

Distributed Sensors & Indoor Air Quality

A trilemma affecting UK classrooms

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Why Indoors? Why Schools?

- We spend 90% of our time indoors, so why focus on just outdoor air pollution?
- Studies highlight the link between air pollution and poor academic achievements.
- Children are particularly vulnerable to respiratory complications due to narrower airways, higher breathing rates and shorter stature.
- We ask: What is the air quality in the classroom and how is this constructed?



Stakeholder
Requirements

Stakeholders are
constrained by budget and
CO2 footprint

Schools need to meet
the health & wellbeing
requirements

Trilemma



Energy

More ventilation =
more energy used



Air Quality

Our Questions

How does air quality vary across the classroom & what factors affect it?

How can we plan for potential challenges regarding data collection in a changing environment?

How best can we provide unobtrusive and actionable air quality data?

Methods – Interviews & Presentation

1. Pre-deployment interview with stakeholders to gauge current engagement with indoor air quality.
2. Post-deployment presentation with stakeholders to add meaning to data.
3. Thematic Analysis of key points and recurring motifs.

| Theme 1 Stakeholder Interactions/Control | | Theme 2 Impacts on Health/Learning | | Theme 3 Building Limitations | | Theme 4 Comfort/Focus | |
|---|--|--|--|---|---|--|--|
| Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| "Children turn the heating up and I open the windows" | On discovering the CO2/Stagnant air around teacher's desk - "I'll definitely be putting a fan on my desk in future, I usually aim them towards the children" | Room described as getting "stuffer" throughout the day. "stuffy" is a recurring keyword. | When made aware of the ~34% air change rate - "I'm breathing in the same air, think of the germs/dust" | "The windows are bolted in place" "So that's the reason that they don't open and then parts of the windows where the ones that only open where you pull them towards you Only open a crack you could 'peek' into." | Efficiency of fans is questioned. "When the heating on, I can control the radiators, so if it's cold, I can send the radiators up or down. If it's warm then, I have the sounds but just thought to go with speed/when I can" | "Well, I always think that if probably if I if I go in and normally every morning, I open the windows as much as I possibly can, which is like a crack. Around four windows on one side of the classroom." | "I tend to have the fans pointed towards the class, but I don't know if it's just moving hot air around" |

Methods - Deployment

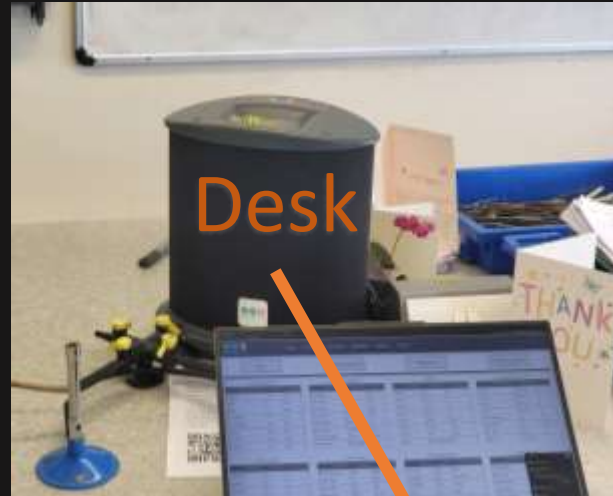
Deployment of 3 NAQTS V2000 IAQ monitors across a laboratory classroom to collect data over 3 week period.

Data Collected includes CO2 (PPM), PM2.5 and PM10 as well as temperature and humidity.

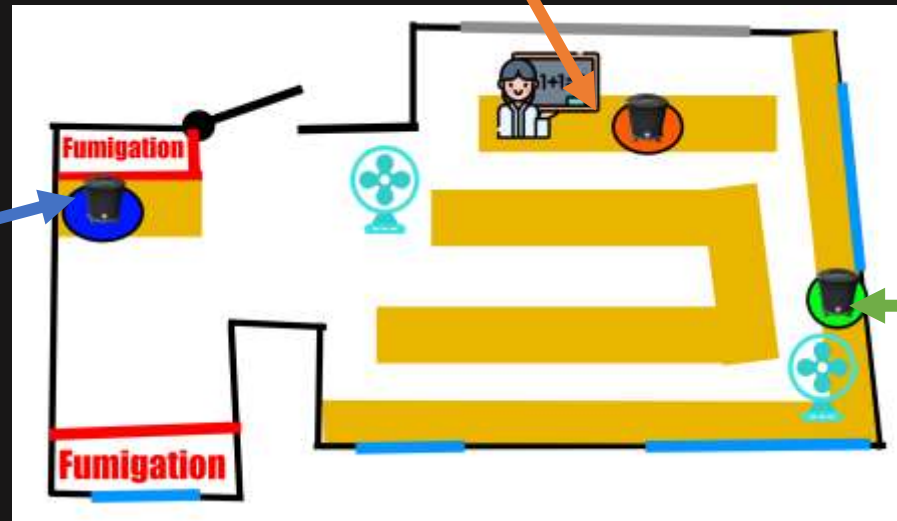
Learn more:



