The Importance of Acoustics & IAQ in Efficient Learning

Jason Hird - Saint-Gobain Gyproc
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INTRODUCTION TO SAINT-GOBAIN GROUP

2018 net sales $47 BN

Present in 67 countries

More than 80% of sales are made in the habitat markets: construction, renovation, infrastructures and civil engineering

Created more than 350 years ago

More than 180,000 employees and 100+ nationalities represented

More than 4,100 sales outlets

One of the top 100 industrial groups in the world with around 950 production sites
Main businesses

Building glass  Plasterboard and Gypsum  Insulation  Acoustic ceilings  Complete pipe systems  Renders and mortars  Technical textiles  Interior and exterior Solutions  Automotive glazing  Abrasives

Specialist brands

Electrochromic glass  Window film  Architectural Membranes  Fire resistant glass  Bearings  Flexible tubing  Refractories  Polymer seals  Adhesive foams  Ceramics for energy
How important is acoustics & indoor air quality in our schools?
Noise is the second largest cause of health problems after air quality.

Evidence indicates that those chronically exposed to high levels of environmental noise have increased risk of cardiovascular diseases.

Noise pollution is considered a threat to public health.

Exposure to excessive noise reduces the cognitive ability in school-age children and impairs their learning.

How noisy are schools?
Where does ‘noise’ in education come from?

1. Multiple & competing classroom discussions
2. Sports activities
3. Movement of chairs and equipment
4. Noisy corridors and dining areas
Background noise levels in dB (decibels)

Average measured level throughout the day = 70 dB

Source: Heriot-Watt University Study
Excessive noise levels in schools

**75dB**

Children's hearing risks being damaged at noise levels exceeding 75 Decibels (dB)

**85dB**

Employers must provide hearing protection and hearing protection zones at 85 Decibels (daily or weekly average exposure)

<table>
<thead>
<tr>
<th>Room/space</th>
<th>Activity</th>
<th>Sound level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports hall</td>
<td>games</td>
<td>89 dB(A)</td>
</tr>
<tr>
<td>Corridor</td>
<td>break</td>
<td>85 dB(A)</td>
</tr>
<tr>
<td>Classroom</td>
<td>lesson</td>
<td>86 dB(A)</td>
</tr>
</tbody>
</table>

Examples of excessive sound levels in schools. Source: Polish Association of Health Education. Publication: Eco Education
WHY IS NOISE CONTROL SO IMPORTANT?

Scientific studies prove that noise levels have a **significant effect** on **educational achievement**
All children are affected by poor classroom acoustics

- Visually impaired
- Learning difficulties
- Behavioral problems
- Hearing loss, either permanent or temporary
- Children who speak multiple languages
Key parameters for good room acoustics

Reverberation time

Speech Clarity
Reverberation

The speed at which sound energy disappears in a room

Long reverberation times:

- No acoustic treatment
- Rooms with hard / reflective surfaces
- Rooms that ‘echo……echo……echo’
- Makes hearing & understanding speech difficult
- Can contribute to high noise levels
Reverberation

The speed at which sound energy disappears in a room

Short reverberation times:

- Acoustic treatment
- Room seems to be quiet and calm
- Easier to hear and understand speech clearly
- Can help to reduce noise levels
Reverberation

The speed at which sound energy disappears in a room

Long/High reverberation – No acoustic treatment
Reverberation

The speed at which sound energy disappears in a room

Short reverberation - acoustic treatment
Understanding Speech – Speech Clarity

- Vowels create the sound volume of speech
- Consonants are the bearers of information
Speech clarity

Concerns the quality of speech transfer to the listener

Unclear Speech:

- Words reverberate and get ‘mixed up’
- Consonant letters are lost at certain frequencies
- Difficult to hear and understand speech
Speech clarity

Concerns the quality of speech transfer to the listener

Clear speech:

- Words are easy to hear and understand
- Makes it easy to follow instructions
- Good Speech Intelligibility
Research shows that children sat in ‘dead spots’ in a classroom can have a 100% loss of consonants. These children would only hear the vowels in speech. They cannot understand what the teacher is saying.

