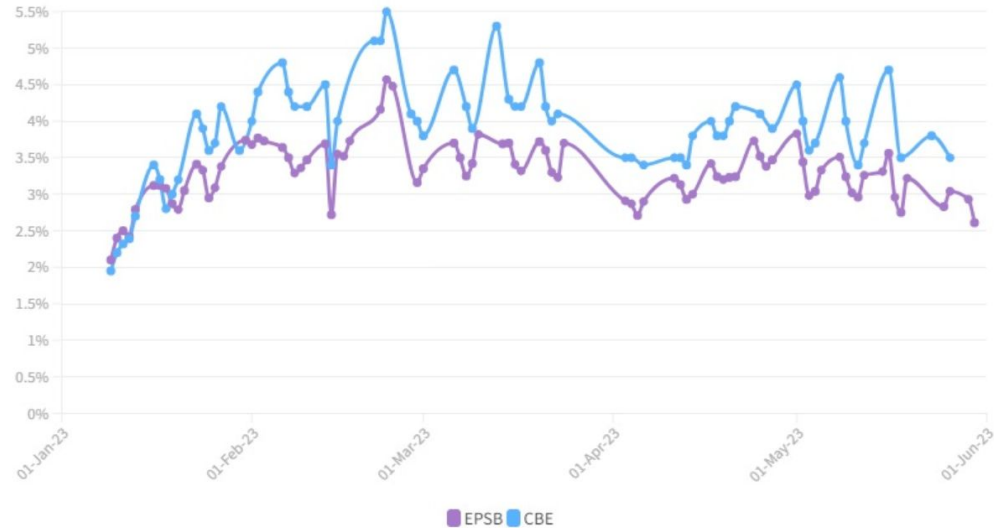
- Move away from walls & corners. (0.5 m - 15 ft)
- Place as close as you can to the centre of the room.
- Avoid blowing directly at anyone.
- Face away from walls & obstructions, e.g. blowing under a table.
- Raised is better than on the floor.
- Keep away from clean air sources: open windows, air vents & other HEPA filters.
- If you have multiple HEPA filters, space them out evenly.

For more information please visit: insidehome.com
infographicsonline.org

Filtering the Air Supplements Ventilation and Reduces Absences

Student absences from Edmonton Public Schools and Calgary Board of Education schools due to any illness (2023)

Percentage of total student population absent on a daily basis. Data reflects student absences reported by parents.



Source: [Edmonton Public Schools](#), [Calgary Board of Education](#) • Graphic: Kyra Markov/CTV News Edmonton

HEPA Filters are used in Edmonton Public Schools but not in Calgary Board of Education

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Improving indoor air quality (IAQ) in schools is an equity issue...

Equity is about providing all students with what they need to succeed.

- some schools are overcrowded and subject to more pollution,
- not all schools have the same quality of HVAC and maintenance,
 - or HEPA filtration,
 - or even windows that open.



School Boards need an IAQ policy

Efforts by School Boards to upgrade furnace filters, and to supply HEPA filters to Kindergartens and schools without HVAC are a step in the right direction. The next step is to create an air quality policy.



IAQ policies are necessary and feasible

- School Boards need a policy to ensure a minimum indoor air quality standard in every school so that all students and education workers have clean air.
- Thankfully, there are already tools to create a minimum standard. Air filtration with HEPA filters or CR boxes could be an interim strategy.



How Can Schools Filter the Air?

- Use MERV-13 filters if the HVAC system can handle them.
- Use HEPA filters at the highest setting and place them away from the wall to ensure air flow.
- Use CR boxes as a cost-effective alternative to HEPA filters.



What is a CR box?

- Corsi-Rosenthal boxes are Do-It-Yourself air filters made from a new box fan filter, four MERV-13 furnace filters, and duct tape.
- CR boxes remove particulate matter like wildfire smoke, as well as infectious viruses and bacteria from the air.
- There are several different configurations to suit rooms of different sizes.
- A CR box costs about \$100 to make—less than the cost of half a day of supply teacher coverage.
- CR boxes make clean air more accessible in schools.



CR boxes are...

