Classroom Noise:

Tips for a quieter learning environment

Who can use this pamphlet?

This pamphlet is aimed at anyone who spends a lot of time in a classroom. It provides some basic information on the acoustical characteristics of classrooms, identifies problems that may result from poor acoustics, and suggests some methods of improving acoustics – all with the aim of improving the learning environment for students and teachers.

This pamphlet is not intended to provide all the answers to acoustical problems, nor does it replace the location-specific information that can be provided by an acoustical consultant. It may be used as a guide for workplace accommodations.

Why is classroom noise a problem?

Noise, by definition, is unwanted sound. In a classroom environment, excessive noise has a significant and negative impact on student learning, performance and behaviour, as well as on the vocal health of teachers.

Specifically, excessive noise in the classroom means that:

- Students experience difficulty hearing their teachers. This contributes to poor understanding, decreased attention and decreased performance. It also contributes to reading deficiencies, reduced motivation and even delayed language acquisition.
- There are fewer verbal interactions between teachers and students.
- More time is spent repeating instructions/information and less material is covered.
- Students become increasingly stressed and dissatisfied.
- Teachers must raise their voices to compete with background noise. This results in vocal strain and consequently poor teacher voice quality. Poor voice quality makes it more challenging for students to hear and understand their teacher in class.
- Teachers may develop voice disorders as they strain to speak above the noise. This in turn can result in teachers taking time off work while their voices recover. In some cases, teachers require voice therapy and even compensation.
- The effects of noise are more pronounced for younger children, with grade 1 students missing 1 out of every 10 words in a typical classroom environment. Noise also has a greater impact on children learning in a second language and those with hearing loss, attention or behaviour issues, and learning disabilities.

Some Acoustic Terminology

The Decibel Scale

The intensity level of sound is measured in units known as decibels (dB). A whisper is about 20 dB. An mp3 player at maximum volume can be 120 dB. If the scale is adjusted to better reflect our perception of the sound, it is referred to as dBA scale.

Reverberation Time

Reverberation Time (RT) is a measure of how long it takes for sound to decay in a room. Large spaces with little sound absorption, such as churches or gymnasiums, typically have long RTs (up to 5 seconds or more), and are thought of as being reverberant. Smaller rooms typically have shorter RTs (less than 1 second).

Where is the noise coming from?

"*I ask the children to stop making so much noise, and then realize that they're not making any noise*." – C. Lichimo, Grade 1 teacher

Student movement and chatter can certainly contribute to classroom noise, but this is not always the source of classroom noise problems. Excessive noise can come from many sources:

- Ventilation/heating systems
- Desk and table movement
- Fluorescent light ballasts (60-cycle hum)
- Adjacent classrooms and hallways
- Poor acoustic design, for example:
  - ineffective sound barriers (thin doors, walls, etc.)
  - hard surfaces, resulting in excessive echo or reverberation
- Exterior traffic noise

Classroom noise can be problematic in both old and new schools. Often noisy classrooms are a symptom of poor acoustical design rather than people being the original noise source.

What are acceptable acoustic conditions in classrooms?

According to research from education, acoustical, hearing and communication sciences, an unoccupied classroom should have a maximum noise level of 35 dBA. This is about the level of sound you would expect in a quiet residence or office.

Classrooms should have a reverberation time of between 0.4 and 0.6 seconds. Too long an RT means that the reflected sound or reverberations muddy the teacher's voice. Too short an RT can also be problematic by creating acoustical "dead spots" in the classroom.

Many factors contribute to the quality of a room's acoustics and are beyond the scope of this pamphlet. A more in-depth resource on classroom acoustics is available at:

http://asa.aip.org//classroom/booklet.html

It is important to remember that what might be an acceptable acoustic environment for an adult is not necessarily appropriate for a child. As younger children have less mature auditory systems and a less-well developed knowledge of language, they require a better quality acoustical environment than adults to understand speech. Therefore, an adult's impression of how "good" a classroom sounds is not an accurate measure of how acceptable it is for children.

Don't most Canadian classrooms have good acoustics?

Unfortunately, no. In a study of noise levels and acoustical conditions of Ontario classrooms, Bradley and Sato (2004)[1] found that only 9% of grade one classes, 40% of grade three classes and 52% of grade six classes had the desired acoustical conditions for learning. We can expect, therefore, that excessive noise in the classroom is a significant barrier to learning in a significant proportion of Canadian classrooms.

More resources can be found at:

http://www.caslpa.ca/english/resources/noise_in_classroom.asp#materials

[1] Bradley, J.S. and Sato, H., Speech intelligibility test results for grades 1, 3 and 6 children in real classrooms. *Proceedings 18th International Congress on Acoustics*, Kyoto, April, 2004.

