UL Research Institutes | Chemical Insights

TECHNICAL BRIEF

Study Protocols for Indoor Air Quality Monitoring in Schools

Introduction

Chemical Insights Research Institute with a university research partner is conducting a field study on indoor air quality in school classrooms while 3D printers are in use. 3D printers have been shown to be sources of ultrafine particles (UFPs) and volatile organic compounds (VOCs) while operating, and concern exists over their impact on the health of students, staff, and faculty. A more in-depth look at our research initiative is available in [Technical Brief 100: A Strategic Research Initiative for Extended Research on 3D Printing School Studies].

Poor indoor air quality can lead to illness, lost productivity, and reduction in academic performance. As a part of the study, indoor air in classrooms is being evaluated for: environmental factors, VOC identifications and concentrations, and particulate matter sizes and concentrations. For every site visit, the physical space is being evaluated, followed by air quality testing and evaluation (**Figure 1**). Particles are being collected for determination of their toxicity.

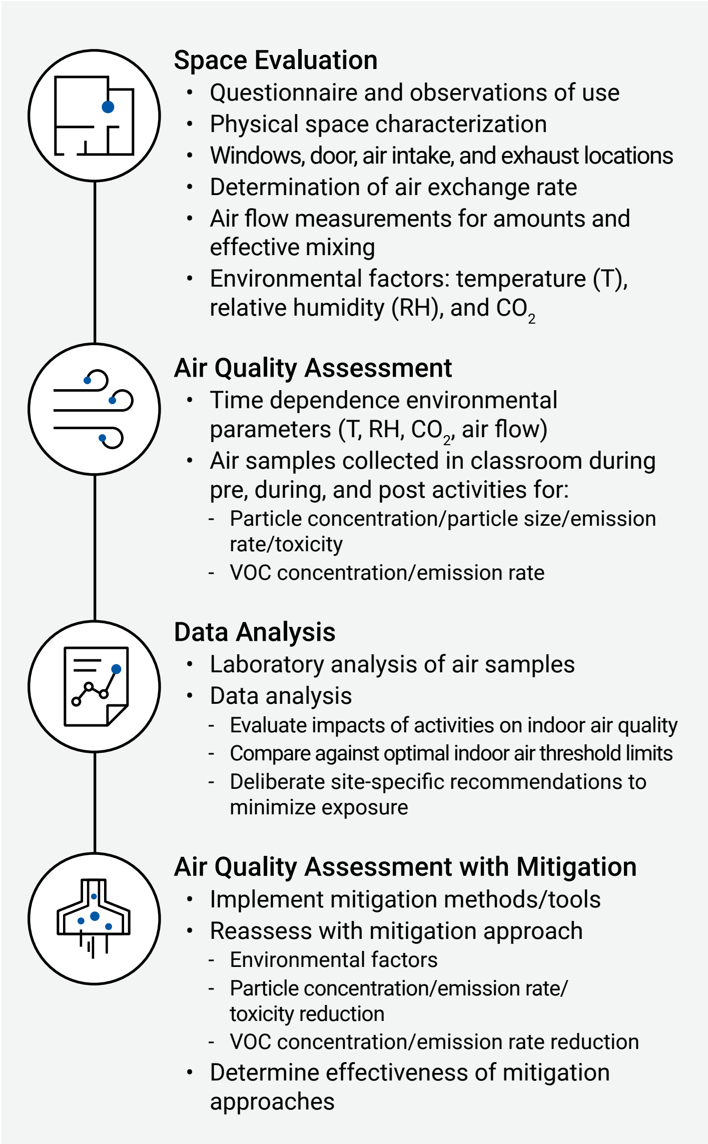

Figure 1: Timeline of indoor air quality monitoring and assessment.

Space Evaluation

- **Questionnaire:** Details about objects, surfaces, and activities within the room are observed and recorded.
- **Dimensions:** Determine the volume of the operable space.
- **Air exchange rate:** Air change within the space is estimated by air flow measurements.
- **Environmental factors:** Room ambient temperature, relative humidity (RH), carbon dioxide (CO_2) concentrations are monitored continuously using sensors.

Indoor Air Quality Assessment

PARTICULATE MATTER

Airborne particles are analyzed for their concentration, size distribution, and toxicity. Real-time particle concentration and size distribution for particles with a diameter between 300 nm and 10 µm are monitored by an optical particle counter and particles between 10 and 400 nm by a scanning mobility particle sizer. Total concentration for overall fine and ultrafine particles are measured by a condensation particle counter. Fine particles are also collected onto filters using a portable pump for offline toxicity analysis such as cellular assays.

VOLATILE ORGANIC COMPOUNDS

Low-level VOCs are collected on sorbent tubes, Tenax for general VOCs and 2,4-dinitrophenylhydrazine (DNPH) cartridges for aldehydes using portable pumps. VOCs media is thermally desorbed and analyzed by gas chromatography–mass spectrometry (GCMS). Aldehydes are solvent extracted and analyzed with high-performance liquid chromatography (HPLC). More details can be found in Technical Brief 08: VOC and Aldehyde Analysis Methods Used in Research Studies. Real-time total VOC, ozone, and carbon monoxide concentrations can be monitored by portable sensors and a photoionization detector.

LOCATION

Air samples are collected at multiple locations simultaneously. In addition to the air in the study room, air outside and in a control room that often has the same air handling system, is measured at the same time, so that potential outdoor air infiltration, background concentration throughout the building can be monitored. Within the study room, samples are collected at various locations next to and away from emission sources to obtain the proximity concentration distribution. Samples are often collected at breathing heights (typically greater than four feet off the ground).

Figure 2: Particle instruments.

TIMING

Measurements are collected continuously, even overnight, for real-time instruments. Time integrated samples such as particle filters and VOCs are collected for pre, during, and post activities affecting air quality in the room. The samples are often collected before any activity to obtain background concentration, followed by samples during an activity or an event (or during class in schools), typically a few hours after the activity has started. Air samples after the activity ends are also collected to understand the natural tendency in concentration decay. This data can be used to predict air exchange and particle loss rate. Sample collection at various time points throughout the day is also important to capture the diurnal effect if applicable.

Figure 3: Air flow capture hood.

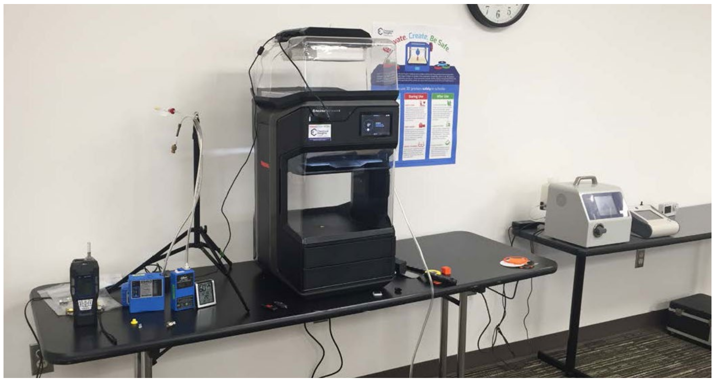

Figure 4: A room with instruments: A PID, pumps with sampling media, a 3D printer with cassette filter attached, and a SMPS (from left to right).

Research Institutes | Chemical Insights

Science for a safer, healthier tomorrow.

2211 Newmarket Parkway, Suite 106, Marietta, Georgia 30067
Web: chemicalinsights.org | **Email:** chemicalinsights@ul.org