- **Safe**
 - see information from the [EPA](#)⁵ and [Underwriters Laboratories](#)⁶
- **Effective**
 - Recommended by engineers as an additional tool to achieve IAQ targets
- **Cheaper** than HEPA (approx. \$100), and
- ultra energy-efficient and quiet when made with PC fans, which lowers energy costs



CR boxes: a cross-curricular STEM learning opportunity

- Building CR boxes is an authentic cross-curricular STEM learning opportunity for students.
- This is a rich task that teaches students problem solving skills and practical applications for technology.
- This task fits current curriculum expectations (2022 Science curriculum).



Grade 2

- Fluids: Air and Water (Properties of air)
- STEM investigations/skills
- Practical applications of technology
- Art (3D objects)

Grade 6

- Matter and Energy: (Properties of air)
- STEM investigations/skills
- Practical applications of technology
- Art (3D objects)

Grade 8

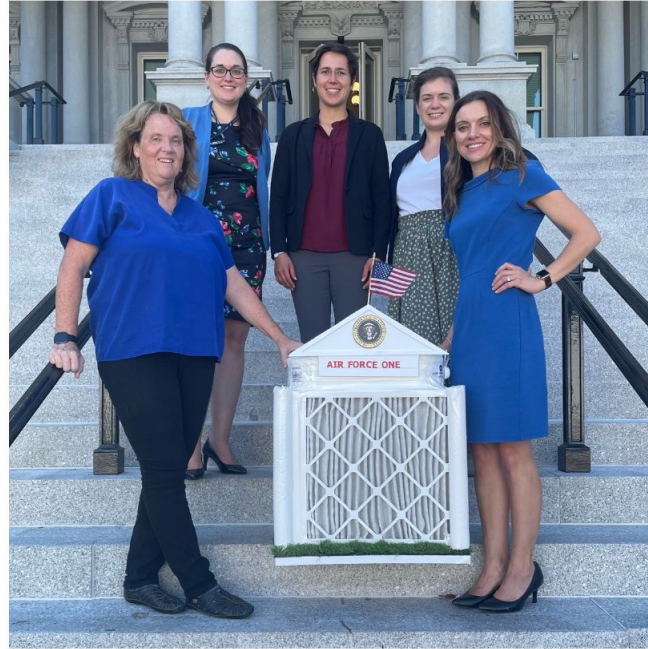
- Geometry: Calculate the surface area and volume of solids
- Fluid mechanics
- STEM investigations/skills
- Practical applications of technology

Grade 9

- Air flow calculations
- Static electricity
- Earn volunteer hours by building CR boxes for schools



Grade 5 students made “Air Force One,” a CR box, donated to the White House Office of Science and Technology



Source: <https://today.ucsd.edu/story/uc-san-diego-professor-presents-air-filtration-fan-to-the-white-house-to-help-fight-covid>



What can school boards do?

- Commission equipment and ensure it is running properly
- Increase the amount of outdoor air supplied to the space
 - Increase the percentage of outdoor air
 - Increase the total airflow to the space
- Upgrade filters to MERV-13
- Supplement with HEPA filters to achieve target rates
- Monitor air quality, especially CO₂

Image Source: OSPE. Retrieved from <https://www.ohcow.on.ca/posts/collaborating-on-solutions-for-cleaner-school-air/>



School Boards already have the tools

Summary of Tools

	HVAC/Building Wide	In-Room
Ventilation	➤ Increase outdoor airflow	➤ Thermostat Fan setting On ➤ Windows
Filtration	➤ Upgrade to MERV-13	➤ HEPA filter or CR Box
Verification & Transparency	➤ Commission HVAC systems ➤ Building Readiness Plan	➤ Monitor CO ₂ ➤ Check airflow

Image Source: OSPE. Retrieved from <https://www.ohcow.on.ca/posts/collaborating-on-solutions-for-cleaner-school-air/>

- IAQ experts can monitor CO₂ and check airflow
- Sometimes it's as simple as switching the HVAC setting from "AUTO" to "FAN"



When we consider the consequences of poor indoor air quality as well as the benefits to improving it, including improved academic performance, and fewer absences, the wise choice becomes clear: **A clean air policy would position your school board as a leader, align with your values that support student well-being, and enhance your reputation.** Let's take steps to analyze and improve air quality in schools to help keep kids healthy.



