WHITE PAPER

The Air **Students Breathe**

How indoor air quality affects health, learning, and educational outcomes in U.S. schools.

A technical reference for architects, engineers, contractors & facility managers · 2026 Edition

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50M
students in U.S. public K–12 schools every day

41%
of districts need HVAC replacement in half their buildings

5×
the recommended CO_2 benchmark reached in peak readings

Ventilation performance in U.S. schools is rarely measured and frequently inadequate

Approximately 50 million students attend U.S. public K–12 schools each day, spending six to ten hours in buildings where ventilation performance is rarely measured and frequently inadequate. Closing that gap starts with knowing exactly how far actual classroom conditions fall short of recommended ventilation benchmarks, and what that shortfall means in practice for the architects, engineers, and facility managers who design, build, and maintain school ventilation systems.

5×
CO_2 concentrations in U.S. classrooms regularly reach five times the recommended benchmark

41%
of school districts need HVAC replacement in at least half their buildings (GAO)

13.8M
school days missed annually to asthma among children aged 5–17 (CDC)

National survey and audit data from the California Energy Commission, the U.S. Government Accountability Office, and the National Center for Education Statistics form the backbone of that picture, alongside a large-scale classroom monitoring study from Boston University published in *The Lancet Regional Health* and a literature review from Lawrence Berkeley National Laboratory. Controlled cognitive-performance studies from Lawrence Berkeley National Laboratory and the Harvard T.H. Chan School of Public Health, among other peer-reviewed sources, add the mechanistic detail behind those numbers.

Across these sources, a consistent pattern emerges: carbon dioxide concentrations in U.S. classrooms regularly reach five times the recommended benchmark, and the GAO found that 41% of school districts need HVAC replacement in at least half their buildings. Levels this high are linked to reduced cognitive performance and lower standardized test scores, along with higher rates of asthma-related absenteeism.

> **Better-designed and better-maintained ventilation could meaningfully benefit both student health and academic performance.**

Fabric duct systems present the technical case as the optimal air delivery mechanism for both new construction and retrofit school projects.

What this paper covers

A structured look at indoor air quality in U.S. schools – from the scale of the problem and its measurable impact on health and learning, to the proven solutions and a practical path forward.

01 | The Invisible Factor in Educational Success

Approximately 50 million students attend public K–12 schools in the United States each day – spending the equivalent of approximately three years of their lives inside school buildings.[1] For teachers and support staff, cumulative exposure is even greater. The quality of the air in those buildings could be shaping health, cognitive performance, and learning outcomes.

Students and teachers attribute afternoon fatigue, recurring headaches, and difficulty concentrating to stress or illness, but exposure to elevated CO_2 levels could also be having an impact. Unlike a failed luminaire or a cracked wall, poor air quality is invisible. This invisibility makes inadequate ventilation uniquely resistant to identification without continuous measurement, meaning that buildings that look and feel well-maintained can have chronically poor air quality.

What follows quantifies those effects using national ventilation data, controlled cognitive studies, and a large-scale U.S. case study. The findings are especially relevant for architects and engineers, since the systems specified today will shape air quality, health, and learning outcomes for the next 30 to 50 years.

> **The systems architects and engineers specify today could meaningfully shape the health and learning conditions of students for decades.**

> **A proven fix already exists: mechanical ventilation paired with air distribution that reaches every seat evenly, not just the diffuser closest to it. Fabric duct systems are engineered to deliver exactly that, helping create a comfortable and energy-efficient environment.**

02 | Why Indoor Air Quality Matters

Every student deserves a classroom that supports learning rather than limits it, and improving indoor air quality (IAQ) benefits the entire school community. The U.S. Environmental Protection Agency explicitly identifies poor IAQ as a contributor to reduced academic performance, increased absenteeism, asthma symptoms, and diminished concentration.[2] Its relevance to schools breaks down into three interconnected areas.[3][4]

Student Health

Children's lungs, immune systems, and brains are still developing, making them more vulnerable to airborne pollutants than adults.