Source: Heriot-Watt University Study
100% loss of consonants

-o-e --a---oo-- -a-e -oo- a-ou--i--
100% loss of vowels

s-m- cl-ssr--ms h-v- p--r -c--st-cs
Good speech intelligibility

some classrooms have poor acoustics
Poor acoustics have a negative effect on educational achievement

- With better speech clarity, there is a 25% greater understanding of speech.
- With good acoustics, there is a 5-7% better result in test scores.
The impact of acoustics on reading development

Children reading in a noisy environment were 1 year behind developmentally to those reading in quiet environments.

Reference: Sutherland, L., Lubman, D., 2001
The story of Midas and his drawings

- Danish ADHD (Attention Deficit Hyperactivity Disorder) Association
- Midas was asked to do his favourite drawing
- Classroom was asked to be silent
The story of Midas and his drawings

- Midas was asked to draw the same picture a second time
- The other pupils could talk but not to Midas
- Same drawing in a noisy environment
Comparison of the drawings

Quiet Environment

Noisy Environment

Pictures from 'Sound Education Seminar', Camilla Lydiksen, CEO ADHD-foreningen
The effect of excessive noise on teachers
Working Sound Pressure Level (SPL) and average Heart Rate_{5min} of the teacher

Source: Saint-Gobain Ecophon & University of Bremen
Teachers working in a good acoustic environment...

- Can work with a relaxed heart rate for more than 80% of the time (it was just 60% in the noisy environment)
- Can reduced their heart rate by 10 beats per minute
- Took less days off sick
- Suffered less voice and throat problems
- Suffered less head aches

Source: Heriot-Watt University, University of Bremen, Saint-Gobain Ecophon
FOUR FEATURES FOR HEALTHY, GREEN SCHOOLS

1. INDOOR AIR QUALITY & VENTILATION

Every 100 parts per million increase in CO₂ was associated to a roughly one-half day per year reduction in school attendance.

2. DAYLIGHTING & LIGHTING

Students in the US showed a 36% increase in oral reading fluency when exposed to high-intensity light, while those in standard lighting conditions increased by only 16%.

3. THERMAL COMFORT

Students citing their classroom as 'comfortable' achieved 4% more correct answers in a math test compared to those who were hot.

4. NOISE & ACOUSTICS

Noise can hurt test scores: for every 10 decibel increase in noise, the language and math scores of French students decreased by 5.5 points.
Acoustics in Schools

WorldGBC believes in green buildings for everyone, everywhere. Schools are no exception. We call for schools that are energy efficient, have low greenhouse gas emissions, and schools which are designed and operated for children’s health, wellbeing and performance.

To help, Better Places for People has produced a series of briefing notes, focusing on four features of indoor environmental quality. These are intended for school board decision-makers, as well as school designers and facility managers, to share how design and operation features affect students’ health and, in turn, their academic performance. By combining health, wellbeing and low carbon operation, we can ensure students spend their days in truly green school buildings.

**PROBLEM:**
Poor acoustics in schools can negatively affect children’s health and academic performance.

**SOLUTION:**
Thoughtful school design and operation can improve acoustics and improve student health and performance. This can also most often be done without increasing greenhouse gas emissions.
What are acoustics?

Acoustics, or noise are typically measured using:

- The **background noise level**, measured in decibel (dB)
- **Reverberation time**, which measures the time a sound can travel in a room (a low reverberation time is desired to minimize echo and disturbances).
Acoustics affects children's health and comfort

Poor acoustics in classrooms can directly impact student health and behaviour:

- Hearing Loss
- Changes in Heart Rate
- Higher Blood Pressure
- Decreased Wellbeing & Higher Stress Responses
- Attention Deficit Hyperactive Disorder (ADHD) & Aggressiveness
- Sleep Disturbance, Fatigue & Irritability
Acoustics affects children's performance at school

**Internal sources of noise**

- **Lower student achievement**
  - Scores were recorded in Florida schools with loud HVAC systems compared to students in quieter classrooms (3)

- **For every 10-dB increase**
  - In noise, the language and math scores of French students decreased by 5.5 points (4)

**External sources of noise**

- **Lower reading levels**
  - Were recorded in students located near a major New York airport (6) and London’s Heathrow Airport, compared to those in a quieter location (7)

