

An Atmosphere for Learning?

A scoping review of educational, behavioural and communication interventions to address school indoor air quality & thermal comfort



UNIVERSITY
of York

inclusive
Citizen Science



Child and Adolescent Health
Impacts of Learning Indoor Environments
Under Net Zero



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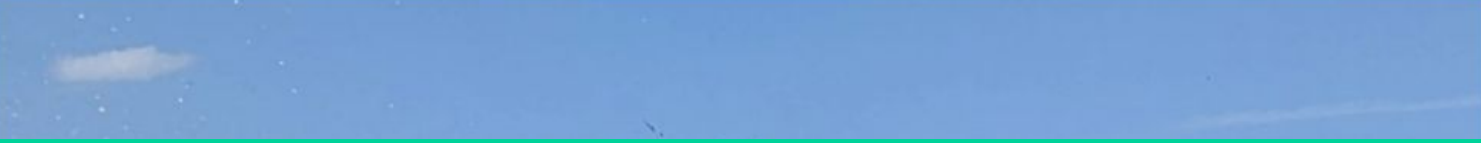
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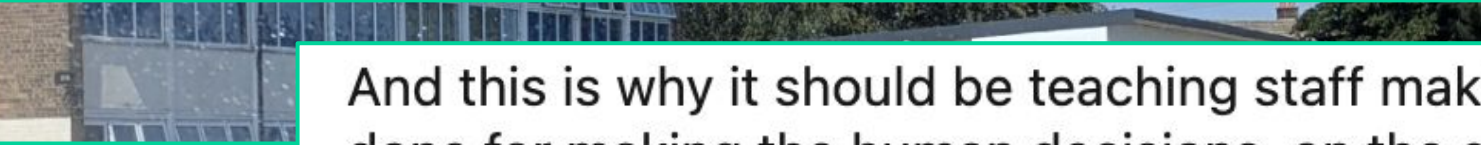
"Today, we have followed the DfE guidance, opening windows, reducing physical activity, moving breaks, relaxing uniform etc. to ensure our children and staff team are safe.

I don't think setting up a makeshift hose pipe misting station on the playground was on the DfE list of suggestions but would definitely 10/10 recommend."



Lots of physics to discuss with that from dispersion of white light into a spectrum, evaporative cooling, terminal velocity of small water droplets. The list goes on...

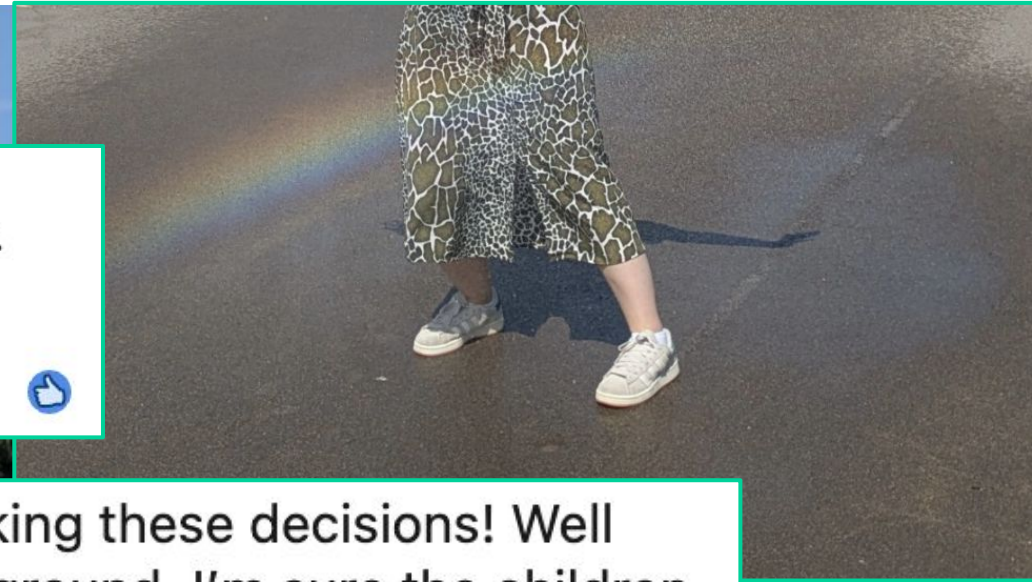
👍 4 💬



And this is why it should be teaching staff making these decisions! Well done for making the human decisions, on the ground, I'm sure the children will remember this for life 🥰

👍 4 💬

Remember this sentiment for later!