Corner



Desk



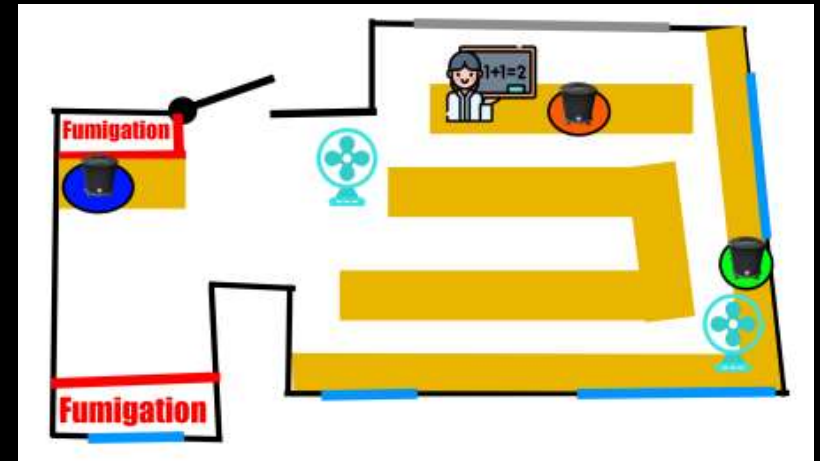
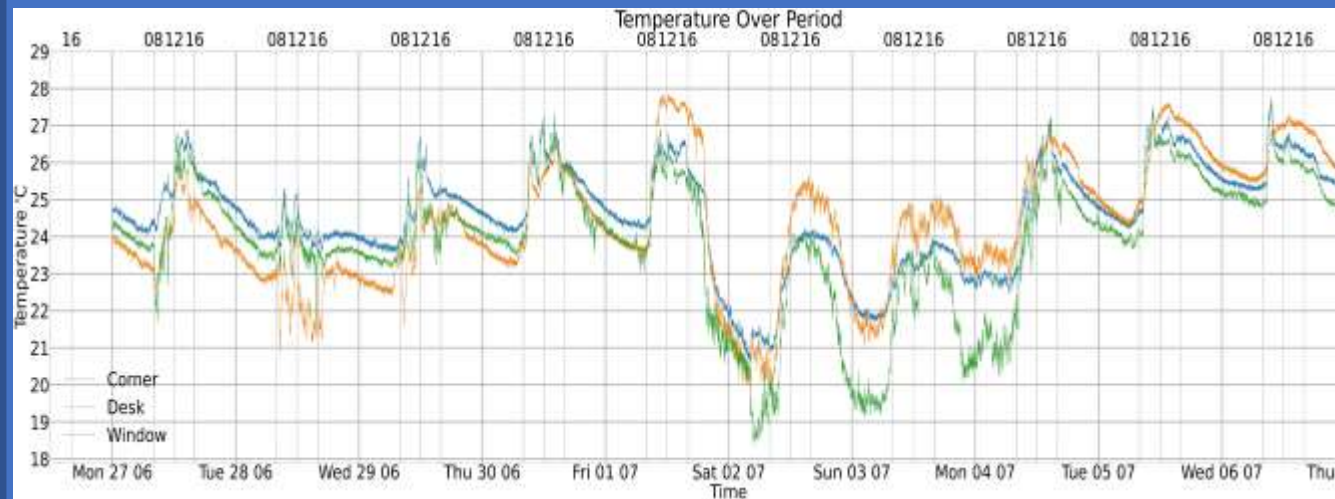
Window



Results – Spatial Variation

Teacher - "I tend to place the fans away from my desk and so that it's impacting on the majority of the of the classroom"

Large variation between window, corner, desk and latent air temperatures.