- **Students in a UK school located in a flight path**
  - Misheard 1 in 4 words, affecting language acquisition skills (5)
The natural sound environment supports teaching and learning.
Use a sound absorbing material

Use a sound absorbing material

Transmitted energy

Absorbed energy

Incident sound energy

Reflected energy
Bring the outside environment inside
Bring the outside environment inside
Bring the outside environment inside
What is the solution?
Give every child the best conditions for learning and for personal development

Empower the teacher, reduce vocal stress

Students’ results for reading and learning are directly correlated to background noise levels
Acoustic solution: Ecophon Focus™ Ds and Ecophon Solo™ Square

Classroom
Acoustic solution: Ecophon Solo™ Freedom

Children's Creative Center
Acoustic solution: Ecophon Master™ Matrix

Lecture Theatre
Acoustic solution:
Ecophon Solo™ Square

University Cafe
Acoustic solution:
Ecophon Solo™ Baffle in Colour S 2050-B

University Break Out Area
Acoustic solutions: Ecophon Super G™ A

Sports Hall
Untreated
It is good design practice to separate noisy from quiet areas when designing the interior layout.
Acoustic design of schools: performance standards

Building bulletin 93

February 2015
Indoor internal environment affects concentration

- Disturbing noise
- Poor lighting
- Wrong temperature
- Poor air quality
FOUR FEATURES FOR HEALTHY, GREEN SCHOOLS

1. INDOOR AIR QUALITY & VENTILATION
   - Every 100 parts per million increase in CO₂ was associated with a roughly one-half day per year reduction in school attendance.⁴

2. DAYLIGHTING & LIGHTING
   - Students in the US showed a 36% increase in oral reading fluency when exposed to high intensity light, while those in standard lighting conditions increased by only 16%.⁷

3. THERMAL COMFORT
   - Students citing their classroom as 'comfortable' achieved 4% more correct answers in a math test compared to those who were hot.⁵

4. NOISE & ACOUSTICS
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SOLUTION:
Thoughtful school design and operation can improve indoor air quality and improve student health and performance. This can also most often be done without increasing greenhouse gas emissions.
What is indoor air quality?

Indoor air quality (IAQ) is defined by the concentrations of various pollutants, including:

- Carbon dioxide (CO₂)
- Volatile organic compounds (VOCs)
- Moulds
- Dusts
- Airborne fungi

Specific concentrations of these pollutants, as well as ventilation rates, have been linked to sick building syndrome (SBS).
Indoor air quality affects children's health and comfort

- Indoor exposure to VOCs has been associated with SBS symptoms in schoolchildren.
- Elevated CO₂ levels have been linked to symptoms of wheezing among children.
- Low ventilation rates have been associated with an increase in incidences of SBS and nurse visits.
Indoor air quality affects children's performance at school

**Examples of Positive Impact**
- In a study of 100 US elementary classrooms, there was a **2.9% and 2.7% increase** in math and reading scores, respectively, for each litre per second per person increase in ventilation rates.
- Higher ventilation rates have been associated with faster and more accurate student responses for colour, picture memory and word recognition.

**Examples of Negative Impact**
- A 1000 parts per million (ppm) increase above ambient levels of CO₂ has been linked to a **10-20% increase in days away from school**.
- Every 100 ppm increase in CO₂ was associated to roughly one-half day per year reduction in school attendance.

*Source numbers refer to the cited references.*
Indoor Air Quality – Better Air, Better future

90%
- Approximately the amount of time we spend indoors

4%
- More than 4% of people suffer from asthma worldwide, with a higher prevalence in children (about 14%)

8%
- Is the increase in the speed performance of schoolwork done with the appropriate air supply
Use low emitting and certified building materials
Active Air – Clears the air

- The first Gypsum board to clear the air!
- Uses an innovative technology to actively improve indoor air quality by taking formaldehyde out of the air
- Converts formaldehydes into safe, inert compounds that are captured in the board
- Cannot be released back in to the air
- Keeps working for 75 years
• Made with special additives in the core of the board

• Meets LEED requirements for buildings to have <26ppm VOC’s

• Aids concentration and learning from cleaner air

• Available as standard with Gyptone perforated acoustic tiles & boards
THANK YOU FOR YOUR ATTENTION