WHAT IS KNOWN

poor air quality
+
high temperatures



affects children's' health,
cognitive function,
school attendance
and attainment



WHAT WE WANTED TO KNOW

1. What is the landscape of non-infrastructure interventions targeting indoor air quality and thermal comfort in schools?
 - how effective were these interventions?
 - what contextual factors influenced the effectiveness?
2. What is the role of education, behaviour and communication in these interventions?



HOW WE FOUND OUT

- scoping review carried out using **PRISMA** guidelines
- **databases:** EBSCOhost, Ovid, Scopus and Web of Science
- inclusion **criteria:** schools (4-18 years old students) in any country, published anytime, with at least title & abstract in English
 - excluded infrastructural interventions, such as structural building modifications and HVAC installations
- some **keywords:**
 - air quality, thermal comfort, airborne pollution, overheating, indoor environmental quality, mold, heatwave



Identified **9482** papers from keywords, removed duplicates



Screened **5919** titles & abstracts $\Rightarrow$ excluded **5661** papers



Assessed **219** papers for eligibility $\Rightarrow$ excluded **129** papers



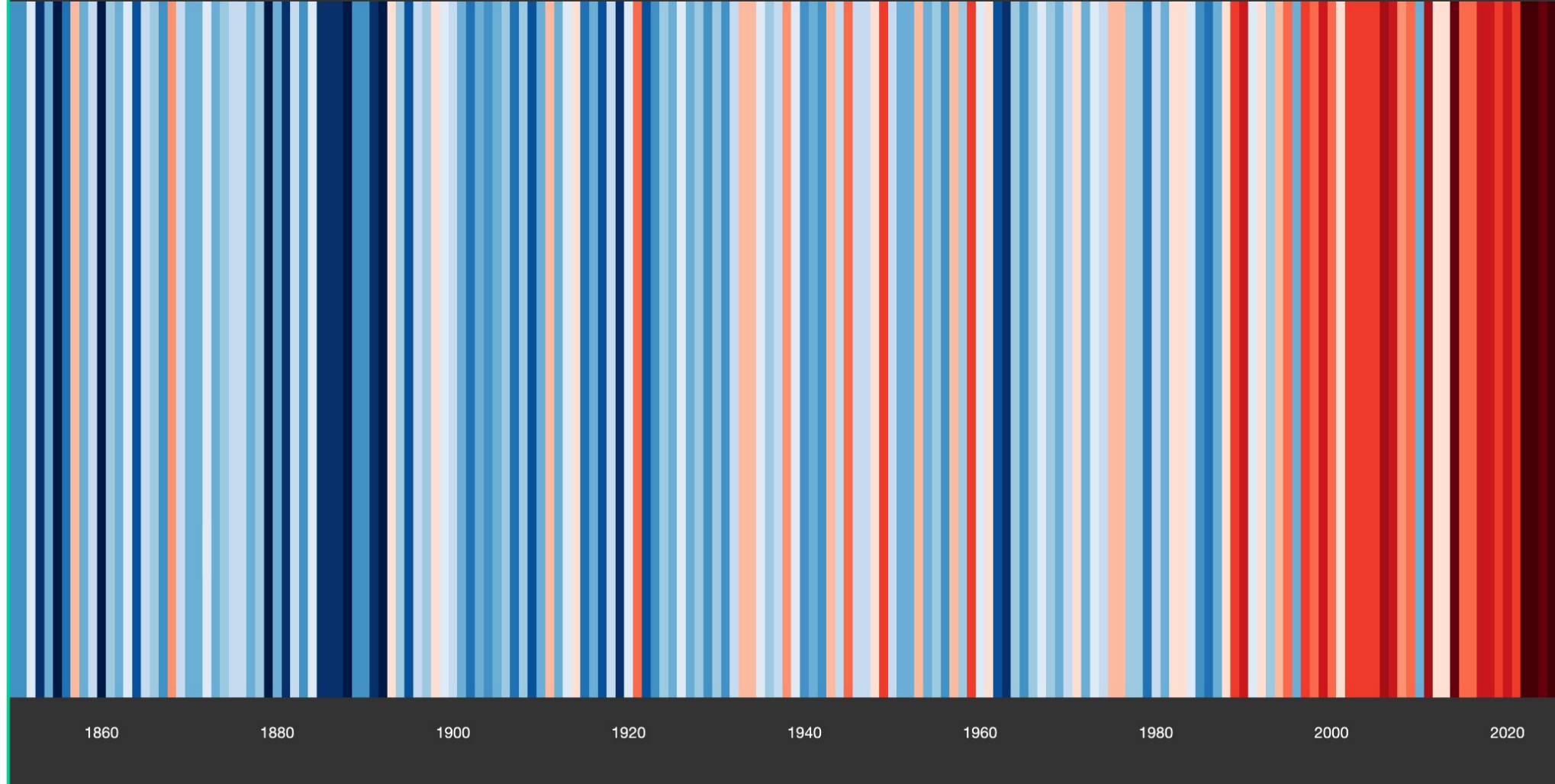
Narrative analysis of **90** papers for review

