

## The Hot New Back-to-School Accessory? An Air Quality Monitor.

Parents are sneaking carbon dioxide monitors into their children's schools to determine whether the buildings are safe.

By Emily Anthes

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When Lizzie Rothwell, an architect in Philadelphia, sent her son to third grade this fall, she stocked his blue L.L. Bean backpack with pencils, wide-ruled paper — and a portable carbon dioxide monitor.

The device gave her a quick way to assess how much fresh air was flowing through the school. Low levels of CO<sub>2</sub> would indicate that it was well-ventilated, reducing her son's odds of catching the coronavirus.

But she quickly discovered that during lunch, CO<sub>2</sub> levels in the cafeteria rose to nearly double those recommended by Centers for Disease Control and Prevention. She shared what she'd learned with the principal and asked if students could eat outside instead.

"He expressed surprise that I had any data at all," she said.

Ms. Rothwell is one of a growing number of parents who are sneaking CO<sub>2</sub> monitors into schools in a clandestine effort to make sure their children's classrooms are safe. Aranet, which makes a monitor popular with parents, says orders have doubled since the new school year began.

Some school systems have made the monitors part of their official pandemic precautions. New York City has distributed the devices to every public school, and the British government has announced plans to do likewise.

But elsewhere, parents are taking matters into their own hands, sneaking in the monitors — which can cost a hundred dollars or more — in their children's backpacks or pants pockets.

Although the devices, which can be set to take readings every few minutes, work best when exposed to the open air, they can generate informative data as long as they are not completely sealed away, said Dr. Alex Huffman, an aerosol scientist at the University of Denver who has sent the monitors to school with his children. (He recommended leaving backpacks or pants pockets unzipped, or tucking the monitor into the mesh water-bottle pouch that is now standard on many backpacks.)



Ms. Rothwell and her son, Luke, at home in Philadelphia. Citing the CO<sub>2</sub> monitor's data, Ms. Rothwell has asked if Luke's school could move lunch outdoors. Rachel Wisniewski for The New York Times

Many of these parents have forged a community on Twitter, where they are using the hashtag #CovidCO2 to trade tips about how to smuggle the monitors into the classroom, how to interpret the data they are collecting and how to approach the school with their findings.

Some school officials have frowned upon these guerrilla air-monitoring efforts, but parents say the devices have armed them with data to advocate for their children.

“It’s possible that the school district may not be all that happy with this because I think it gives us a window into the fact that they may not actually be treating ventilation as seriously as they should be,” Dr. Huffman said.

## A window into indoor air

The coronavirus spreads through tiny, airborne droplets known as aerosols. Improving indoor ventilation reduces the concentration of these aerosols and the risk of infection in an indoor space, but there is no easy way for members of the public to measure the ventilation rate — let alone the accumulation of viral aerosols — in shared spaces.

“Ideally there’d be some machine that cost \$100 and it starts beeping if the virus is in the air,” said Jose-Luis Jimenez, an aerosol scientist at the University of Colorado Boulder, who is sending a carbon dioxide monitor to school with his son. But in the absence of such a device, he said, “CO2 is something that provides an affordable and very meaningful shortcut.”

Every time we exhale, we expel not just aerosols but also carbon dioxide; the worse the ventilation, the more carbon dioxide builds up in an occupied room.

“If we see the CO2 rising, then that also implies that the concentration of aerosols are rising,” Dr. Huffman said. “Even just bringing sensor for a day or two can give you a really interesting and useful window into the world of the ventilation of that space.”

Jeanne Norris, who lives in the St. Louis area, said that she bought her monitor after losing confidence in officials in her son’s school district.

“They just hadn’t been very transparent about their ventilation,” she said. “They say that it’s fine and that they did their own testing but then they wouldn’t share that data with me.”

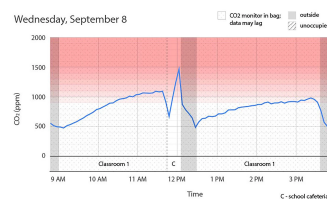
Ms. Norris and her husband are both science teachers, and so far their data suggest that the ventilation is excellent in both of their classrooms. But CO2 levels in her son’s classroom sometimes surpass 1300 parts per million. The C.D.C. recommends that indoor carbon dioxide levels remain below 800 p.p.m.

