When in noise – “I can’t hear myself think!”

how does it affect teaching and learning activities?
Education is changing….
It is no longer like it was in my day!
More engagement is needed!
#IEQ Indoor Environmental Quality

- **Illuminance**: 1,666 lux
- **Noise level**: 57 dB
- **Temperature**: 22.9°C
- **Humidity**: 38%

© Ecophon Group
Noise is now recognised as second most damaging to our health after air pollution
Drawing in a quiet environment
Same drawing in a noisy environment
Same child / drawing different sound levels

Pictures from ‘Sound Education Seminar’, Camilla Lydiksen, CEO ADHD-foreningen
Acoustics in and beyond the classroom

Create the natural outdoors - outdoors vs indoors
Our resources - human capital in EDUnet

- Design and acoustics
- Acoustics and surveying
- Pedagogics and networking
- Acoustics and measurements

Expertise in NET

- Architecture and acoustics
- Teaching and technical
- Pedagogics and teaching
Key Classroom acoustic studies:

EDUnet
Drive & cooperation

Acoustic focus on teaching and learning conditions. Improved teacher working conditions. Improve student learning conditions.

Increasing acoustic shows a clear link preferred acoustic qualities for both teachers and students.

High performance acoustics leads to higher educational quality.
Work Load Stress

Working SPL and average Heart Rate_{5\text{min}} of the teacher
Classroom noise and concentration

Increase of Basic SPL ($L_{A95}$) before and after refurbishment

Data: Lab School, all lessons
Teaching styles and sound level differences

Working Sound Pressure levels ($L_{Aeq,5min}$) before and after refurbishment

Data: Lab School, all lessons
Essex Study- Optimised classroom acoustics for all

Study financed by Essex County Council, NDCS, FPS and the ANC
Carried out by Hear2Learn and AJA Ltd

Is there a benefit designing for the Inclusion of Hearing Impaired students
- for all students and teachers?

(2007- 2012) UK
Essex Study - 4 classrooms – 3 acoustic criteria

1. Untreated “control” room
2. BB93 Min (Tmf)
3. BB93 Hi (Tmf)
4. BATOD (125-4000Hz)
Sound Education
Essex Study - “Balloon pop” - room response
Short Version Bad - Good
Visit www.soundeducation.tv
Eliminating the perceived negatives
Sound levels (SNR) – ”Reverse Lombard”

Measured over 120 hours of lessons

- Untreated: 8 dB(A)
- BB93: 18 dB(A)

dB(A)
Activity Based Acoustic Design approach
Need for balancing room acoustic qualities

- Sound
- Speech Clarity
- Reverberance
- Reverberance in low frequencies
Acoustic conditions for Speech, Listening & Learning

Room acoustics

Speakers voice

• Hear the speech clearly
• Understand what is said
• Remember what was said
• Capacity to think

Listeners ears
Typical persons hearing threshold

- Pain threshold
- Normal hearing threshold
- The area audible by the human ear

Sound level, dB

Fundamental tone area
- Vowels
- Voiced consonants
- Unvoiced consonants

Frequency, Hz

Ecophon
SAINT-GOBAIN
A SOUND EFFECT ON PEOPLE
1. Impaired hearing
Speech (im)balance - Information and Energy

Consonants

Vowels
Reducing unwanted reflected sounds

Promoting positive sounds
Summary for speech and listener comfort

Traditional teaching and group work

Speaker comfort

Listener comfort

Acoustic Sky

Acoustic Forest

Reflector
Benefits of combined acoustic systems

1. Lower sound levels
2. Balance speech & hearing frequencies
3. Increase the speech intelligibility
4. Increase speaker comfort
Flexible classroom solutions - beyond min standards

- Working environment – Teachers` speech comfort
- Learning environment – Students` listening comfort
Other spaces, beyond the traditional classroom

Moving around, communicating and concentrating

As students and teachers leave one class they should be able to relax and prepare for the next one. But since corridors and breakout spaces are increasingly used as learning environments and group work areas during lesson hours, they have become areas that are highly multipurpose. At any given time there can be people moving from class to class, students talking and playing around, group work and individual students trying to concentrate. If left unchecked, a cacophony of noise will easily be created. The noise will spread throughout the space and can also enter adjoining classrooms.