- Respiratory irritation and asthma exacerbation
- Increased susceptibility to airborne infections
- Allergy symptoms from unfiltered indoor air
- General fatigue and physical discomfort

Student Performance

Research links poor ventilation and elevated CO_2 directly to the cognitive functions that learning requires.

- Reduced concentration and attention span
- Slower information processing speed
- Impaired decision-making and reasoning
- Lower test scores – gains of 3–15% with improved ventilation

Teacher Wellbeing

Teachers spend more continuous hours in classrooms than students, facing the same conditions with greater cumulative exposure.

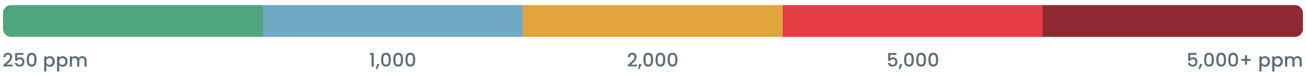
- Headaches, fatigue, and voice strain
- Reduced concentration and instruction quality
- Increased sick leave
- Lower job satisfaction and retention

03 | Key Indicators

Several measures are used to track ventilation adequacy in classrooms, most commonly CO_2 concentration, fine particulate matter ($PM_{2.5}$), relative humidity, and direct airflow rate per occupant (cfm/person). Among these, CO_2 is the most practical and widely adopted indicator.

CO_2 rises quickly once fresh-air supply falls short, and because it is inexpensive to monitor continuously, it anchors most of the classroom ventilation research cited in this paper. It also tracks closely with the fuller contaminant mix that builds up alongside it – allergens, VOCs, and biological matter – while particulate counts and humidity readings remain useful for confirming conditions directly.

In the United States, CO_2 concentration is measured in parts per million (ppm). There is no direct regulatory limit set for schools, but ASHRAE specifies that a healthy indoor CO_2 level should stay within approximately 700 ppm above outdoor levels – commonly interpreted as roughly 1,000–1,100 ppm indoors for occupied classrooms, a benchmark the EPA cites in its school IAQ guidance.[2]



Indoor CO_2 Levels and Classroom Conditions

CO_2 Level	Health & Cognitive Effects
250–450 ppm	Normal outdoor air. EPA/ASHRAE baseline.
450–1,000 ppm	Well-ventilated indoor air. ASHRAE target: classrooms should remain below ~1,100 ppm (700 ppm above outdoor air). CDC and EPA suggest 800 ppm as a tighter target for infection risk reduction.
1,000–2,000 ppm	Inadequate ventilation. Exceeds the ASHRAE 62.1 benchmark. LBNL controlled experiments found significant decision-making impairment beginning at 1,000 ppm.[5] Sick Building Syndrome symptoms emerge: fatigue, headaches, reduced concentration.
2,000–5,000 ppm	Severely polluted air. An LBNL review found peak concentrations in this range are commonly recorded in U.S. classrooms.[6] The CEC confirmed 9% of recently retrofitted California classrooms exceeded 2,000 ppm.[7] Measurable cognitive impairment and airway irritation.
Above 5,000 ppm	OSHA maximum occupational exposure limit (8-hour TWA). Peak readings at this level recorded in U.S. classroom studies, including Boston Public Schools (5,080 ppm).

04 | The U.S. Air Quality Challenge: Key Findings

Research conducted across the United States consistently documents the same pattern: classroom CO_2 levels routinely exceed ASHRAE benchmarks, ventilation systems frequently underperform, and the consequences for health and academic performance are measurable.

