The importance of indoor air quality and some Danish school examples

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Agenda

Indoor air quality
• Health, absence rates, performance (with slides of Pawel Wargocki)

Examples of Danish school buildings
• Vibeengen school & Nordstjerne School
Components in the indoor air

• Dust, pollen, pollen, VOC's, radon, fungal spores, smoke, ultra-fine particles

VOC's alone are counted in thousands:
• acrolein, formaldehyde, benzene, hexachlorobutadiene, acetaldehyde, 1,3-butadiene, benzyl chloride, 1,4-dichlorobenzene, carbon tetrachloride, acrylonitrile, vinyl chloride, ozone, carbon monoxide and more...

The origin of ultra-fine particles

76% of particulates in building stem from indoor sources

24% of particulates in building stem from outdoor sources
Schools suffer from bad indoor air

- 20% of EU’s population go to school
- Pupils spend 20% of their time in schools
- Children must attend school; they can not absent themselves or find another school
- The work that children are obliged to perform in schools is not optional and almost always new
- Children have far fewer ways of registering complaints
- The effects of IAQ on children are likely to be more marked than for adults as children are more vulnerable and their bodies are still growing
School environment is special

- Children (pupils) and adults (teachers and other personnel)
- Occupancy is higher in classrooms than in other buildings (offices/dwellings)
- Teaching is carried out in groups (classes) with low area/volume per person
- There should be as least as possible distraction during teaching

Standardized tests – math and reading

% of students who passed the test vs. Outdoor air supply rate (L/s/person)

- Math: 15% (3% per 1 L/sp)
- Reading: 2x

Haverinen-Shaughnessy et al., 2013
School attendance

Predicted Proportion of Illness Absence %

- Predicted Proportion of Illness Absence (%)
- 7-day Average Ventilation Rate (L/s per person)

Mendell et al., 2013

Temperature and school tasks

Performance

- Performance
- Temperature

Wargocki et al., 2012
Noise, daylight and school work

- Text comprehension and memory were negatively affected by increased episodic noise from airplanes; the effect was linear
- There were no strong effects of the continuous traffic noise (cars) on the performance of schoolwork – cognitive tasks, only episodic memory was slightly affected
- School grades in elementary schools were improved by 21% for pupils in classes with much daylight compared with classes with least daylight

Summing up

1 L/s per pupil higher ventilation rate

- Approx. 3% higher performance of schoolwork
- Approx. 1.5% lower absence rates
Danish examples of schools

Starshaped with central ‘heart’ room

- Division of school into smaller units
- Access to daylight (skylights)
- Efficient nighttime ventilation by opening of windows
- Decentral ventilation units in each classroom
Small classrooms with plenty of satellite workspaces

Breaking down long hallways into smaller spaces
Indoor air quality and temperatures

Sensations - opinions
Decentral ventilation units

Noise
Draught
Fits only one setup

Renovated and non-renovated classrooms
Decentral ventilation with improved acoustics and no draught risk

Airsupply: 950 m³/h
CO2-level: 1000 ppm

Low-noise decentral ventilation

Noise from decentral ventilation unit

Point below exhaust

Measurement points
Thank you for your attention!

Questions?