Noise and Education: The effects of floor coverings on Acoustics in the Classroom

Bruce Bedwell B.Sc (Hon) Physics/Electronics

The author has extensive experience with sound, acoustics and the design and construction of spaces such as sound studios, control rooms and general work areas. He studied Physics and Electronics at the University of East Anglia in the UK and worked in audio and TV sound for many years. He has recently been working with a leading manufacturer on acoustic backings and integral underlay systems for quality commercial carpet tiles.

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INTRODUCTION

There have been many studies over the years on the effects of noise on children and it is widely acknowledged that noise has a detrimental effect upon the learning and performance of children at school. It is also accepted that high levels of noise affect both the teachers and students and contribute to increased stress levels.
A small number of the most significant of these studies are referenced at the end of this paper.

There is increasing evidence that poor classroom acoustics can have a particularly negative effect upon children with special needs such as hearing impairment (Nelson & Soli 2000) or learning difficulties (Bradlow et al. 2003)

Noise is broadly defined as unwanted or uncontrolled sound. It can be externally generated (e.g. traffic noise, aircraft) and transmitted through walls into the rooms or internally generated (babble of voices, air conditioning, computers, moving furniture, footsteps, etc.).
Ideally, externally generated noise should be prevented from entering the space but this is an unrealistic ideal and it is equally unrealistic to expect no internally generated sound.
In both cases however, it is what happens to that unwanted sound that is important and, left to its own devices, it can produce substantial problems.

Noise and reverberation degrade the acoustic signal of wanted sound and adversely affect the comprehension of the spoken word. Reducing noise and reverberation helps with the intelligibility of speech and creates a more pleasant learning environment, improving student and teacher motivation and morale.

REFLECTED SOUND AND REVERBERATION TIMES

Sound waves created in or entering a space will travel to the boundaries of that space and will either be reflected back into the room or be transmitted through, or absorbed by, the boundary — or most likely, a combination of all three. The amount of sound reflected or absorbed/transmitted depends greatly on the frequency of the sound and the physical characteristics of the boundary materials.

Low frequency sounds are very difficult to suppress and contain, but mid to high frequency sound can be more easily dealt with using surface treatments.

Reverberation is the effect of the combination of all the reflected sounds and the time it takes for the level of these reflected sound waves to reduce by 60dB is known as the reverberation time or RT.

As a result of several research studies, it has been established that reverberation times in excess of 0.6 seconds are unsuitable for a learning environment. For the hearing impaired, an RT less than 0.4 has been established as a recommended objective (BATOD standard).

Noise and reverberation degrade the acoustic signal of wanted sound and adversely affect the comprehension of the spoken word making teacher to student communication more difficult. Additionally, noise is a distraction and creates the effect of elevated volumes of speech to compensate. This is known as the “Lombard Effect”. The reverse is also the case and is known as the “Library Effect” where it was found that as the level of noise reduces, so does the volume of people speaking in the room.

The reverberation times of sound at various frequencies can be reduced by employing surfaces with higher sound absorption coefficients. These coefficients are usually weighted to be an average number across a range of frequencies (α_w) and the higher this number, the more sound is absorbed.

Floor coverings

Typically, a floor represents somewhere between 20 – 30% of the surface area of a room and is invariably constructed of hard reflective materials. Uncovered, these surfaces are not good at absorbing mid to high frequency sound where intelligibility of voices is most important. Hard reflective floor covering such as ceramic tiles, wood and vinyl do little to improve things and contribute to higher RTs than we would like. When combined with high ceilings made from hard reflective materials, the problem is exacerbated further.

Even without considering the effects of other surfaces in the room, such as walls, windows and ceilings, considerable improvements in the acoustics of a room can be achieved by selecting appropriate floor coverings.

Carpeting is the most efficient and effective floor covering to improve acoustics and for absorbing excessive reverberation of mid/high frequency sounds and dampening noise from students and the movement of furniture.

Conventional carpet on underlay can produce average weighted sound absorption coefficients of around α_w = 0.3 – 0.4 (H) but there are a number of possible disadvantages with conventional broadloom carpet installations such as:

- Relatively high installation costs
- Easily soiled
- Tendency for rucking and stretching
- Relatively poor appearance retention
- Inability to replace small areas

Properly constructed carpet tiles with acoustic cushion backing not only achieve absorption coefficients of 0.40 (H) which is comparable with the best results of conventionally laid carpet, but they avoid the disadvantages outlined above.

It is important that any floor covering selected for a school environment is hard wearing. Quality carpet tiles tend to have good appearance retention and longer warranties than conventional carpeting.

CONCLUSIONS

The results of many studies demonstrate a very strong correlation between reverberation times and perceived quality of the learning environment. Similarly, the same strong correlation applied in that noise levels during teaching diminished as reverberation times reduce. Teachers reported significant improvements in behaviour in rooms with the shortest RT as well as lower stress levels for teachers and students and better comprehension from both hearing and hearing impaired students.

It is also clear that both chronic and acute exposure to environmental and class-room noise have a detrimental effect upon children's learning and performance. Children with special educational needs were found to be more susceptible to the effects of classroom babble on verbal tasks than other children. These results raise specific challenges for education policies which aim to educate all children in 'inclusive' environments.

These studies illustrate the need to give careful consideration to the acoustic design of a school in order to optimize conditions for teaching and learning.

Much of the work needed to achieve improvements should be done through better design and construction at the outset but major improvements can be done to existing facilities through the appropriate selection of furnishing and coverings of surfaces, particularly windows and floors.

The floors in any space can constitute a significant proportion of the unwanted noise reflection and reverberation and their coverings play a crucial role in the overall acoustic performance of an education environment.

Hard reflective surfaces may wear well in some circumstances but perform very poorly from the point of view of noise and comfort and should be avoided in classrooms and other areas where acoustics are important.

Conventional carpet on underlay can perform well acoustically but has many disadvantages as previously outlined.

Hard backed carpet tiles can appear good value but provide little in the way of comfort and their acoustic performance falls a long way short of what is ideally required.

High performance carpet tiles with acoustically optimised integral underlay provide an excellent alternative whilst bringing other benefits such as good underfoot comfort, excellent wear and appearance retention, the ability to be replaced in damaged or stained areas, and relatively low installation costs.

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