Study / Location	Key Finding
Boston, MA Lancet (2025)[8]	Average school-day CO_2: 841 ppm (SD 405 ppm). Peak in a single classroom: 5,080 ppm. Buildings with central mechanical ventilation had consistently lower and more stable CO_2 than those using natural or mixed ventilation. Authors concluded classroom-level monitoring is essential – building averages mask severely under-ventilated rooms.
California Energy Commission (2020) [7]	Only 15% of 104 classrooms met required ventilation rates. 9% had CO_2 above 2,000 ppm for substantial portions of the school day. Even recently retrofitted systems frequently failed – due to improper commissioning or fan control settings.
National Review LBNL / Fisk (2017)[6]	In virtually all reviewed studies, average or peak CO_2 exceeded 1,000 ppm. Maximum classroom CO_2 commonly ranged from 3,000–6,000 ppm. Widespread failure to provide ASHRAE minimum ventilation rates. 8 of 11 studies found statistically significant performance improvements with increased ventilation.
5th-grade classrooms Haverinen-Shaughnessy et al. (2011)[9]	87 of 100 classrooms failed to meet the ASHRAE 15 cfm/person minimum. For each 2.1 cfm/person increase in ventilation rate: math pass rates +2.9%, reading pass rates +2.7%. LBNL: "compelling evidence" of a ventilation–performance link.
New York State NY Dept. of Health (2015)[3]	64 classrooms, 10 schools. For every 100 ppm increase in CO_2 above 1,000 ppm, teacher neurophysiologic symptom odds increased by 30%.
National GAO (2020)[10]	41% of school districts need HVAC replacement in at least half their buildings – approximately 36,000 buildings nationwide. HVAC is the most commonly cited infrastructure need across all district sizes.
National NCES (2024)[11]	Average U.S. public school is 49 years old. 38% built before 1970, before modern ASHRAE codes. Only 39% of schools have a designated IAQ coordinator.

> ✓ Boston buildings with central mechanical ventilation held consistently lower and more stable CO_2 – proof that proper mechanical ventilation is achievable and measurable in existing U.S. school buildings.[8]

The pattern is consistent across all regions and study methodologies: inadequate ventilation in U.S. schools is the prevailing condition, not the exception. Buildings with properly designed and maintained mechanical ventilation consistently outperform those relying on natural or mixed strategies.

FabricAir's fabric duct systems are purpose-built to close this gap – delivering ASHRAE-compliant fresh air evenly across every classroom without the drafts and noise that lead teachers to switch ventilation systems off.

05 | Health and Learning Consequences

5.1 · Sick Building Syndrome

Sick Building Syndrome (SBS) is a recognized condition caused by the accumulation of pollutants in inadequately ventilated spaces. CO_2 is the measurable proxy: its elevation signals the presence of the broader contaminant mix – biological matter, volatile organic compounds, particulates, and allergens – that drives the condition. Symptoms begin to appear above 1,000 ppm CO_2 and include fatigue, headaches, eye and throat irritation, difficulty concentrating, and increased absenteeism. The New York State study found that for every 100 ppm increase in CO_2 above 1,000 ppm, teacher neurophysiologic symptom odds rose 30%.[3]

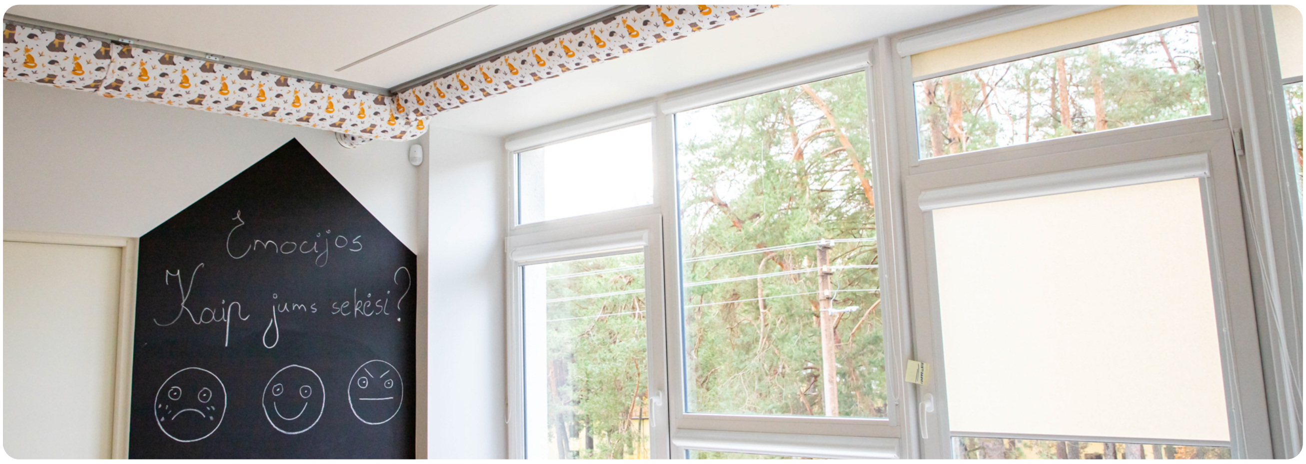
5.2 · Asthma: 13.8 Million Missed School Days