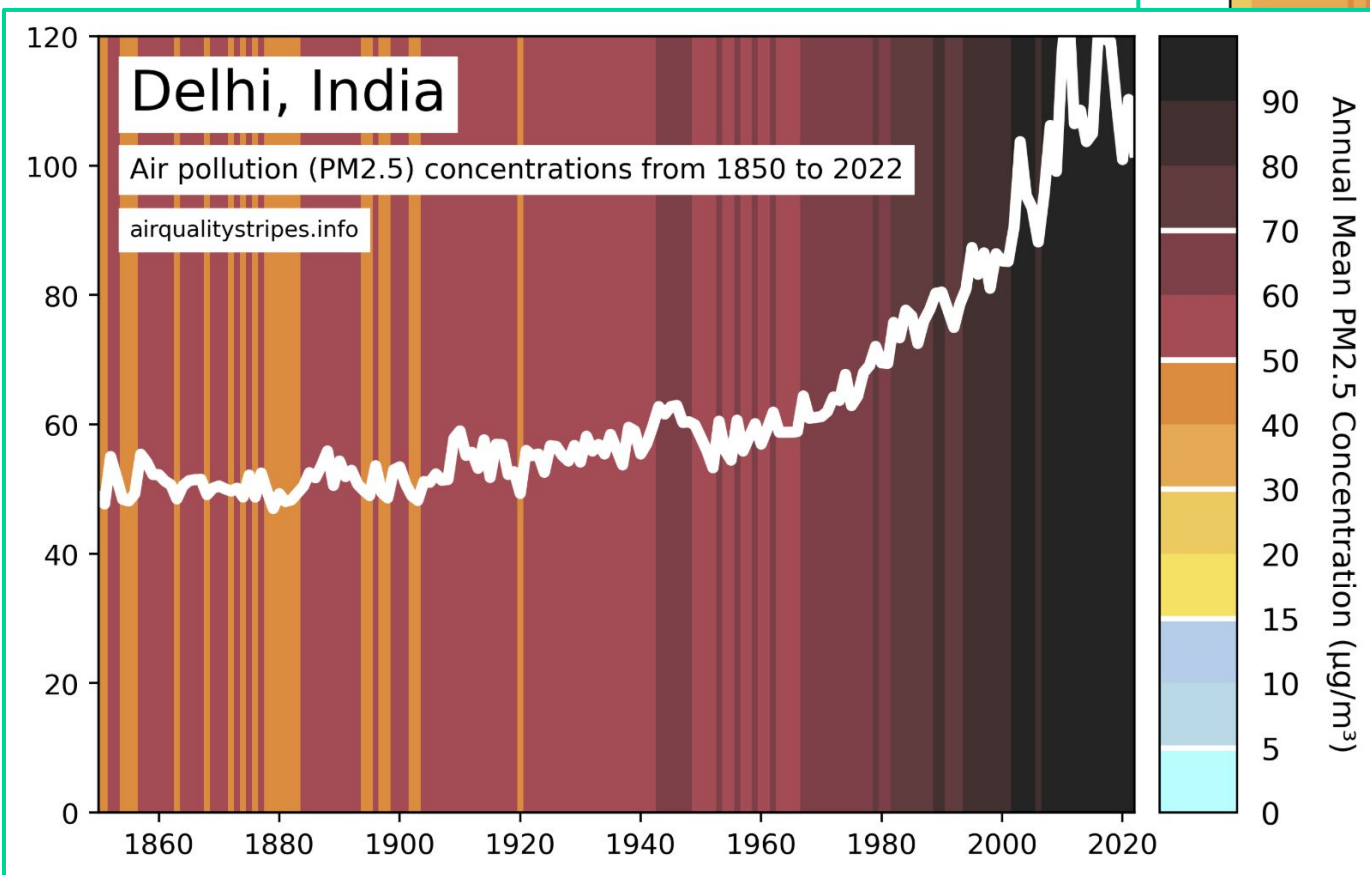