How can I assess the acoustics in my classroom?

If you are a teacher, you can contact your occupational health and safety officer to have a noise level survey done in your classroom and discuss the results with him/her and your school administrator.

Identifying the source of a classroom's acoustical problems and possible solutions may require the help of an acoustical consultant. Such would be the case where reverberation time needs to be assessed and addressed, or where problems unique to the particular classroom cannot be easily identified.

Specific standards for classroom acoustical conditions are provided in the ANSI standard document ANSI S12.60-2002, available free of charge through the *Acoustical Society of America*, at:

http://asastore.aip.org

What can I do to help make a classroom acoustically sound?

Improving classroom acoustics involves a number of strategies. The following 4 steps are recommended, the first steps likely being easiest to implement and most effective, the later steps being less effective and more costly to implement.

1. Implement classroom management strategies to help keep the classroom quiet.

2. Identify and, where possible, eliminate or minimize noise sources:

Noise source	Solution
Desk/chair movement	• Slip tennis balls onto the feet of chairs and desks. Make these yourself by cutting an "x" into each tennis ball. Pre-cut tennis balls can be purchased from "Hushups" (*www.hushhups.com*) for about $250 per class. This will also reduce noise in the room(s) below the classroom.
Fluorescent light ballasts	• *Electronic* ballasts should be standard in all new construction; older style *magnetic* ballasts should be replaced.
Equipment	• Turn off unnecessary equipment, e.g. projectors, fish tanks, etc.
External sources (traffic, industry, students out of doors)	• Install windows/doors with high noise reduction rating and good weatherstripping • Move outdoor student activities away from classrooms, especially those that are south-facing where windows are more likely to be open.
Adjacent classrooms, hallways	• Improve sound separation between rooms. • Improve sound absorption of neighbouring areas.
Noise in open-plan classroom	• Separate classroom into smaller spaces (floor-to-ceiling stud wall, sliding partitions).
Noise from heating and ventilation system	• Servicing of the system may reduce noise. • Modifications to the HVAC system may include better vibration isolation of fans and motors, addition of acoustic duct liners, conversion to quieter louvres, etc.
Material-based noise (furniture made from light-weight materials that resonate easily)	• Choose more solid materials to reduce potential reverberation noise.

3. Modify the classroom acoustical characteristics to increase absorption and reduce the reverberation time:

> *Note: The suggestions identified in this section are not intended to preclude the need for input from an acoustical consultant. They do however give an indication of solutions that can be effective in many situations where classroom acoustics are poor.*

Although acoustic problems are often the result of poor initial design decisions, there are some inexpensive interventions that can be done after the fact to improve the situation.

> *Note: Some of these suggestions require the attachment of elements to the existing building structure. It is most important that the method of attachment be reviewed by someone able to judge the structural integrity to avoid creating any potential hazards to the occupants.*

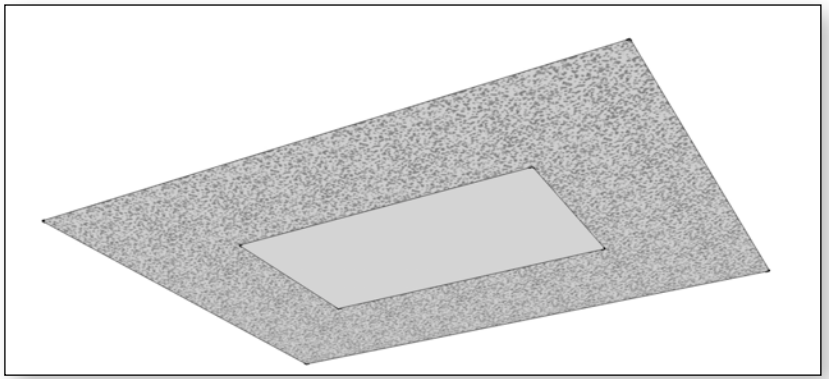
Addressing sound sources within the classroom

The most effective approach is to reduce the RT by adding sound absorbing elements to the surfaces of the space.

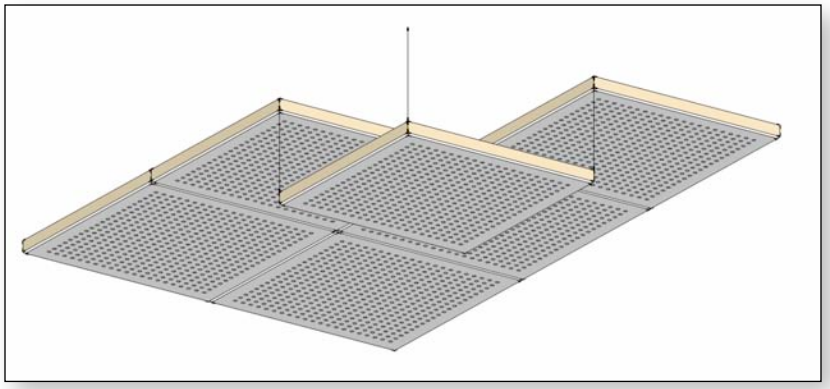
CEILING

This is usually the simplest and most effective place to add sound absorption, since it interferes least with any activities in the space and is comprised of a large surface area. If the ceiling surface is presently a hard surface (drywall or wood), any treatment will be quite helpful.