13.8M school days missed annually to asthma among U.S. children aged 5–17 – the leading chronic disease among schoolchildren and the primary cause of illness-related absence.[12]

The burden is not evenly distributed – approximately 7.5% of U.S. children have asthma, and those children miss school 1.54 times more often than their peers.[13]

Indoor air quality is the primary driver of this burden. Without adequate fresh-air exchange, biological contaminants, dust mites, mold spores, and VOCs accumulate to concentrations that provoke airway inflammation. The 2025 Boston *Lancet* study found that buildings with central mechanical ventilation maintained lower, more stable CO_2 levels associated with reduced allergen and contaminant exposure.[8] For architects and engineers, this evidence quantifies the health return of specifying MERV-13 filtration and ASHRAE-compliant ventilation rates as design requirements, not optional upgrades.

Condensation inside ductwork and diffusers compounds this risk. Trapped moisture creates the conditions mold needs to establish itself, and mold exposure is independently linked to asthma onset and worsening symptoms in children – making moisture control as important to respiratory health as filtration itself.



Machine-washable fabric ducting in an early-years classroom – the distribution system itself stays free of dust, allergens, and mold spores.

5.3 · Academic Performance: The Controlled Evidence

Beyond missed school days, poor indoor air quality also affects the concentration and cognitive performance of students who are in the classroom, directly shaping academic outcomes. The link between classroom ventilation and student academic performance is supported by both large-scale field studies and controlled laboratory experiments conducted at U.S. institutions. Together, they provide two distinct lines of evidence: correlational data from real classrooms showing test score improvements with better ventilation, and controlled experimental data showing the direct cognitive mechanism.

Field evidence: classroom ventilation and test scores

Lawrence Berkeley National Laboratory's comprehensive review concluded that the available evidence provides “compelling evidence” of an association between improved classroom ventilation and improved student performance. Across 11 reviewed studies, 8 found statistically significant improvements with increased ventilation or lower CO_2. Performance gains ranged from a few percent in most studies to as high as 15% in some, with the range reflecting differences in study design, baseline ventilation conditions, and age groups.[6]

Haverinen-Shaughnessy et al. (2011) – 100 fifth-grade U.S. classrooms.[9]

The most precisely quantified U.S. finding comes from Haverinen-Shaughnessy et al. (2011): in 87 classrooms failing to meet ASHRAE minimum ventilation rates, both math and reading standardized test pass rates increased linearly with ventilation rate. These are not marginal effects – they represent the difference between students passing and failing state standards at the class level.[9]

More recent meta-analytic evidence reinforces these field findings. A 2023 systematic review and meta-analysis of 15 controlled exposure studies found statistically significant reductions in cognitive task performance at CO_2 concentrations between 1,000 and 5,000 ppm,[14] and a separate 2023 meta-analysis of the ventilation–intellectual productivity literature reached consistent conclusions across a broader set of building types.[15] The pattern identified more than a decade ago in U.S. classrooms continues to hold up under updated, aggregated analysis.

> **A ventilation system that meets ASHRAE 62.1 measurably improves the academic outcomes of the students who use that building – and achieves compliance.**

Controlled evidence: the cognitive mechanism

Two controlled U.S. experiments isolate CO_2 and ventilation from every other variable – establishing cause, not correlation.