The key to turning these spaces into good sound environments is to stop sound from spreading.

**Challenge:** To reduce sound levels and to prevent sound from spreading.

**Solution:** Using a sound-absorbing ceiling with good absorption qualities and high efficiency in reducing sound propagation, and wall absorbers wherever needed and possible.

Corridors and breakout spaces need to be able to cope with the unexpected. It is therefore a good idea to make sure that the ceiling is impact-resistant. This will increase its durability.
Educational Environments Research
- Innovative Learning Environments and Teacher Change

Australasian educators and their industry partners are going to explore how space enhances teaching.

The University of Melbourne’s Learning Environments Applied Research Network (LEaRN) is partnering schools in NSW, Queensland, the ACT, Victoria and New Zealand to research how teachers can utilise ‘innovative learning environments’ to improve their teaching skills.

The Innovative Learning Environments and Teacher Change project was awarded a four-year ARC...
ILETC – background and aims

• It is becoming clear that new learning environments require new teaching methods, and apart from a small number of examples, teaching practices in ILEs remain the same as in traditional classrooms.
• This project aims to demonstrate how maximising the use of ILEs facilitates improved teaching practices and learning outcomes. It will collect data on how teachers enable learning most effectively in ILEs and identify causal evidence concerning the relationship between quality teaching and effective use of ILEs.

This project will bridge the gap between the unrealised educational potential of innovative learning environment design and how they are currently used.
ILETC – further aims

• Develop mechanisms to identify "teacher mindset" characteristics.
• Develop strategies to assist teachers to maximise benefits available by the spaces in which they teach.
• Conduct research on the effect this increased knowledge has on the quality of teaching, student’s deep learning and learning outcomes.

Can altering teacher mind frames unlock the potential of innovative learning environments

Collaborating on effective use of these learning spaces

Acoustics is included, 1st time in a large pedagogic study
Beyond traditional cellular learning spaces…

Key considerations for a transition from cellular to open learning landscapes.

Guidance for the transition from cellular to open learning

1. Educational vision
2. Pedagogic approach
3. Activity Based Working
4. Case study examples
5. Simple Activity Based Acoustic Design guidance

Figure 1. Dovey and Fisher’s learning space typologies (2014), adapted by Soccio & Cleveland, 2015
Innovative Learning Environments
Teaching control vs Learning Freedom
Matching the activities to the spaces
Mobility - for teachers as well as students

If collaboration is important, how frequently do teachers engage in it? The picture is actually mixed. When it comes to informal exchange and co-ordination, teachers are generally very active. However, the kind of deep professional collaboration I referred to … is actually quite rare … And the picture is similar for collaborative professional development … on this you still find only a third of teachers doing this at least once per month. And least frequent is classroom observation that you also saw closely related to job satisfaction.

(Andreas Schleicher, OECD 2016)
Devolved responsibility for learning

The Gradual Release Model

**Teacher Responsibility**

- Focus Lesson: Modeled Instruction
  - I do it (you watch)
- Shared Instruction
  - We do it (together)
- Guided Practice
  - You do it (I watch/guide)
- Independent Practice
  - You do it alone (Reflect)

**Student Responsibility**

Figure 1: The Gradual Release Model
Teaching and Learning Typologies - ILETC
Learning Space Typologies - ILETC

Figure 1. Dovey and Fisher’s learning space typologies (2014), adapted by Soccio & Cleveland, 2015
Witzenhausen semi-open school

-Pedagogically open but acoustically closed
Sound mapping across the spaces
Witzenhausen Semi-open school case study
Typical classroom space