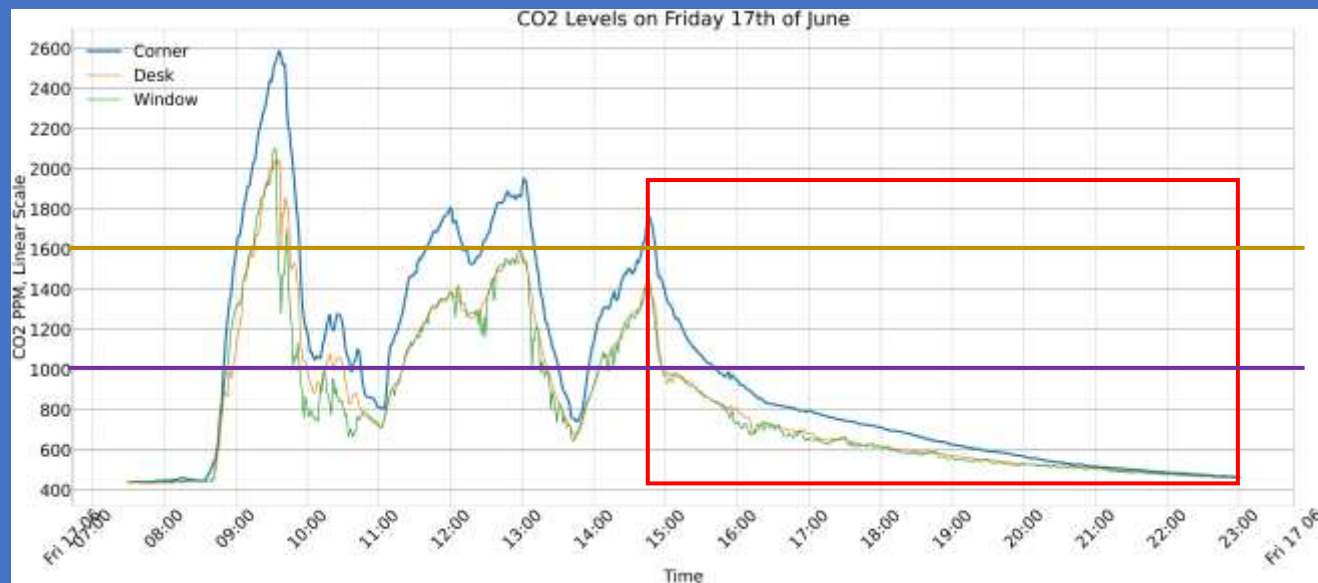


Discussion:
"I don't know... it's just moving hot air around"
"Children tend to open the windows, I have the fans on"

Results – Building Limitations

Teacher - “windows are bolted in place with perspex... they only open a crack”

Air Change Rate = ~35.34%



Discussion:

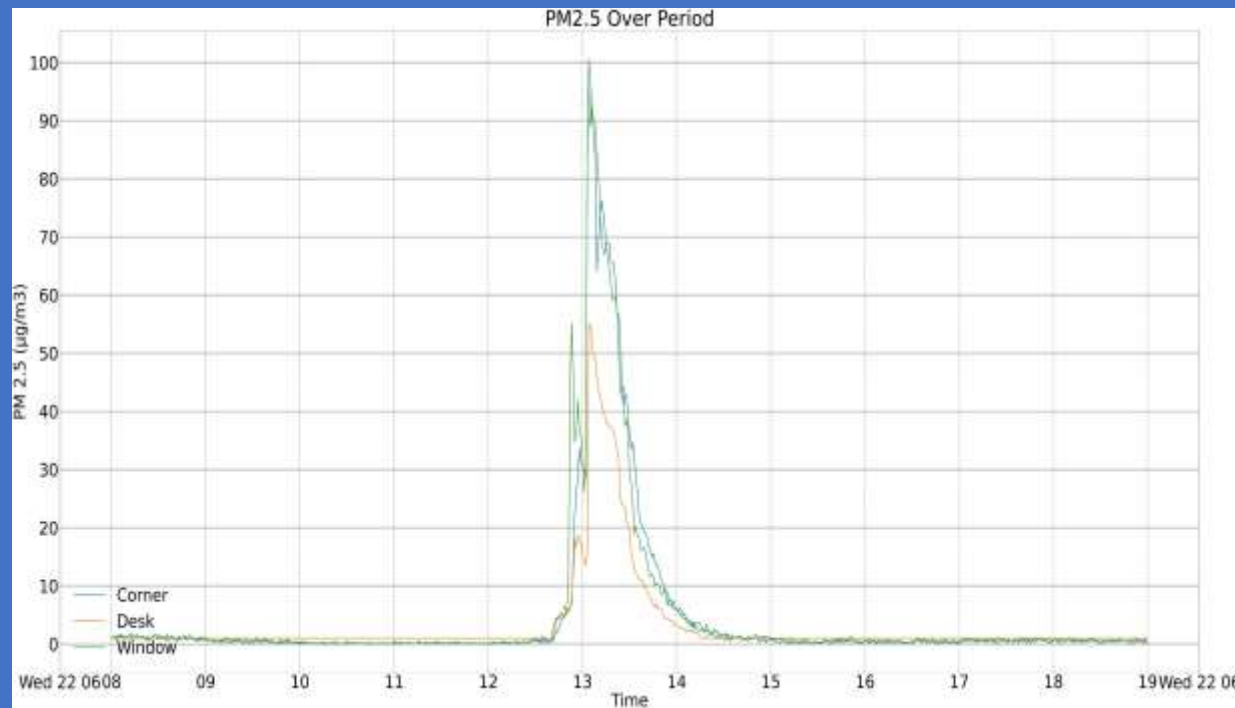
“if only 35% of the air is fresh then I’m breathing in the same air... think of the germs & dust”