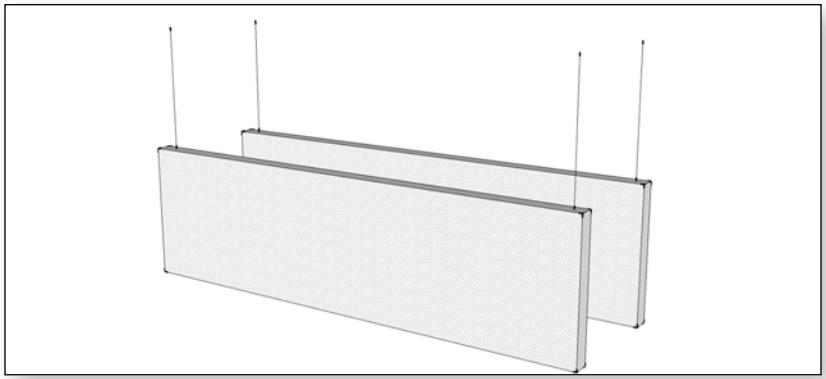
There are some advantages in terms of projecting sound from a teacher's voice to other parts of the room if the ceiling in the middle of the room is left untreated.



Proprietary acoustic tiles (usually 12" square, but can be larger) with an NRC value of 0.50 to 0.75 are usually the most cost-effective solution, and can be fixed to the ceiling with special adhesive. They are most effective when left unpainted, as the paint tends to reduce their sound absorptive properties.

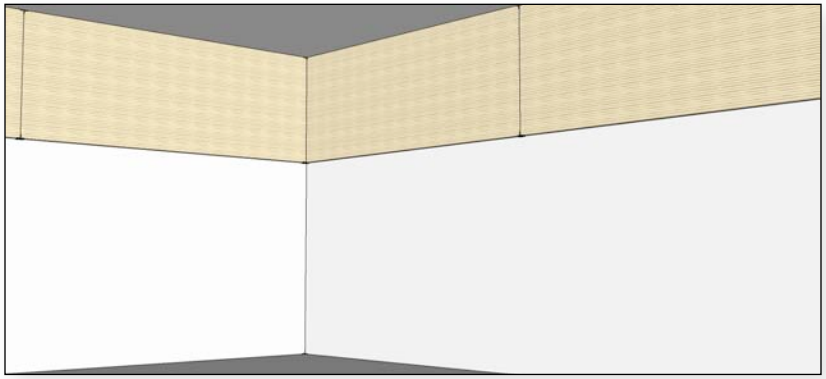


In certain situations suspended elements can be introduced into the classroom. These need to be of sound absorbent materials, and are usually hung at a high level from the ceiling. Care should be taken in their placement to avoid conflicts with lights and air diffusers.



WALLS

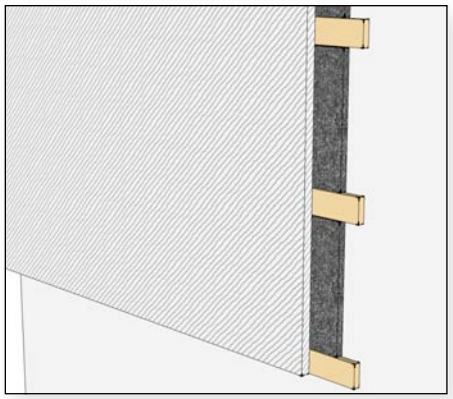
Placing absorptive material on the walls of the classroom will also reduce the RT value and usually improve intelligibility, however the reduction in sound energy is not always totally desirable. In some instances it is better to diffuse the sound through the use of reflective diffusion elements.



UPPER WALLS

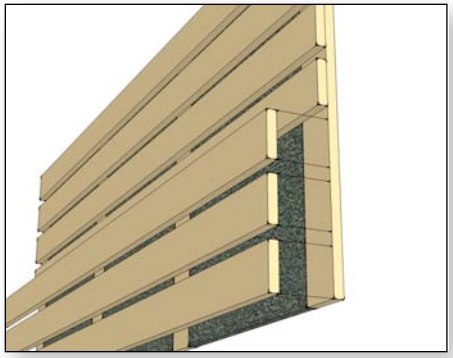
A similar approach as used on the ceiling can be used here as well, provided it is high enough to prevent physical damage to the material.

