"Research Proposal" GLOBE Detectives

Topic: What Do We Breathe When It's Heating Season? (Parallel Air Quality Monitoring)

We propose this project to scientifically substantiate conclusions about the impact of the heating season on the health of students and the community.

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Basic Information

Project Details

Project Name

GLOBE Detectives (Search for Clean Air)

Topic (GLOBE)

Atmosphere / Air Quality (Air Quality, Aerosols)

Measured Substances

PM2.5 and PM10 (Particulate Matter), VOC (Volatile Organic Compounds)

Measuring Instruments

2x ATMOTUBE PRO sensory devices for air quality measurement

Equipment Source

Borrowed from DAFNE GLOBE

Measurement Period

January - February

Description of Study Location

- **Location Name:** Primary School, Blatné Remety 98, Sobrance District, Slovak Republic.
- **GPS Coordinates:** 48°42'29.1"N 22°06'19.8"E
- **Type of area:** We are on a plain (East Slovak Lowland). It is a village where family houses stand around the school.
- **Weather and Smoke:** Although there is no hard frost in January 2026, **humidity and calm weather** are important. When there is no wind, smoke from surrounding houses hangs motionlessly over the schoolyard like a "heavy duvet."
- **Main Problem:** Neighbors around the school burn solid fuels. It's worst in the morning when people start heating – the smoke then doesn't circulate and stays low to the ground. With our measurements, we want to find out how much of this invisible dust penetrates through the windows into our classroom, even when it's not freezing outside.
- **Visual Materials:**48°42'29.1"N 22°06'19.8"E

1. Research Question and Research Hypothesis

Research Question:

What is the difference in the concentration of toxic PM2.5 particles between the classroom interior and exterior, if measured at exactly the same second during the coldest months (January – February)?

Research Hypothesis:

1

PM Particles (Exterior vs. Interior)

We assume that during cold, windless days (risk of temperature inversion), outdoor PM2.5 will significantly exceed health limits and will always be higher than PM2.5 measured indoors. At the same time, we expect that particle penetration indoors will still be visible.

2

VOC Particles (Interior)

We assume that on days with the highest outdoor PM concentration (in the absence of ventilation), the concentration of VOC (stale air) in the classroom will be unhealthily high, which will demonstrate a compromise between fighting smog and fighting stuffiness.

2. Methodology and Measurement Procedure

Types of Data and GLOBE Protocols
In the project, we will use the following protocols from the GLOBE Atmosphere area:

- **Air Quality:** Measurement of PM2.5, PM10 and VOC (main focus on smoke).
- **Air Temperature:** Measurement of current temperature (helps determine the intensity of heating in the village).
- **Relative Humidity:** Monitoring humidity (high humidity and fog worsen smoke dispersion).
- **Barometric Pressure:** Monitoring air pressure (high pressure is often associated with calm weather and smog accumulation).

Measurement is Synchronized

Measurement is synchronized thanks to two devices at the same time each day (e.g., 10:00:00), for 8 weeks. Duration of measurement 5 minutes at both locations

Division of Tasks and Detective Record:

Team A (Interior)	Atmotube PRO #1	Center of classroom (at the height of children's breathing zone)	They monitor: how quickly temperature drops when ventilating and how PM 2.5 rises when smoke enters the room. Goal: Determine if the air in the classroom is safe.
Team B (Exterior)	Atmotube PRO #2	School yard - as close as possible to the chimney	They monitor: How frost, pressure and humidity affect the density of smoke from surrounding houses. Goal: Find the source of pollution in the village.

Who will process the data?

After measurement, both teams meet, download data via Bluetooth into a shared table and calculate the difference. If outdoor PM2.5 is, for example, 80 $\mu g/m3mug/mcubed$ and indoors 20 ■■/■3, we know that the school walls protect us, but ventilation can be risky.

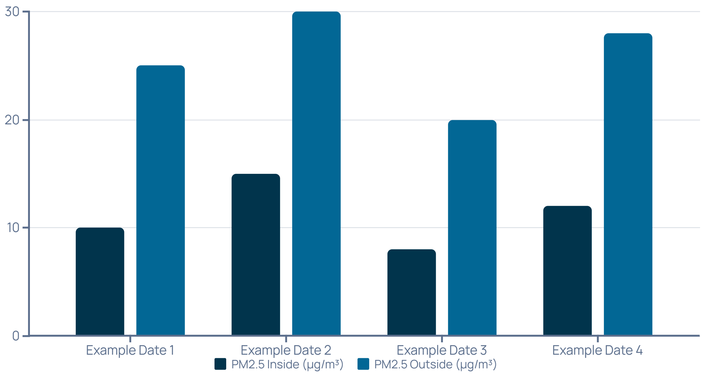
(**Why are two teams important for our community?**

