

REHVA WORKSHOP REPORT CLIMA 2007:

INDOOR CLIMATE AND VENTILATION OF SCHOOLS

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INTRODUCTION

At Clima 2005 in Lausanne a first REHVA workshop was organised about Indoor Air Quality and thermal comfort in schools (see the post conference proceedings of Clima 2005 for a written workshop summary [1]).

One of the conclusions at the Lausanne workshop was that IEQ (= Indoor Environmental Quality) is a problem in many schools all over the world. High CO₂ concentrations over 2000 ppm indicating the lack of ventilation and poor temperature control with summer temperatures often over 30 °C are quite usual.

Five recent studies in schools have investigated the linkage of ventilation rates to objectively measured school work performance [2–7]. The influence of moderately elevated temperatures on student performance was investigated via field studies conducted in classrooms [6,8]. These studies show that IEQ problems have severe consequences: recent studies have proved that this not only leads to adverse health effects and e.g. sickness absence of both students and teachers but also to severely hampered learning performance of students. It is concluded that the available scientific literature indicates the potential for 5% to 10% increases in aspects of student performance with increased classroom ventilation rates or better temperature control [9].

Another conclusion at the Lausanne workshop was that REHVA should develop more initiatives to improve IEQ in schools as heating, ventilation and air conditioning systems could play a major role in the needed improvement.

Therefore the REHVA board decided to have a 2nd workshop on ‘Indoor Climate and ventilation in schools’ at the Clima 2007 conference in Helsinki.

OBJECTIVE

The objectives of the Clima 2007 workshop were as follows:

- Making a State of the Art inventory;
- Constructing a “declaration of Helsinki” on indoor climate and ventilation of schools;
- Defining future REHVA actions needed to improve IEQ in (European) schools.

The target group for the REHVA school workshop was in general Clima 2007 attendants including HVAC, IEQ and energy consultants and installers, (HVAC) equipment manufacturers and providers of building maintenance and operation services plus building owners.

PROGRAM

The workshop was held on Wednesday, June 13, 2007 from 12.30 to 14.30 hours.
Below the program of the workshop is presented:

Time	Topic	Speakers	Organisation
	<i>Introduction by the chairs</i>		
15 min	Objective of the workshop and general introduction on indoor climate and ventilation in schools	Atze Boerstra	BBA, the Netherlands
15 min	Overview of the latest research related to ventilation and indoor environmental performance in schools	Jarek Kurnitski	Helsinki University of Technology, Finland
	<i>Discussion and consensus statements</i>		
60 min	4 x 3 minutes presentations General discussion by all workshop participants following the prepared questions of the chairs	Iwashita, Yoshino, Kumagai, Van Leeuwen All	

About 45 people attended the workshop.

WORKSHOP RESULTS AND RECOMMENDATIONS

Outcome State of the art inventory

Below the central discussions that were looked at during the workshop discussion are presented. Per question the general response (answer to the question) is described.

1. What are the main IAQ and thermal comfort problems in schools and how can these be solved?

1.1 Can we specify the main problems in old/new school buildings?

The general feeling amongst the workshop participants was: yes we can. Analysis of extensive (field) studies from all over the world show that main problems are: insufficient fresh air supply (leading to high CO₂ concentrations), IAQ problems related to insufficient cleaning, IAQ problems related to emissions from building materials, IAQ problems related to (local) outdoor air pollution problems, IAQ problems related to deterioration of (mechanical) ventilation systems over time, winter thermal comfort (e.g. draft, inability to adjust temperature) and summer thermal comfort (e.g. overheating).

One of the people present brought up that one point of worrying is that when discussion IAQ in schools, the focus is often just on bioeffluents / CO₂.

And stressed that it is important to not forget other pollutants (e.g. volatile organic compounds) too and e.g. look at emissions of building materials too.

1.2 Can we solve these problems by present day HVAC technology?

Yes. Most of the present day IAQ/thermal comfort problems in schools can be solved by readily available Heating, Ventilation and Cooling solutions.

One workshop participant mentioned that outdoor air is important too in this context. On some locations (e.g. due to contamination of outdoor air with fine particles) filtering and/or purification of the 'fresh' air might be needed.

1.3 Is it possible to build good schools for the standard budgets available?

Hardly. In many countries the standard budgets for school building and operation are insufficient. Which means that good installations and good indoor environmental quality can often not be achieved.

1.4 Could we expect similar healthy and productive IEQ in schools as in offices?

In principal: yes. In fact: because children's lungs and other organs are still developing one could argue that IEQ in schools should even be better than in offices. On the other hand: designing for good IEQ in schools is more complicated as occupancy levels in schools often about 5 times higher than in offices. Meaning that guaranteeing certain CO₂ and temperature levels is more of a challenge.