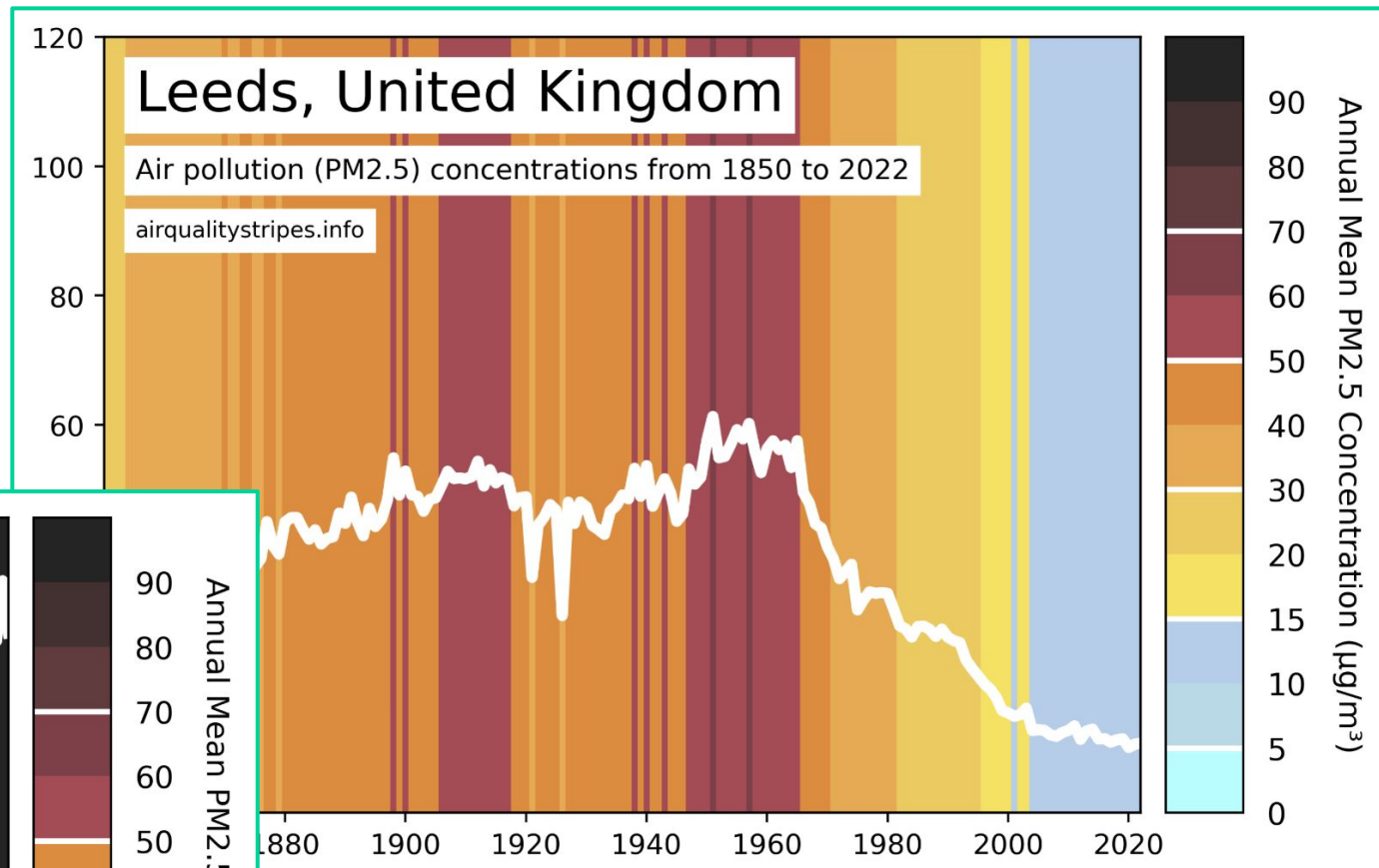