6/9

cognitive domains impaired at 1,000 ppm

LBNL researchers (Satish, Fisk, Mendell et al., 2012) tested 24 participants at CO_2 concentrations of 600, 1,000, and 2,500 ppm in a controlled chamber, holding all other variables – temperature, humidity, ventilation rate – constant. At 1,000 ppm, significant decision-making impairment was recorded on 6 of 9 cognitive scales. At 2,500 ppm, large reductions were found on 7 of 9 scales. The researchers noted that CO_2 concentrations frequently near or above these levels have been found in elementary school classrooms.[5]

Satish U, Mendell MJ, Shekhar K, et al. *Environ Health Perspect.* 2012;120(12):1671–1677. DOI: 10.1289/ehp.1104789

101%

higher cognitive scores with enhanced ventilation

The Harvard COGfx Study (Allen, MacNaughton, Satish, Spengler et al., 2016) conducted a double-blind controlled experiment with 24 office workers at the Syracuse Center of Excellence. Participants worked in conventional building conditions (CO_2 ~950 ppm) or enhanced green conditions (lower CO_2 and VOCs, higher ventilation). Cognitive function scores were 61% higher in Green conditions and 101% higher in Green+ conditions compared to conventional building conditions across all nine cognitive functional domains – including crisis response, information usage, and focused activity. CO_2 and VOCs were independently associated with cognitive scores. The study was conducted under conditions that directly parallel typical U.S. classroom environments.[19]

Allen JG, MacNaughton P, Satish U, et al. *Environ Health Perspect.* 2016;124:805–812. DOI: 10.1289/ehp.1510037

Both studies share an important characteristic: they are controlled experiments, not merely correlational observations. This means the cognitive impairment is not explained by other differences between schools or classrooms, but is rather a direct consequence of the CO_2 and ventilation conditions themselves. For design professionals, this mechanistic evidence extends ventilation's role beyond comfort to human cognitive capacity.

A 2025 field study extends these laboratory findings into a real, occupied classroom setting. Harvard researchers monitoring university classrooms operating with COVID-era elevated ventilation rates found that lower real-time CO_2 concentrations were associated with higher cognitive test scores, with peak classroom CO_2 exposures showing the strongest association.[16] This closes the gap between the controlled-chamber evidence above and everyday classroom conditions.

06 | Mechanical Ventilation as the Proven Solution

Mechanical ventilation provides controlled, predictable fresh-air exchange regardless of outdoor conditions, occupancy, or building orientation. A well-designed system delivers consistent ASHRAE-compliant air supply, high-efficiency filtration, heat or energy recovery, and – through continuous CO_2 monitoring – verifiable performance data. Natural ventilation cannot reliably match any of these characteristics.

The evidence confirms this at scale. The Boston 2025 *Lancet* study found that buildings with central mechanical ventilation had consistently lower and more stable CO_2 than those relying on natural or mixed ventilation.[8] LBNL's comprehensive review found that all five intervention studies that increased ventilation rates measured statistically significant performance improvements.[6] The California Energy Commission study found that only 15% of classrooms met required ventilation rates – but those that did met or exceeded air quality standards.[7]

Demand-Controlled Ventilation (DCV)

DCV systems dynamically adjust airflow based on real-time CO_2 feedback, maintaining ASHRAE-compliant air quality during peak occupancy while reducing fan energy during unoccupied periods. For K–12 schools, where classrooms sit empty for substantial portions of each day, DCV delivers both IAQ compliance and meaningful operating cost reductions. The 2025 Boston *Lancet* study specifically recommended DCV as the infrastructure solution for school IAQ compliance.[8]

MERV-13 Filtration

MERV-13 is the commercial-grade specification appropriate for school environments, capturing fine particulates ($PM_{2.5}$), biological contaminants, allergens, and airborne viruses at rates significantly higher than the MERV-8 filters typically specified as a default baseline.

The case for high-efficiency filtration extends beyond allergen control. A multi-country study by Harvard's Healthy Buildings Program (Cedeño Laurent, MacNaughton, Allen et al., 2021) enrolled 302 office workers across six countries including the United States, measuring cognitive performance against real-time $PM_{2.5}$ and CO_2. It found 0.8–0.9% slower cognitive response times for every 10 μg/m³ increase in $PM_{2.5}$ – at concentrations common indoors. $PM_{2.5}$ and CO_2 were independently associated with cognitive impairment.[17]

MERV-13 is compatible with standard commercial HVAC static pressure envelopes when properly accounted for in design. Where 7.5% of students have asthma and $PM_{2.5}$ independently impairs cognition, MERV-13 is a requirement, not an optional upgrade.