Thank You



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Endnotes

^{1, 2} Health Canada. (2021). *Wildfire smoke 101: Wildfire smoke and your health.*

<https://www.canada.ca/en/health-canada/services/publications/healthy-living/wildfire-smoke-health.html>

³ Public Health Ontario. (2022, November 18). *Environmental Scan: COVID-19 and Other Respiratory Illnesses in Pediatric Populations.*

[https://www.publichealthontario.ca/-/media/Documents/nCoV/phm/2022/11/covid-respiratory-illnesses-pediatric-populations-fall-2022.pdf?rev=0fd12bb2aaa84145b7470a4492746ab3&sc_lang=en#:~:text=Up%20to%20October%201%2C%202022,per%20week%20\(Figure%20\).&text=Pediatric%20ICU%20admissions%20ranged%20from,2022%20to%20early%20March%202022.](https://www.publichealthontario.ca/-/media/Documents/nCoV/phm/2022/11/covid-respiratory-illnesses-pediatric-populations-fall-2022.pdf?rev=0fd12bb2aaa84145b7470a4492746ab3&sc_lang=en#:~:text=Up%20to%20October%201%2C%202022,per%20week%20(Figure%20).&text=Pediatric%20ICU%20admissions%20ranged%20from,2022%20to%20early%20March%202022.)

⁴ Royal Academy of Engineering. (2022, June). *Infection Resilient Environments Social Cost Benefit Analysis.*

<https://raeng.org.uk/media/fupdixju/nera-social-cost-benefit-analysis.pdf>

⁵ EPA. (2023, December 12). *Research on DIY Air Cleaners to Reduce Wildfire Smoke Indoors.*

<https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors>

⁶ Davis, A. and Black, M. *Wildfire Safety Research: An Evaluation of DIY Air Filtration.*

<https://chemicalinsights.org/wp-content/uploads/2022/03/DIY-Box-Fan-Report-2021.pdf>



References

Improved IAQ reduces the burden of asthma and allergies

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3266016/>

<https://www.epa.gov/indoor-air-quality-iaq>



OSPE recommends six air changes per hour in schools

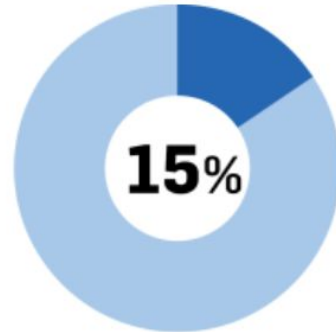
- A new ASHRAE Standard 241 was released in June 2023, which aims to reduce the transmission of viruses and bacteria in buildings.
- The new ASHRAE 241 sets a standard of 6.7 ACH in schools.
- The old ASHRAE Standard 62.1 set a standard of 2.5 ACH in schools. It does not take into account the reality of crowded classrooms and poorly ventilated spaces.
- Professional Engineers recommend 6 ACH in schools.

Sources: <https://itsairborne.com/ashrae-241-control-of-infectious-aerosols-part-1-the-history-of-the-standard-ef6abd43c59c>
<https://itsairborne.com/ashrae-241-control-of-infectious-aerosols-part-2-equivalent-clean-airflow-rates-76a511769d4d>
<https://ospe.on.ca/advocacy/ospe-supports-adoption-of-ashrae-standard-241-in-the-canadian-national-building-code/#:~:text=ASHRAE%20Standard%20241%20provides%20comprehensive,the%20spread%20of%20airborne%20pathogens>
<https://www.ashrae.org/about/news/2023/ashrae-publishes-standard-241-control-of-infectious-aerosols>



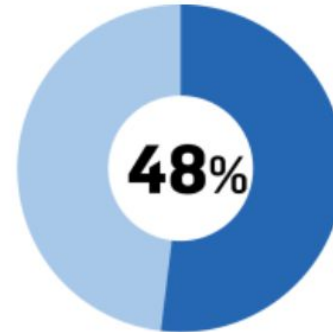
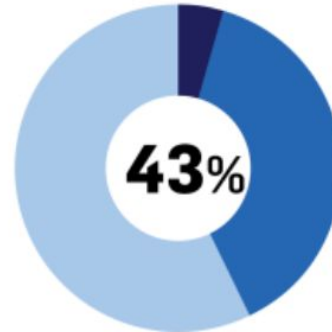
Classrooms are often underventilated, especially crowded portables