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After she collects more data, she plans to take her findings to school officials and ask them to improve the ventilation. “I’m willing to be creative and brainstorm with them,” she said.



A reading from the device that Luke took to school on Sept. 8. The school’s principal has said he is committed to improving the cafeteria’s ventilation. via Lizzie Rothwell



A readout from the device Jeremy Chrysler sent to school with his 13-year-old daughter. It reported CO2 levels above 4,000 p.p.m. when the school’s HVAC system was broken. via Jeremy Chrysler

Some parents have gotten results. When Jeremy Chrysler, of Conway, Ark., sent a monitor in with his 13-year-old daughter, this fall, the CO2 readings were a sky-high 4,000 p.p.m.

He brought his findings to district officials, who discovered that two components of the school's HVAC system were not working properly. After the units were fixed, CO2 levels plummeted.

"What my measurements showed was, hey, measuring CO2 can identify problems and sometimes those problems are easy to fix," he said.

Although Ms. Rothwell has not convinced her son's school to move lunch outdoors, the principal has said he is committed to improving the ventilation in the cafeteria, she said.

## Results may vary

"There are some success stories," said Kimberly Prather, an atmospheric chemist at the University of California, San Diego. "Unfortunately I've heard more parents rejected."

After Shanon Kerr, of Waterloo, Canada, found high CO2 levels in some of her daughter's school spaces, she asked district officials to monitor indoor air quality throughout the building, even offering up her own CO2 monitor. "They've been very dismissive," she said.

In an email to The Times, Loretta Notten, director of education of the Waterloo Catholic District School Board, said that follow-up testing in the classrooms Ms. Kerr identified revealed that carbon dioxide levels "were within acceptable parameters."

Air quality testing is done on an as-needed basis, she said: "The Board does not intend on performing ongoing monitoring of carbon dioxide."

(Ms. Kerr has also run into resistance closer to home. Her daughter no longer wants to take the monitor to school. "I've been bribing her with KitKat chocolate bars but it's not working anymore," she said.)

Graham Freeman, the father of two boys in Santa Cruz, Calif., said his request to send CO2 monitors to school with his sons was denied.

Kris Munro, the superintendent of Santa Cruz City Schools, said she is confident in the ventilation upgrades the district performed last winter and that it would be inappropriate to put individual students in the position of monitoring school air quality.

Luke carries his monitor in a Minecraft-inspired 3-D printed case. Rachel Wisniewski for  
The New York Times

"It's our responsibility to assure every space is safe," she said. "Not just to have individuals coming on campus to find out: Is a specific space safe?"

Mr. Freeman has been sending the monitors into school anyway, tucked into the pockets of his sons' cargo pants. He's been pleasantly surprised by the readings, which have remained under 700 p.p.m. as long as the classroom doors and windows have been open.

But the monitors did capture a small spike, when CO2 rose above 900 p.p.m., during a lockdown drill at his son's middle school, when the teacher closed the classroom door.

So his sons will continue taking the devices to school for the indefinite future. "We're going to be wearing a lot of REI cargo pants and CO2 monitors in the pockets," he said.

## **A monitor in every classroom**

There are limitations to the monitoring. Some devices are more reliable than others, and the readings can be skewed by a variety of factors, including where the monitor is placed.

Children can still catch the virus in spaces with low CO2 levels and good ventilation. And high-quality air filters can trap viral aerosols, but have no effect on carbon dioxide levels. So in schools that have installed these filters, CO2 readings alone may overestimate the risk of viral transmission.

But even in the absence of the virus, reducing indoor carbon dioxide levels can have benefits. Studies show that even moderately high levels of the gas may muddle thinking and that improving ventilation can boost performance on cognitive tasks.

Of course, many families cannot afford a \$100 air quality monitor — and they should not have to, parents and scientists said.

Mr. Chrysler, whose CO2 readings prompted his Arkansas district to repair its HVAC system, is now lobbying officials to buy air quality monitors for every classroom in the district.

Pointing to Belgium, which has mandated CO2 monitors in restaurants, gyms and other buildings, Dr. Jimenez said he would like all public indoor spaces to provide permanent real-time displays of the carbon dioxide levels: “This is something that we should do permanently in schools but also in all places where we share air.”