> **HVAC systems transform IAQ from a variable, invisible outcome into a measurable, manageable performance parameter. FabricAir's fabric ducting systems ensure a safe, silent and comfortable environment that supports academic performance.**

07 | Why Air Distribution Matters

Ventilation system performance is determined not only by the total volume of air supplied, but by how uniformly that air reaches every occupied space. A system with adequate aggregate airflow can still fail to achieve ASHRAE-compliant conditions if distribution is uneven – creating stagnation zones where CO_2 and pollutants accumulate to concentrations far above the building average.

ASHRAE 62.1's Ventilation Rate Procedure accounts for this through the zone air distribution effectiveness factor, E_Z. When supply air mixes thoroughly with room air, E_Z sits at or near 1.0 and the calculated outdoor air rate reaches the breathing zone as designed. When air stratifies or short-circuits to the return before mixing, effective E_Z drops and the same nominal cfm delivers less real-world dilution. Uniform, low-velocity delivery keeps E_Z close to its design value – turning a code-compliant airflow rate into code-compliant air quality at the breathing zone.[18]

841	6×	5,080
ppm – Boston building-average CO_2	room-level variation	ppm – peak in a single classroom inside those same buildings

Boston Public Schools, Lancet Regional Health – Americas (2025).[8] Building averages mask severely under-ventilated rooms.

The Boston Public Schools study demonstrates this directly. While the building-average CO_2 was 841 ppm, the study documented peak classroom concentrations of 5,080 ppm and significant room-by-room variation within the same buildings. Individual classrooms chronically exposed to 2,000–4,000+ ppm will not be identified by building-level monitoring alone, nor resolved by system capacity upgrades alone. Distribution must be addressed at the room level.[8]

Distribution failures carry a behavioral consequence engineers must design against: occupant discomfort. Cold drafts directed at students, airflow noise competing with instruction, and uneven temperature gradients are the most commonly cited reasons teachers restrict or disable ventilation systems. The California Energy Commission found many HVAC operational problems were attributable to occupant adjustments made in response to discomfort.[7] A correctly specified system that is switched off delivers zero IAQ benefit.

> **A ventilation system switched off by a teacher achieves nothing. Occupant comfort is not a secondary consideration – it determines whether the system functions at all.**

08 | Fabric Air Distribution: The Optimal Solution for School Environments

Fabric-based air distribution systems address the specific technical and occupancy conditions that cause conventional metal ductwork to underperform in classrooms. Unlike metal duct systems with point-source diffusers, fabric ducts distribute air uniformly along their entire length through engineered micro-perforations. Consequently, they achieve the low-velocity, draft-free delivery that keeps occupants comfortable and ventilation systems operational – in both new construction and retrofit projects.

Draft-free delivery that keeps systems running

Uniform low-velocity air through micro-perforations along the full duct length eliminates the cold-blast effect of conventional ceiling diffusers. Where cold air directed at students is the most common driver of system override, draft-free delivery is the single most important factor in ensuring a system actually operates as designed.

Acoustic performance suited to classroom use

Fabric ducts operate at significantly lower sound pressure levels than metal ductwork and conventional diffusers, typically achieving NC-35 or lower without additional attenuation hardware. Where a teacher's voice must be clearly audible, airflow noise is a functional concern that directly affects instruction quality.

Machine-washable – the only duct system that is

Unlike rigid metal ductwork, fabric ducts can be removed and machine-laundered, eliminating the accumulation of dust, allergens, mold spores, and biological contaminants inside the distribution system. Where MERV-13 filtration is specified for source control, maintaining the hygiene of the distribution system itself is the logical completion of that strategy.