Five years of Toronto measurements



106/591 SCHOOLS TESTED
IN THE PAST 5 YEARS

46/106 SCHOOLS HAD A
READING ABOVE 1000 PPM

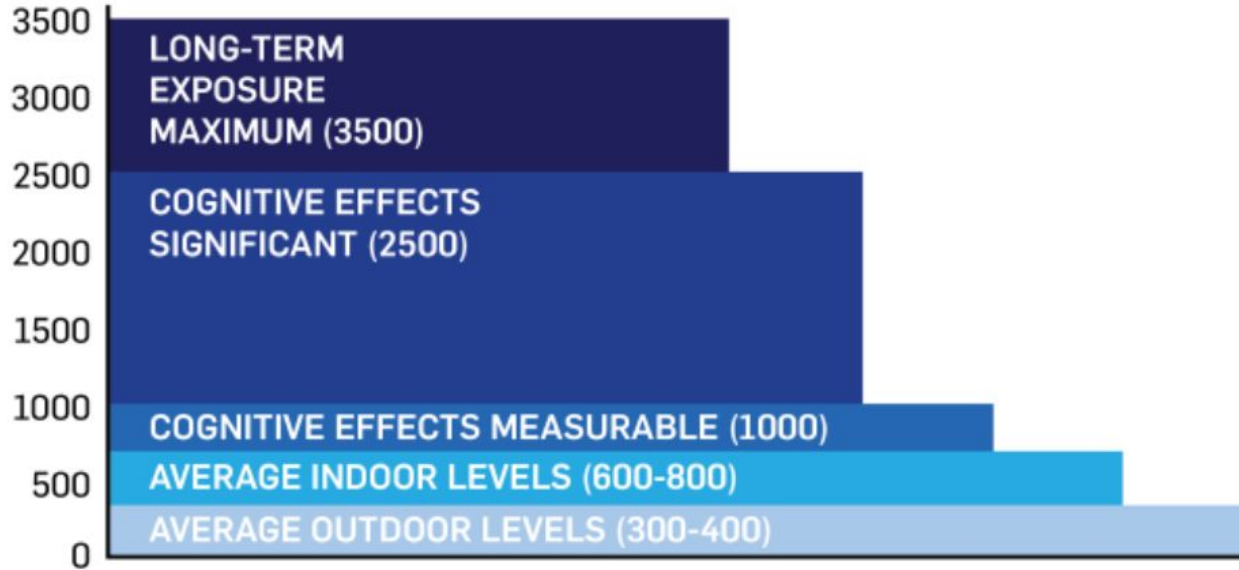


51/106 SCHOOLS TESTED
ONCE WITHOUT FOLLOW-UP

Source: <https://toronto.ctvnews.ca/poor-air-quality-in-toronto-schools-could-impair-learning-environment-1.2219342>, 2015.



CARBON DIOXIDE LEVELS (PPM)



A problem for students in particular

Current average outdoor levels of CO₂ are now 420 ppm. Current federal building code < 1000 ppm.

Source: <https://toronto.ctvnews.ca/poor-air-quality-in-toronto-schools-could-impair-learning-environment-1.2219342>, 2015.)

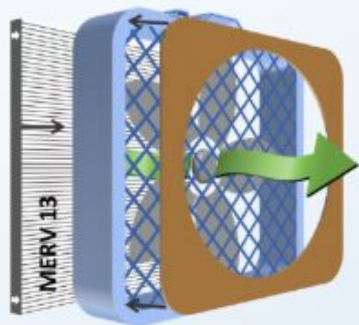


Filter the air to improve IAQ in classrooms with insufficient ventilation

- Filtering the air in classrooms reduces airborne particles, including infectious aerosols (respiratory viruses and some bacteria) and particulate matter (PM_{2.5}), like soot and dust, can reduce the burden of illness when it isn't practical to increase ventilation sufficiently.
- Ensuring classrooms support the needs of all students includes air quality.