WHAT WE FOUND OUT

- 85% of studies were from North America and Europe
 - few in Asia, South America & Australia, none from Africa
- 67% of studies from primary schools
 - 18% across multiple sites, 10% in secondary school & 5% in middle school
- 64% of studies published since 2020
 - growing research topic of interest, given the climate change crisis and extreme heat events, and urbanisation and exposure to poor air quality

Temperature change in Leeds since 1850







EDUCATIONAL INTERVENTIONS (21%)

Students showed improvements in stated and inferred learning outcomes when interventions were:

- involving students and teachers in the research & project design
 - e.g. engaging in learning about air quality with external experts and building DIY air filtration units
- using a citizen science approach (public participation in research with experts)

BEHAVIOURAL INTERVENTIONS (52%)



COMMUNICATION INTERVENTIONS (27%)

- visual alert systems stating air quality condition: flags, changing images
- campaigns and posters rely on community engagement, while policies rely on incentives and protocols to improve air quality
- toolkits support understanding and provide context-specific solutions
- differing teacher, student & parent priorities for interventions

How communication systems will be used (are they disruptive?)

Who needs to access information (is it accessible for diverse groups?)

What teachers and pupils can and cannot do in response (is it actionable?)

Why schools should take part (what is the benefit in the here and now?)



MENU OF INTERVENTIONS

Intervention Type	Nature of Intervention	Key Intervention Findings	Role of pupils in intervention	Role of teachers in intervention
window and/or door opening (n = 41)	behavioural	cross ventilation with windows and doors open reduce indoor CO ₂ and PM (especially diagonally positioned in room), if outdoor PM is low (little nearby traffic) and wind conditions are favourable for air mixing	some agency to open windows and doors, modify clothing	full agency to open windows and doors
anti-idling campaign (n = 12)	behavioural educational communication	General reductions in idling times (~50% decrease), and resulting reductions of PM _{2.5} and NOx; especially if vehicles do not idle near outdoor air intakes; incentives to non-idling drivers provided positive reinforcement of positive behaviour; poster competition provided pupil learning about air pollution and advocacy	design communication about anti-idling, communicate about the campaign with school and local community	create opportunities for communication about anti-idling campaign, communicate about the campaign with school and local community
room furniture layout and ventilation (n = 7)	behavioural	U-shaped desk layout with slightly open windows reduced indoor PM _{2.5} at seated student heights	passive role	passive role
green infrastructure / trede on school grounds (n = 6)	educational	green infrastructure, e.g. ivy screen or red cedar trede (tree + hedge), reduced PM _{2.5} & PM ₁ between street and classrooms by 24-49% (statistically significant); trede should be no taller than adult height to avoid airflow restriction around school grounds	co-create infrastructure plans and execution; learn about air pollution and could influence outdoor play behaviour	co-create infrastructure plans, and develop related learning engagements



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classroom indoor air quality monitors (electronic) (n = 3)	educational behavioural	visual display of indoor air quality effective to prompt ventilation behaviour response; though sound cues are distracting and undesirable in classrooms	learn about meaning of monitor readings, potentially adjust ventilation conditions	teach about meaning of monitor readings, potentially adjust ventilation conditions
creative storytelling about thermal comfort (n = 3)	educational behavioural	effective learning tool about thermal comfort and potential behavioural responses; co-creation builds greater pupil engagement	co-create stories for learning and transferring knowledge about actions for thermal comfort	facilitate co-creation of stories and youth agency for ventilation and thermal comfort
instructions about shoes off and addressing excessive clothing (n = 3)	behavioural educational	statistically significant reduction in PM ₁₀ and PM ₁₅ in schools with socks only, compared with schools allowing shoes, especially in corridors due to organic sediment movement; about 20% reduction for total carbon concentrations	understand significance of excessive clothing on thermal comfort, and dirt from shoes affecting indoor air quality	create learning engagements about thermal comfort and indoor air quality related to what students wear
paper and petroleum jelly as no-tech sensors (n = 1)	educational	applying no-tech monitoring improved science knowledge integration; citizen science considered the social context of learning and made the topic personally relevant.	learn about meaning of monitor readings in a tactile and visual way primary students can understand and think critically about	create learning engagements about significance of petroleum jelly & paper results

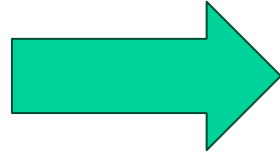


MISSED OPPORTUNITIES

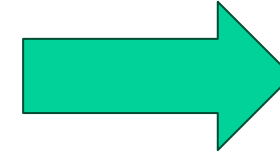
contextualize findings, engage in realistic and minimally-disruptive actions