Installation flexibility – new build and retrofit

Fabric ducts integrate into any ceiling configuration – circular, flat-bottom, or D-profile – with no sheet metal fabrication lead time. Systems install up to 60% faster than equivalent metal duct, with delivery typically within 14 days of order. At under 0.5 lb/ft, they eliminate heavy lifting equipment and structural reinforcement – the practical solution for the 38% of U.S. school buildings built before 1970.[11]

Energy-efficient – ASHRAE 90.1, ENERGY STAR, LEED & WELL

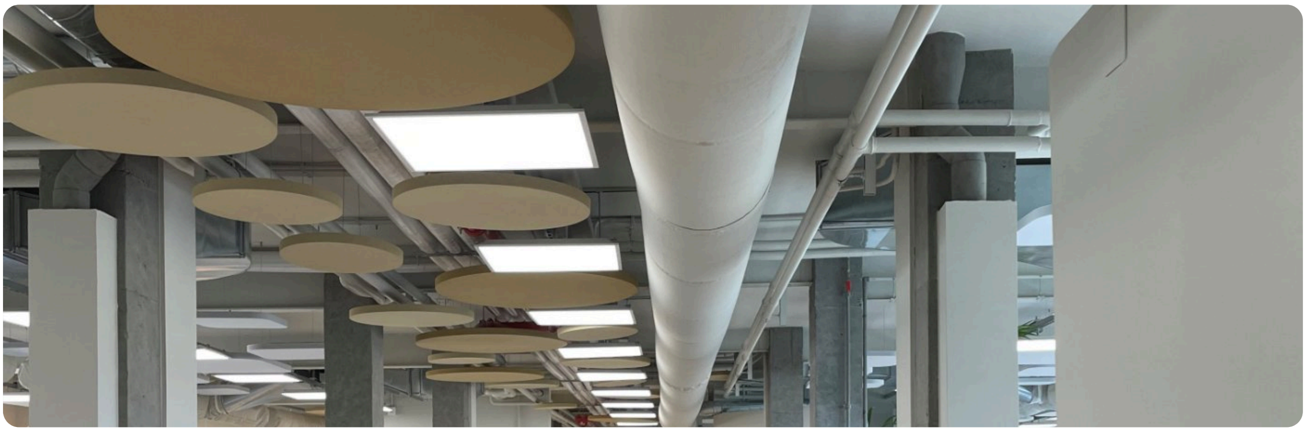
Low-velocity delivery reduces the static pressure required from supply fans, directly cutting fan energy – one study found fabric systems 24.5% more efficient than conventional ceiling diffuser systems in heating mode. Combined with DCV and energy recovery, fabric duct systems support ASHRAE 90.1 compliance, ENERGY STAR for K–12 Schools targets, and LEED and WELL requirements.

Customizable for any educational environment

Fabric ducts can be specified in custom colors to match ceiling finishes, school branding, or institutional color systems. Profiles range from circular to flat-bottom to D-shaped. In new construction this allows full architectural integration; in retrofit it minimizes the visual impact of added infrastructure.

Fabric duct construction also stays largely condensation-free. Because the material breathes rather than presenting a cold metal surface to conditioned air, it is far less likely to collect the surface moisture mold needs to establish itself – keeping the air delivered to classrooms cleaner at the source, not just after cleaning.

> **The most effective ventilation system is the one that operates consistently – because occupants remain comfortable enough to leave it running.**



Fabric ducting specified to integrate with the exposed ceiling and finishes of a school circulation space, following the building's own geometry.

Technical Specification Reference for Engineers

The following parameters represent typical specification guidance for fabric duct air distribution in K–12 school environments, applicable to both new construction and retrofit projects.