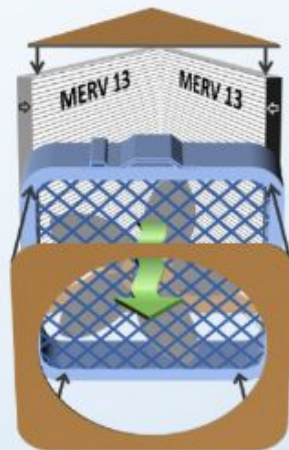
DIY Air Cleaner Designs: Beyond the Basic



Good

Basic Supplies:

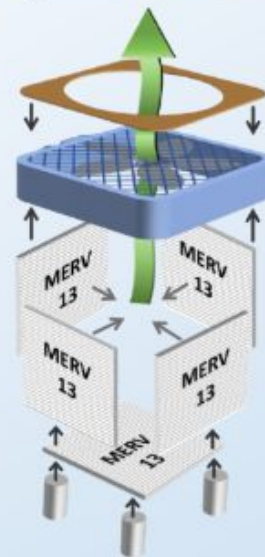
- 20" x 20" box fan
- 20" x 20" x 1" or 4" MERV 13 air filter
- 20" x 20" cardboard shroud (cutout the size of the fan blades)
- Clamps, duct tape, or bungee cords



Better

Additional Supplies:

- Two - MERV 13 air filters
- Triangle cardboard cutout for base on top



Best

Additional Supplies:

- Four or five - MERV 13 air filters
- If using five filter design, use leg supports (e.g., blocks) to allow airflow through bottom

Ways to Improve Effectiveness:

- Add a cardboard shroud (no-cost improvement)
- Use thicker filters (4" rather than 1" MERV 13 filters)
- Use multiple filters (2-5 filter designs)

Key Reminders:

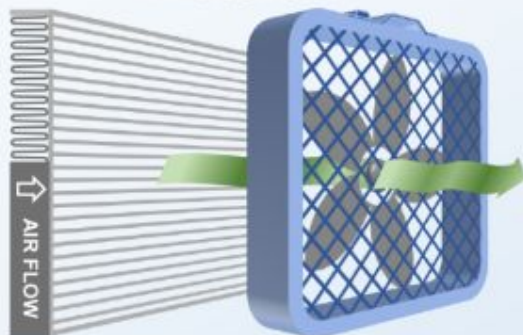
- Only use certified fans with UL or ETL marking (2012 model or newer)
- Keep extra filters on hand
- Replace filters when dirty

Source: <https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors>



DIY Air Cleaner to Reduce Wildfire Smoke Indoors: Basic Design

Materials



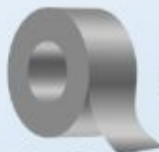
20" X 20" X 1" or 4" air filter
Suggested rating: MERV 13

20" X 20" box fan
Only use certified fans
with UL or ETL marking
(2012 model or newer)



Clamps

or



Duct Tape

or



Bungee Cords

Assembly

1. Attach the air filter to the back of the box fan using either clamps, duct tape or bungee cords.
2. Check the filter for the direction of the air flow (marked on the side of the filter).
3. Replace filters when dirty.

Learn about box fan safety tips:

<https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors#FAQ>



“Designing the Corsi-Rosenthal box has been one of the most gratifying things that I have done in my career as an engineer,” he said. “I am thrilled to be part of something that is so accessible to people around the world, helping to protect children in school and families in their homes, all the while inspiring children about the power of STEM.”

— **Dr. Richard Corsi, Dean of Engineering, UC Davis**

Source: <https://news.3m.com/2022-02-24-3M-scientists-This-Corsi-Rosenthal-box-movement-is-legit>



<https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>

<https://www.epa.gov/iaq-schools/indoor-air-quality-high-performance-schools>

<https://www.epa.gov/iaq-schools/evidence-scientific-literature-about-improved-academic-performance>

https://www.epa.gov/sites/default/files/2014-08/documents/student_performance_findings.pdf

<https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/COVID-19-and-Improving-Indoor-Air-Quality-in-Schools.aspx#>

<https://education-forum.ca/2022/11/08/corsi-rosenthal-boxes-as-school-based-learning-activities/>



Speaker Notes

- **Slide 7** We breathe over 11,000 L of air every day - far more than the 2L of water most adults need each day. When we breathe recirculated air, some of that air has been inside other people's lungs. Most of us wouldn't drink from other people's water bottles, so why settle for re-breathed air?
- **Slide 11** Free downloadable infographic to help education workers improve air quality in classrooms. Source: Joey Fox, P. Eng., Chair of the IAQ Committee for the Ontario Society of Professional Engineers. <https://itsairborne.com/how-can-you-clean-the-air-w-a-t-c-h-f1fc3f11fba5>
- Children need clean indoor air in all spaces where they gather (e.g., including gyms, cafeterias, locker rooms, library commons, portables, buses, etc.)

