PROJECT ABSTRACT

Smart Classroom CO2 and Comfort Monitor with Ventilation Dashboard

An ESP32 indoor-air station measuring CO2, temperature and humidity with NDIR sensing, stuffy-air alerts and a classroom dashboard with ventilation advice. Delivered built-to-order with working hardware prototype, companion dashboard web app, firmware, wiring documentation, report, PPT and viva Q&A.;

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01. Title

Smart Classroom CO2 and Comfort Monitor with Ventilation Dashboard

02. Introduction / Background

A classroom of forty students with closed windows climbs past 1000 ppm of CO■ within an hour — and concentration, comfort and health slide with it. Nobody notices because CO■ is invisible; the room just feels stuffy. The student-scale answer is an honest indoor-air station: an NDIR CO■ sensor (MH-Z19 class), a temperature-humidity probe and an ESP32 serving a dashboard that shows exactly what the room air is doing. The dashboard does not just display numbers — it gives plain ventilation advice: air is fine, watch the trend, ventilate now. Every high-CO■ episode is logged with peak and duration for the report.

03. Problem Statement

Classroom air quality degrades invisibly during occupied periods, and manual airing happens on habit rather than data. The project addresses this with a demonstrable environmental monitor: NDIR CO■ sensing, comfort-band assessment and a genuinely working web dashboard — with all comfort thresholds presented as design values the student justifies from references, never as measured claims.

04. Objectives

- Measure CO■ with an NDIR sensor and temperature/humidity with a digital probe.
- Raise buzzer and dashboard alerts when CO■ stays above the stuffy threshold.
- Serve a live dashboard with gauges, a school-day trend and an episode log.
- Generate plain-language ventilation advice from the live readings.
- Log timestamped readings to a microSD card as CSV.
- Provide a calibration procedure against fresh-air baseline.
- Deliver the complete student kit: prototype, firmware, dashboard source, docs, report, PPT and viva Q&A.;

05. Proposed Methodology

The station is built in three stages. (1) Sensing: the NDIR sensor and probe are mounted in a ventilated enclosure at classroom height; fresh-air baseline calibration is performed

outdoors. (2) Monitoring: the ESP32 samples continuously, checks CO■ against the configurable threshold (1000 ppm default) and updates the advice engine. (3) Dashboard and logging: the single-file HTML dashboard shows gauges, a school-day trend with the stuffy line marked, and an episode log; every sample is CSV-logged with timestamps for the report's analysis.

06. System Architecture / Working

CO■, temperature and humidity are sampled continuously and shown on live gauges. When CO■ crosses the threshold, the firmware sounds the buzzer, the dashboard banner switches to 'Ventilate now', and the episode is logged with start time. When readings recover, the episode closes with peak and duration. The trend chart reveals the classic signature: CO■ climbing after students re-enter with windows closed, dipping at the lunch break — exactly the story the student's report analyzes.

07. Hardware / Software Requirements

- ESP32 development board (Wi-Fi)
- MH-Z19-class NDIR CO■ sensor
- DHT22/AM2302 temperature-humidity probe
- Buzzer + 16x2 character LCD
- MicroSD card module
- Single-file HTML/CSS/JS dashboard (gauges, trend, advice engine)
- Arduino IDE (C/C++ firmware)

08. Expected Outcomes

- A working station showing live CO■, temperature and humidity.
- Data-driven ventilation advice on the dashboard.
- A timestamped CSV log and episode records supporting the report's analysis.
- A complete report, PPT and viva Q&A; on indoor air quality and NDIR sensing.

09. Applications

- Demonstrating indoor air-quality monitoring for schools and offices.
- Teaching NDIR sensing, threshold alarming and dashboard design.
- A base platform for adding PM or VOC sensing channels.

10. Future Scope

- Automated window/damper actuation closing the loop.
- Multi-room deployment with a central dashboard.
- Occupancy counting to normalize CO■ per person.
- Long-term study of air quality vs. academic performance.