2. What standards are there? To what extent are they used?

2.1 What standards are relevant for ventilation, IAQ and thermal comfort in schools?

In general workshop participants agreed that many standards are available already describing IAQ and thermal comfort criteria for schools. Standards mentioned are for example: EN-ISO 7730, EN 15251, CR 1752, EN 13779, ASHRAE standard 55 and ASHRAE standard 62. In these standards (esp. 7730 and 15251) specific design values for schools are mentioned (often in 3 quality levels: A B C). These standards present performance criteria for CO₂ concentration, installation noise, draft, minimum temperature in winter and maximum temperature in summer (or even adaptive temperature limits partly following momentary outside temperature).

2.2 To what extent do existing schools meet these standards?

Many schools do not meet the standards. Not even the lowest 'class C / category III levels'. The estimate is that at least half of all schools worldwide (in some countries over 80%) can be labelled as having 'very bad' indoor climate.

2.3 And what about new schools?

Often but not always is the IEQ in new schools better. However, from the literature we know that also new schools can have severe IAQ and thermal comfort problems. E.g. due to malfunctioning of (mechanical) ventilation systems or excessive use of glazing (=overheating risk). Nevertheless, as one participant put is: 'The differences between old and new schools e.g. in teacher / pupil IEQ expectancy are huge. This should be taken into account e.g. when developing guidelines for both new and existing schools.'

2.4 How about Programs of Constraints: is it standard practice already to work with good performance criteria yet?

No. In most countries school building designers do NOT work with a good technical program of constraints describing IEQ performance criteria that should be met. Especially for smaller schools and primary schools in general this is a problem.

3. Which technical solutions and good practices can be recommended?

3.1 Which technical solutions and good practices for ventilation and temperature control can be recommended?

Many. See e.g. the Dutch publication initiated by TVVL and ISSO describing over 20 HVAC solutions for schools in moderate climates.

A general conclusion was that THE solution for IEQ problems in schools does not exist. Local conditions and e.g. regional climate for a large extent put a constraint on which solutions might work and which solutions might not work.

3.2 Is natural or mechanical ventilation the solution for schools?

This question lead to a lively debate. There seemed to be general consensus that different climates ask for different solutions (see above). In other words: in some countries natural supply will not work because this leads to unacceptable draft problems in winter, while in other countries mechanical ventilation is hardly an option because maintenance budgets are much to low to guarantee smooth operation and long term cleanliness of the system.

During the discussion several participants stated that the use of operable windows (e.g. as addition to basic natural ventilation with façade vents or as addition to mechanical ventilation) needs specific attention. In many situations (especially in winter) opening a window will lead to severe draught complaints. However, there are many advantages of having operable windows (e.g. direct control of building occupants over (additional) fresh air supply as long as they are used in addition to other (more structural) ventilation devices.

3.3 How about cooling? Unavoidable or not in a school?

Participants agreed that the internal heat gain (from people, lighting, computers etc) is generally very high in classrooms (due to high occupancy levels). Combine this with an often high external heat load (solar gain due to large windows on East, South or West façade) and the conclusion is at least that avoiding too high temperatures in schools at least is a challenge. Whether this challenge should be met by passive means (e.g. solar shading, extra building mass) or active means (cooling) depends (amongst other things) on the local climate.

3.4 What (new) HVAC techniques are especially promising for schools?

Several new HVAC techniques were mentioned by the participants. Some examples: displacement ventilation (very suitable in situations with high internal heat load!), personal ventilation systems (probably to expensive for schools) and phase change materials (adding to the thermally active building mass).

4. Is it possible to achieve good IEQ in an energy efficient manner?

There was general consensus that good IAQ and adequate thermal comfort does not always has to result in higher energy bills. As long as school building are designed in an integrated way (e.g. good building physics in combination with smart building systems) a class A energy performance can be combined with class A IEQ performance. There are some challenges however: for example when renovating an existing school improving fresh air supply with (advanced) natural ventilation will lead to worsened energy performance.

5. What are special considerations in the HVAC-design for schools?

School building design and e.g. maintenance differs in many ways from e.g. office building design/maintenance. The participants agreed first and for all that budgetary limitations often are an important issue. Both when trying to invest in improved HVAC systems and when trying to improve operation and maintenance. Another issue are new educational developments. 'Open school concepts' that lead to pupils moving around in class rooms and e.g. working part-time in the hallway (e.g. doing computer work) affects schools design and therefore school HVAC system design. Also: flexibility demands are changing, leading to flexibility demands on HVAC systems that in past years were not heard of.