**MORE
INVOLVEMENT**



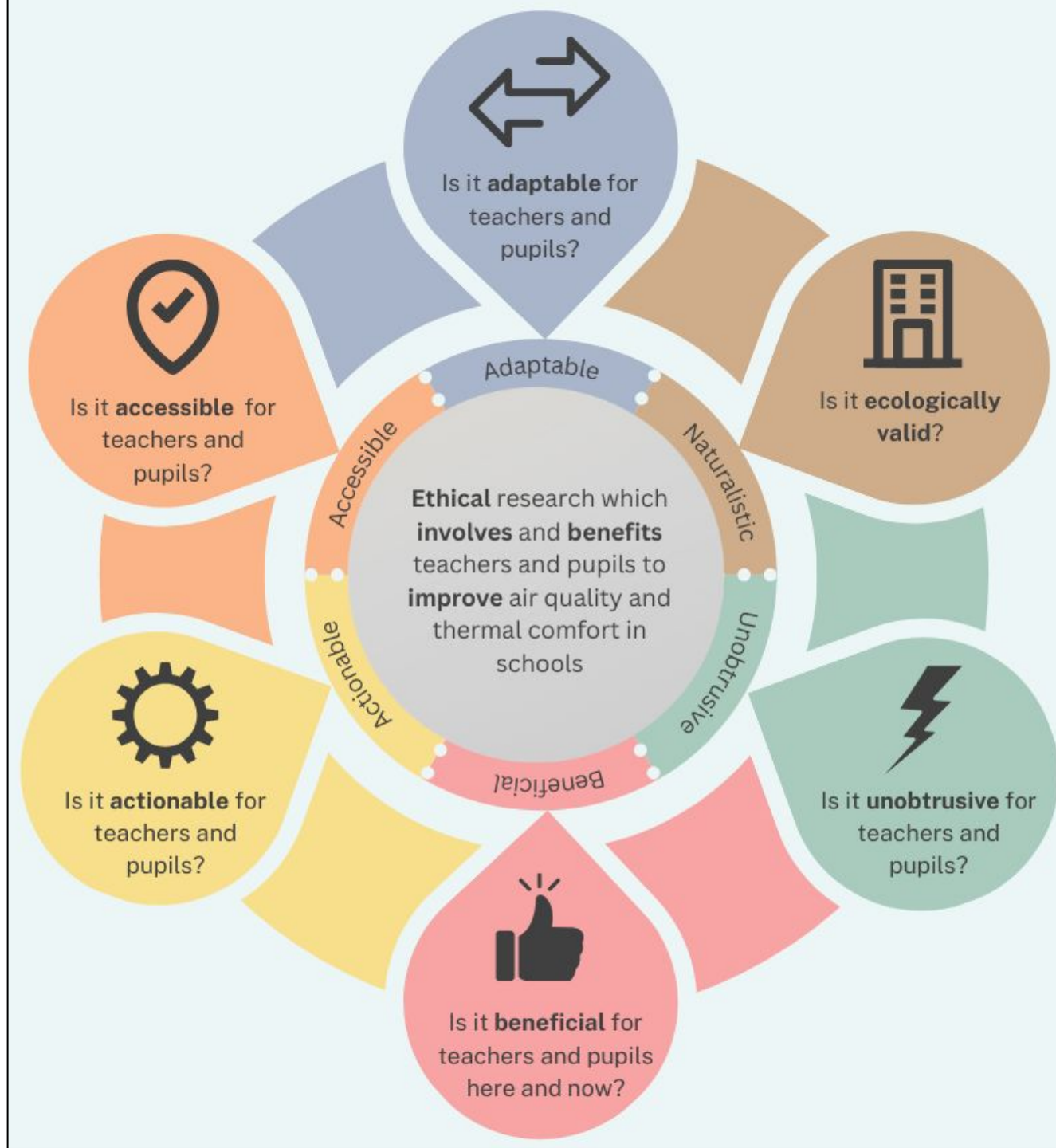
**BETTER
SCIENCE**



**GREATER
IMPACT ON AIR
QUALITY**

Key Questions

What to consider
when conducting
air quality and
thermal comfort
research **with** schools
(*and not just in schools*)



There is a need to rethink the **role of students and teachers** as more than just "subjects", and use **legitimate and contemporary educational practices** when doing environmental monitoring research with them.

Invite them on your team - your research and impact will be better for it.

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