Witzenhausen School, Germany –
how to create a semi-open learning environment, with successful acoustic detailing

- Glass screening allows daylight into previously gloomy corridor, but prevents sound transmission between classroom and breakout space
- Plasterboard barriers in the ceiling void prevents room to room sound transmission
- Wall of storage prevents sound transmission + functionality
- Side-on entry to classroom greatly reduces noise ingress and sound transmission out
Breakout and multi-purpose spaces

Witzenhausen School, Germany – how to create a semi-open learning environment, with successful acoustic detailing

Ecophon Focus DS
Class A suspended ceiling

Plenty of natural daylight, which also illuminates the breakout spaces

Akusto Texona acoustic wall panels, flush into plasterboard – prevents flutter echo and reduces the overall sound pressure level

Akusto Texona wall panels, fitted flush into 3 layers of 12.5mm plasterboard – reduces the sound pressure level in breakout spaces
Balancing transparency & acoustic control
Sound reduction over distance

Rm 163

Rm 164
Line of sight vs line of sound

Rm 163

Rm 164
Sound reduction from classroom to classroom

RT: 0.48s (Reverberence)  
C50: 8dB (Speech clarity)  
STI values >0.7 (Good – Excellent)  
(Speech Transmission Index)

Corridor:  
STI values around 0.5 (Poor – Fair)

Adjacent / neighbouring classrooms:  
STI values <0.2 (Bad)

Figure 4.8  
Sound propagation along measurement path S3.
2D sound mapping – speech perception
Werkplaats existing & extension building

Traditional semi-open and new open learning landscapes
Existing classroom - sliding door
De Werkplaats School in the Netherlands
Sound mapping across the spaces
<table>
<thead>
<tr>
<th>Sound Source</th>
<th>To Class breakout</th>
<th>To Adjacent class breakout</th>
<th>To Adjacent classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rm1 door open &amp; Rm2 door open</td>
<td>10dB</td>
<td>20-25dB</td>
<td>27-33dB</td>
</tr>
<tr>
<td>Rm1 door closed &amp; Rm2 door open</td>
<td>23dB</td>
<td>30-35dB</td>
<td>38-42dB</td>
</tr>
<tr>
<td>Rm1 door closed &amp; Rm2 door closed</td>
<td>23dB</td>
<td>30-35dB</td>
<td>37-43dB*</td>
</tr>
<tr>
<td>Recommended standard for attenuation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended standard for sound insulation between rooms</td>
<td></td>
<td></td>
<td>40-45dB</td>
</tr>
<tr>
<td>Recommended standard for sound insulation for doorsets</td>
<td></td>
<td>30-35dB</td>
<td></td>
</tr>
</tbody>
</table>

Werkplaats Bithoven

Configuration 2 - Door 1 closed, door 2 open to circulation area

Figure 3

Measured sound pressure levels ($L_{Aeq}$) as a result of the reference sound source in position S1. Sliding door 1 is closed, sliding door 2 is open.
Age appropriate spaces - acclimatisation

Age Funnel

Pedagogy manifested in physical spaces - teaching vs learning

- Lecture
- Reading
- Practice

- Explore
- Discover
- Teach

Discipline

Learning by heart

Reflection

Creativity

Classroom

Cluster

Learning landscape
Werkplaats - New Extension
Sound level reduction mapping
Data: word doc/upcoming LBPSight report & ppt
Werkplaats - New Extension

More wall absorption added to reduce class to class disturbance
Good acoustics not just for traditional classrooms

- Starting with the key teaching and learning activities in the classroom
- Good acoustics is a necessity for all learning activity spaces
Spaces where we can hear ourselves think!

‘I never teach my pupils; I only attempt to provide the conditions in which they can learn.’

- Albert Einstein
Thank you for listening
Online news service about room acoustics

http://www.acousticbulletin.com/