Parameter	Typical Value / Requirement	Notes
Supply air velocity	**0.5–1.5 m/s (100–300 fpm) at perforations**	Low-velocity delivery prevents draft sensation; the primary performance differentiator from diffuser-based systems.
Noise criterion (NC)	**NC-35 or lower**	Appropriate for educational occupancy per the ASHRAE 2023 Handbook; confirm with manufacturer NC/RC data.
Minimum fresh air – code	**15 cfm/person (ASHRAE 62.1)**	Mandatory ASHRAE 62.1 minimum for K–12 classrooms.
Fresh air – health-optimized	**20 cfm/person**	LBNL found adverse health effects strongest when ventilation fell below 20 cfm/person, with additional performance benefits at higher rates.[6] Exceeds the ASHRAE minimum and reflects the research-supported optimum.
CO_2 setpoint (DCV)	**800–900 ppm**	EPA/CDC recommend 800 ppm for infection risk; the ASHRAE basis is ~1,000–1,100 ppm. Target the tighter setpoint where the DCV system allows.
Filtration	**MERV-13 minimum**	Captures $PM_{2.5}$, allergens, and biological contaminants; independently associated with cognitive performance.[17] Compatible with standard static pressure envelopes when designed accordingly.
Fabric maintenance	**Machine wash, annual minimum**	Machine-washable construction eliminates duct interior contamination – an advantage over metal ductwork.
Ceiling void – retrofit	**150 mm (6 in.) minimum**	Significantly lower void requirement than equivalent metal duct.
Material compliance	**NFPA 90A / UL 2518**	Confirm fire rating compliance for the applicable jurisdiction and occupancy classification.
Zone air distribution effectiveness (E_z)	**$E_z \approx 1.0$ achievable**	Per ASHRAE 62.1 Table 6.2.2.2, well-mixed low-velocity supply supports E_z at or near 1.0, versus as low as 0.8 for stratified ceiling supply of warm air. Higher E_z means the calculated outdoor air rate actually reaches the breathing zone.

These are typical specification values; confirm exact figures against manufacturer data sheets and project-specific load calculations before finalizing a design.

09 | Final Recommendations, as Backed by Research

School Administrators

Facility managers and school boards set the conditions for IAQ to be measured and acted on.

- Install classroom-level CO_2 monitors
- Include IAQ in facility management programs
- Evaluate ventilation performance regularly
- Prioritize ventilation upgrades in capital planning
- Enroll in EPA Tools for Schools

Engineers & Architects

Design and specification decisions determine air quality for the lifetime of the building.

- Design for health-based ventilation targets, not just code minimums
- Prioritize occupant comfort alongside air quality
- Specify MERV-13 filtration and demand-controlled ventilation
- Consider fabric air distribution effectiveness in system design
- Include IAQ performance as a design criterion from inception

Contractors & Facility Managers

Installation quality and ongoing maintenance determine whether designed performance is delivered.

- Commission post-installation with measured CO_2 data
- Validate ventilation at design occupancy, not just off-load
- Train staff on fabric duct hygiene and annual washing
- Document DCV sensor placement and calibration at handover
- Include filter and duct maintenance in the handover pack

10 | Conclusion

The evidence is clear and consistent: inadequate ventilation is the prevailing condition in American school classrooms. CO_2 levels routinely exceed ASHRAE benchmarks. These are not exceptional outliers, but the documented norm across states, building types, and construction eras.

The consequences are not abstract. Controlled experiments from Lawrence Berkeley National Laboratory and the Harvard T.H. Chan School of Public Health have demonstrated that CO_2 and particulate concentrations at the levels routinely found in U.S. classrooms directly impair human cognitive function across multiple domains. Field research documents lower standardized test scores, higher illness-related absenteeism, and 13.8 million missed school days annually from asthma alone.

The technical solution is proven and available. Mechanical ventilation with demand control and MERV-13 filtration provides the controlled, measurable air quality that natural ventilation cannot. Fabric duct air distribution delivers that air in the draft-free, acoustically appropriate, hygienically maintainable form that keeps systems operational in real classroom conditions – whether in a new LEED-certified school building or a 1960s structure undergoing renovation.

The specification decisions made on every school project directly determine the air quality – and by extension, the cognitive capacity and health outcomes – of the students and teachers who occupy that building for decades.

> **Improving indoor air quality in schools carries a return that extends past the facility, into the health and educational performance of students who learn in that space.**

FabricAir

FabricAir is a global provider of fabric-based air distribution solutions in educational facilities, healthcare buildings, sports venues, industrial facilities, and commercial spaces worldwide. Through collaboration with architects, engineers, contractors, and facility managers, FabricAir helps create indoor environments that prioritize health, air quality, and energy efficiency. Solutions are installed in more than 120 countries and engineered to deliver consistent, comfortable air distribution in every season.

fabricair.com

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