In place of the acoustic tiles, a proprietary fibrous wood-based panel product could be used, which is more resistive to damage, especially if within reach of the occupants. The panels can be mounted directly against the wall surface (providing a Noise Reduction Coefficient – *NRC* – value of about 0.40), or spaced out on furring strips or over rigid insulation (up to NRC of 0.85).



If a more architectural look is preferred, consider a system making use of spaced wood boards such as solid wood or a particle-board type product. They can be cut into slats of various dimensions, and installed on spacers away from the actual wall surface.

The space behind the wood slats can be filled with a layer of insulation (a coated duct-liner type insulation works well) installed to provide the required sound absorption.



LOWER WALLS

Due to the need for usable wall space at the lower level, there is usually little space left for applying acoustically absorbent material, though soft tack surfaces (cloth-covered or cork) can provide some absorption.

The hanging of artwork made from felt, cork, paper egg carton or other absorptive materials can also play a role in reducing the RT value.

Curtains or drapes as window coverings, if appropriate, also typically provide better sound absorption than do blinds or sliding panel window covers.

FLOOR

A removable area carpet over at least part of a classroom floor will result in considerable sound absorption and reduction in RT value for the space. Washable materials, such as synthetic/foam interlocking tiles will also help.

PARTICULAR PROBLEM AREAS

One of the problems that can occur in classroom spaces is the presence of localized “flutter echoes”, usually the result of two reflective surfaces being parallel to one another, i.e. floor and ceiling, or two parallel walls. These echoes can usually be eliminated by applying some absorptive treatment to at least one of the two offending surfaces.

Whatever material is used for sound absorption, care should be taken to avoiding creating another problem such as a fire hazard or surfaces which collect dust and other pollutants.

Addressing sound sources outside the classroom

SEALING LEAKS

Surprisingly enough, sound has the ability to “leak” through quite small openings. Proper weatherstripping of exterior doors and opening windows can have a significant impact on reducing exterior noise (as well as the added benefit of reducing drafts!).

MULTIPLE PANE WINDOWS

Though all recently-constructed buildings have at least double-glazed windows, in mild climates like BC’s Lower Mainland, some older buildings still have single-pane windows. Although acoustics alone are not likely to justify upgrading of windows, should renovations be undertaken, replacement of single-pane with multiple-pane windows will reduce heat loss and will also significantly reduce transmission of the exterior noise.

HEATING & VENTILATION SYSTEMS

Heating and ventilation systems are often the source of almost continual noise. Regular maintenance can ensure that these systems are operating properly and as quietly as possible.

Some considerations:

- Can noise-generating components be identified and made more quiet, eliminating squeaks and rattles?
- Can equipment (fans, pumps, etc.) be mounted on resilient supports to minimize transfer of sound to the building structure?
- Can old diffusers and grilles be cleaned and/or replaced with more efficient quieter ones?
- Can fans perhaps be run at a slower speed while still providing the correct fresh air volume?
- Can acoustic liners be placed in ductwork to reduce sound transmission?

4. Soundfield amplification systems

Soundfield amplification can help improve audibility of the teacher's voice by amplifying his/her voice to a level that is easily heard above the background noise in the classroom. This can also ease vocal strain of teachers as they try to speak above the classroom noise.

It is important to recognize that soundfield amplification is not a solution for all classroom noise problems, especially those with excessive reverberation. Soundfield systems will not reduce background noise. These systems require correct installation of the soundfield speakers to ensure maximal effectiveness. They also require commitment from the teacher to use the system and proper maintenance so that the system remains functional.

Teachers can ease vocal strain and improve vocal health by learning good classroom management and vocal techniques. Speech-language pathologists can provide vocal rehabilitation and prevention programs. General vocal care guidelines and additional resources can be found at the website:

http://www.pvcrp.com

What regulations are in place to ensure that classrooms have the acoustical conditions necessary for effective learning and teaching?

Currently, there are no regulations or standards in British Columbia to ensure that new schools and those being structurally updated meet these standards for classroom acoustics. Several US states have adopted acoustical standards for classrooms, as specified by ANSI standard *ANSI S12.60-2002*, mentioned earlier in this document.

In England and Wales, acoustical standards for new schools and extensions are mandatory as defined by the Building Bulletin 93 (BB93) *Acoustic Design of Schools*.

It is essential that new and renovated schools provide an acoustical environment that is appropriate for learning and education, where all children can learn and perform to the best of their ability and instructors can teach without risk of damaging their voices.

The public can help by encouraging their provincial Department of Education to adopt acoustical standards (e.g. ANSI S12.60-2002) as part of the building standards for schools and other educational facilities.