

Poor air quality in classrooms detrimental to wellbeing and learning

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Many Australian school kids could be learning in classrooms with poor indoor air quality that exceeds safety guidelines.

A team from the UNSW Sydney's School of Built Environment found [concentrations of carbon dioxide](#) (CO₂) in classrooms peaked significantly higher than the 850-ppm threshold prescribed by the National Construction Code due to a lack of proper [ventilation](#).

[The study](#) also showed that low ventilation rates raise the concentration of other contaminants in a [classroom](#) environment, such as emissions from the building materials and furniture and particulate matter from indoor/outdoor sources.

Poor indoor air quality and high indoor air temperatures in classrooms are critical problems worldwide. This is only worsened when ventilation rates are insufficient to remove excessive heat or pollutants.

The lead author of the study, Associate Lecturer Dr. Shamila Haddad, said children are particularly vulnerable to the impacts of [poor air quality](#).

"Poor indoor air quality in classrooms is a critical problem given that students spend a substantial amount of their daytime in the classroom," Dr. Haddad said. "Pollutant exposure during developmental stages may produce lifelong issues such as respiratory infections and upper and lower airways disorders."

Ventilation, not just air-conditioning

Poor air quality in the classroom doesn't just affect student health and wellbeing but also learning capacity through concentration loss, tiredness and fatigue.

"High concentration of CO₂ released by the occupants of the classroom can lead to fatigue, concentration loss, and poor learning performance. Elevated CO₂ concentrations can cause headache, sleepiness, and

tiredness." Dr. Haddad said.

"If we want to improve productivity in the classroom, we need to revise the shortcomings of the building itself to enhance health, wellbeing and comfort.

"Improving indoor thermal and environmental quality is as important as improving the teaching material in the classroom."

[Previous research](#) conducted by UNSW Professor Mat Santamouris found CO₂ levels of up to 4000ppm in classrooms, more than four times the recommended threshold.

"Under these conditions, both the teacher and the students are sleepy and tired, and their learning capacity is reduced tremendously," Professor Santamouris said.

While each state in Australia has its guidelines for indoor air quality in schools, school classroom ventilation typically relies upon natural and manual airing, which is not always possible. Often, windows are closed to avoid discomfort caused by external noise from people, traffic and construction and extreme weather to prevent drafts.

However, without adequate ventilation, high concentrations of pollutants build up inside the school, and microbes are likely to circulate the environment.

"Adequate ventilation and indoor air quality in classrooms cannot be achieved by split-type air-conditioners without the supply of fresh air leading to an accumulation of contaminants," Dr. Haddad said.

"A good ventilation system inside classrooms, on the other hand, can ensure good air quality and thermal comfort, which can enhance learning

capacity and also protect students against the transmission of airborne diseases, like COVID-19."

During the study, the research team installed a demand-controlled ventilation system inside a classroom to monitor air quality and pollutants. The system uses real-time feedback to regulate indoor air quality in line with safe recommended levels by adjusting the ventilation rate in response to occupancy numbers and pollutant concentration.

Once the air quality exceeds the school classrooms' recommended thresholds, the ventilation system supplies fresh air and flushes out polluted air based on measured air quality in the classroom.

"Demand controlled ventilation with air extraction removes excessive heat and stale air and allows fresh cool air to enter the classroom and maintain indoor air quality and thermal comfort," Dr. Haddad said.

"It utilizes both natural and mechanical ventilation systems and provides an effective opportunity for controlling indoor air quality in school buildings by adjusting airflow rates based on indoor air quality measures such as CO₂, Total Volatile Organic Compound (TVOC) and thermal comfort parameters."

The demand control ventilation system is more reliable than [natural ventilation](#) and is more efficient and cheaper to run than other conventional ventilation systems that use open-loop controls with constant ventilation rates, Dr. Haddad said.

Child-based design guidelines for schools

Dr. Haddad said the study supports a growing case for developing specific health guidelines that consider the combination of indoor- based ventilation and thermal comfort needed specifically for schools.

"School kids aren't just little adults, due to several reasons, namely age-dependent morphological, physiological, and psychological factors," Dr. Haddad said. "They need specific environmental conditions to be comfortable."

"This study provides evidence-based findings, which can be taken forward to develop a new set of child-based design guidelines for future [school](#) buildings... where students' thermal comfort and satisfaction, health and energy consumption measures are undertaken."

More information: Shamila Haddad et al. On the potential of demand-controlled ventilation system to enhance indoor air quality and thermal condition in Australian school classrooms, *Energy and Buildings* (2021). [DOI: 10.1016/j.enbuild.2021.110838](https://doi.org/10.1016/j.enbuild.2021.110838)

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