Declaration of Helsinki

In 2000 the World Health Organisation (WHO) released a statement called 'Right to good Indoor Air' [10]. The principals presented in the statement (condensed version) are presented below:

1. Everyone has the right to breathe healthy indoor air.
2. Everyone has the right to information about potentially harmful exposures.
3. No agent at a concentration that exposes any occupant to an unnecessary health risk should be introduced into indoor air.
4. All individuals, groups and organisations associated with a building bear responsibility to work for acceptable air quality for the occupants.
5. The socio-economic status of occupants should have no bearing on their access to healthy indoor air, but health status may determine special needs for some groups.
6. All relevant organisations should establish explicit criteria for evaluating and assessing building air quality and its impact on the health of the population and the environment.
7. Where there is a risk of harmful indoor air exposure, the presence of uncertainty shall not be used as a reason for postponing cost-effective measures to prevent such exposure.
8. The polluter is accountable for any harm to health and/or welfare resulting from unhealthy indoor air exposure(s). In addition, the polluter is responsible for mitigation and remediation.
9. Health and environmental concerns can not be separated, and the provision of healthy indoor air should not compromise global or local ecological integrity, or the rights of future generations.

In line with this WHO statement a RHVA declaration on indoor environment in schools was developed during the Clima 2007 conference. The draft version of the text was discussed during the workshop and changed where necessary.

Below the final version of this 'declaration of Helsinki' is presented.

REHVA DECLARATION OF HELSINKI ON INDOOR ENVIRONMENT IN SCHOOLS

1. Indoor Air Quality (IAQ) and indoor environment in the majority of schools worldwide is inadequate. This leads for both pupils and teachers to unacceptable health effects, poor comfort and lower learning performance.
2. All children & teachers, independent of socio-economic status, have the right to breathe healthy air at school. The quality of the indoor environment should stimulate (the joy of) learning.
3. REHVA's nr. 1 mission for the next decade is to ensure that IAQ and indoor environment in schools is improved to minimum levels as described in standards like EN 15251, EN-ISO 7730 and EN 13779.
4. School building users have the right to information about the importance of healthy air at school and potentially harmful exposures. REHVA will initiate and support the dissemination of knowledge on good IAQ where possible.
5. HVAC systems for schools should be designed, installed, operated and maintained in such a way that unnecessary health risks from indoor air are minimised, whether harmful agents are of outdoor or indoor origin.
6. HVAC consultants, installers, HVAC equipment manufacturers and others involved in school buildings bear responsibility to achieve good IAQ.
7. Special needs for some groups should be taken into account. Vulnerable building users like children with asthma ask for 'class A' IAQ.
8. REHVA will disseminate performance criteria to be used for design and evaluation of IAQ and indoor environment in school buildings.
9. Decisions about school HVAC systems should be based on life cycle cost instead of investment costs.
10. Indoor Air Quality optimisation in schools should be combined with improvement of energy performance. For example by choosing passive ventilation and passive cooling solutions where possible.
11. Adequate operation and thorough maintenance of HVAC systems are essential for creating a healthy learning environment. So is consequent monitoring of IAQ and other environmental parameters.
12. REHVA should take action to establish a 'WellBeing Indoors label' to be used in combination with the EPBD Energy Performance label.

Future REHVA actions

The most important conclusions concerning the question ‘What REHVA actions are needed to improve IEQ in schools?’ are presented below:

- A 2 track dissemination approach is needed. One track addressing the ‘How question’ (How can schools be improved? What techniques are available to improve IEQ?). And one track addressing the ‘Why question’ (Why is bad IEQ in schools a problem? What are the (health, learning performance etc) consequences of inadequate IEQ in schools?) We could start with developing the ‘Why pamphlet’ and publishing it on the REHVA website...

Please note that in the context of this ‘2 track suggestion’ the idea was discussed to write a standard REHVA publication on IEQ in schools. Amongst the participants there seemed to be several people that doubted whether ‘yet another REHVA publication’ is what the world is waiting for. The spin off of such a publication might be limited (of some REHVA publication only 30 or so copies are sold) according to some. Other ways to ‘spread the news’ might be more effective...

- Maybe the ‘paybacktime argument’ should be the main argument for REHVA towards third parties. Meaning that possible financial gains of better IEQ (and better HVAC systems) should be made visible. Looking not just at energy savings (if they are there) but also at e.g. personell costs savings due to lowered sickness absence of teachers and e.g. student costs due to higher student performance.
- Another possible action could be to keep IAQ and thermal comfort in schools on the agenda of the HVAC community by initiating follow up workshops at e.g. the next Clima 2010 conference in Turkey, the next Indoor Air 2008 conference in Denmark and the next Healthy Buildings conference in the US.

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