“For a member of staff that’s been teaching in there every day... what’s the long term impact going to be on that member of staff?.. Like it’s quite worrying”

Results – Niche Events

Teacher - "I've gone into other classrooms, ICT, they're cooler, they have AC"

PM2.5 Rise during experiment period

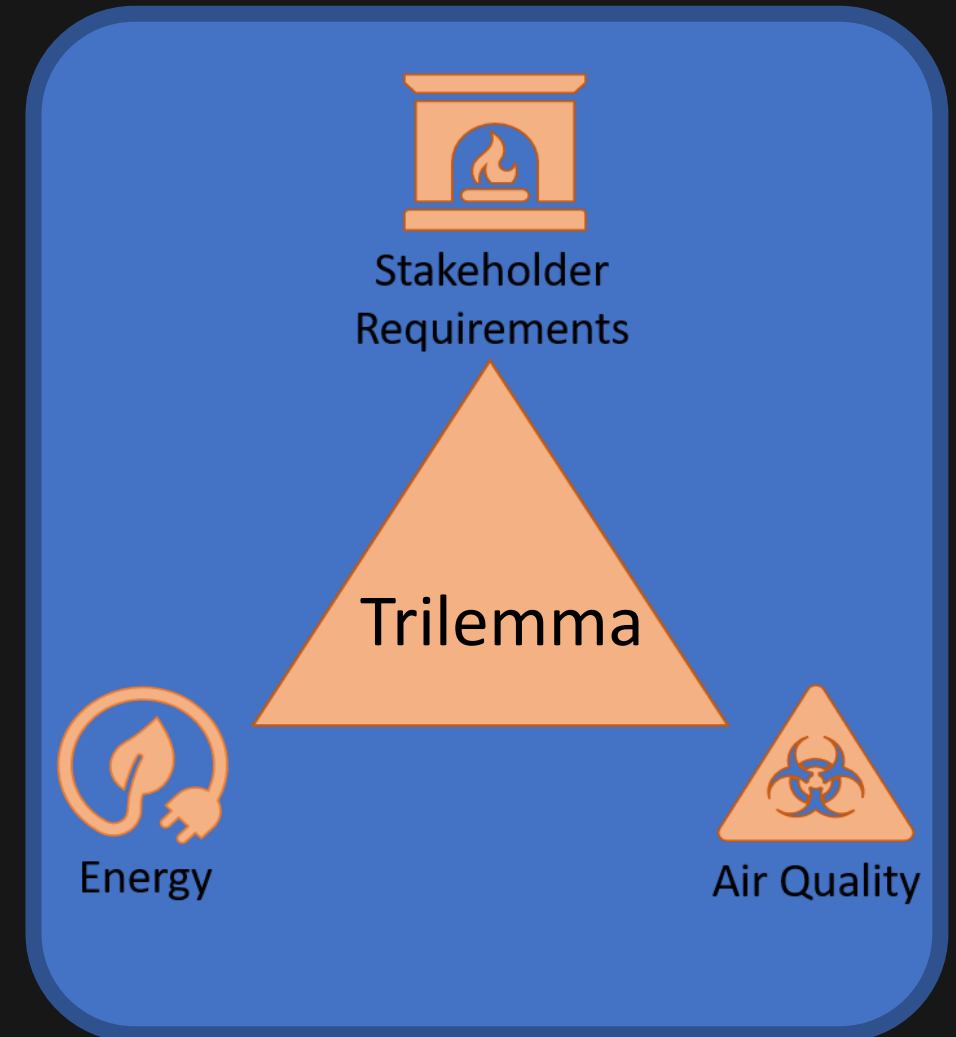


Discussion:

"I did a practical looking at the effect of either temperature and concentration on the rate of reaction... producing sulfur."
"We assume if we don't have to use fume cupboards the room ventilation will be enough..."

Conclusion

- The data shows that **air quality can vary by a large margin** across a classroom.
- **Conflict** in stakeholder needs = **inefficiencies**.
- Could be **solved by using sensors** to help make HVAC decisions.
- These sensors must be **affordable, small and simple**.
- Data collected needs to be **readable/actionable by all stakeholders** – this will be explored in future research.



Questions?

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