Thanks to two teams, you can show parents in Blatné Remety exactly: *"Look, at this moment the smoke from plastics outside was so strong that even in our closed classroom the humidity and dust got worse."*)

Working Table:

Date	Time	PM2.5 Inside (µg/m³)	VOC Inside (ppb)	PM2.5 Outside (µg/m³)	Difference (Outside - Inside)	Temperature (°C)	Pressure (hPa)	Humidity (%)

PM2.5 Comparison Chart:



3. Project Conclusion and Recommendations

A) Key Findings

- **Relationship with Weather:** Data will confirm that the most toxic pollution (highest PM2.5) in January and February occurs during frosty and windless days due to a phenomenon called temperature inversion. On such days, the largest difference between outdoor and indoor PM was recorded.
- **Compromise:** It was confirmed that the school faces a compromise: whenever we try to ventilate stale air (reduce VOC), we risk letting in outdoor toxic smoke (increasing PM) into the classroom.

B) Data Usage Plan

- We will compare our measured PM2.5 values with the nearest official SHMÚ monitoring station to verify the accuracy of our sensors.

C) Recommendations for School (Intervention Plan)

01

PM-Traffic Light

DO NOT VENTILATE if Atmotube PRO outside shows RED or PURPLE color (PM2.5 significantly above 50 $\mu g/m^3$). In such cases, smoke would be more dangerous than stale air.

02

Quick Ventilation

If outdoor PM is at a safe level (GREEN), quick burst ventilation during breaks is recommended to reduce VOC.

D) Recommendations for Community (Children's Health)

The project results showed that burning toxic waste creates pollution that gets into the lungs of all children in the village and school. These PM2.5 particles are the main cause of respiratory problems and diseases. This was also the reason why we chose this topic - due to the increased incidence of cough among classmates in winter).

Direct Communication

Invite parents and the community to a meeting and present them with data from Atmotube PRO as evidence that smoke from burning plastics and waste is directly in the breathing zone of their children.

Focus on Health

Emphasize that burning any waste (plastics, clothing) creates the most toxic PM particles that penetrate deep into the lungs and pose a serious health risk.

Cooperation

Propose cooperation with the municipality to improve waste collection and education about proper heating (only with dry wood/coal) to eliminate illegal smoke and improve air quality for everyone.

4. Challenges and Considerations

Possible Problems and How We Will Solve Them:

- **Weak Battery in Winter:** In cold weather, the device discharges faster.
  - *Solution:* We will charge the ATMOTUBE PRO after each measurement to ensure they are always 100% ready.
- **Snow and Rain:** Moisture can spoil the measurement or the device.
  - *Solution:* If it snows, Team B (outside) will hold the device under a canopy to protect it from rain, but still allow it to measure the air.
- **Poor Synchronization:** If we don't start at the same time, the data will not be comparable.
  - *Solution:* The outdoor team and the indoor team will signal each other (e.g., by waving through the window) to start the measurement at the same second.
- **Missing Data:** If someone gets sick or the device fails.
  - *Solution:* Only those days when air was successfully measured both outside and inside simultaneously will be included in the final graph.

5. Sources and Literature

1. **The GLOBE Program:** *Atmosphere Protocols (Air Quality, Air Temperature, Barometric Pressure, Relative Humidity).* [Online]. Available at: https://www.globe.gov
2. **Slovak Hydrometeorological Institute (SHMÚ):** *Air Quality Monitoring in Slovakia.* [Online]. Available at: https://www.shmu.sk
3. **Institute of Environmental Policy (IEP):** *Analysis of Air Pollution from Household Heating.* [Online]. Available at: www.minzp.sk
4. **DAFNE – Institute of Applied Ecology:** *Methodological Manual for Working with Atmotube PRO Devices in the GLOBE Slovakia Program.*
5. **Atmotube:** *User Guide for Atmotube PRO Portable Air Quality Monitor.* [Online]. Available at: https://atmotube.com
6. **World Health Organization (WHO):** *Global Air Quality Guidelines (PM2.5 and PM10 levels).* [Online]. Available at: https://www.who.int
7. **Blatné Remety Primary School:** *School Environmental Action Plan and School Educational Program.* [Online]. Available at: https://zsbremety.edupage.or