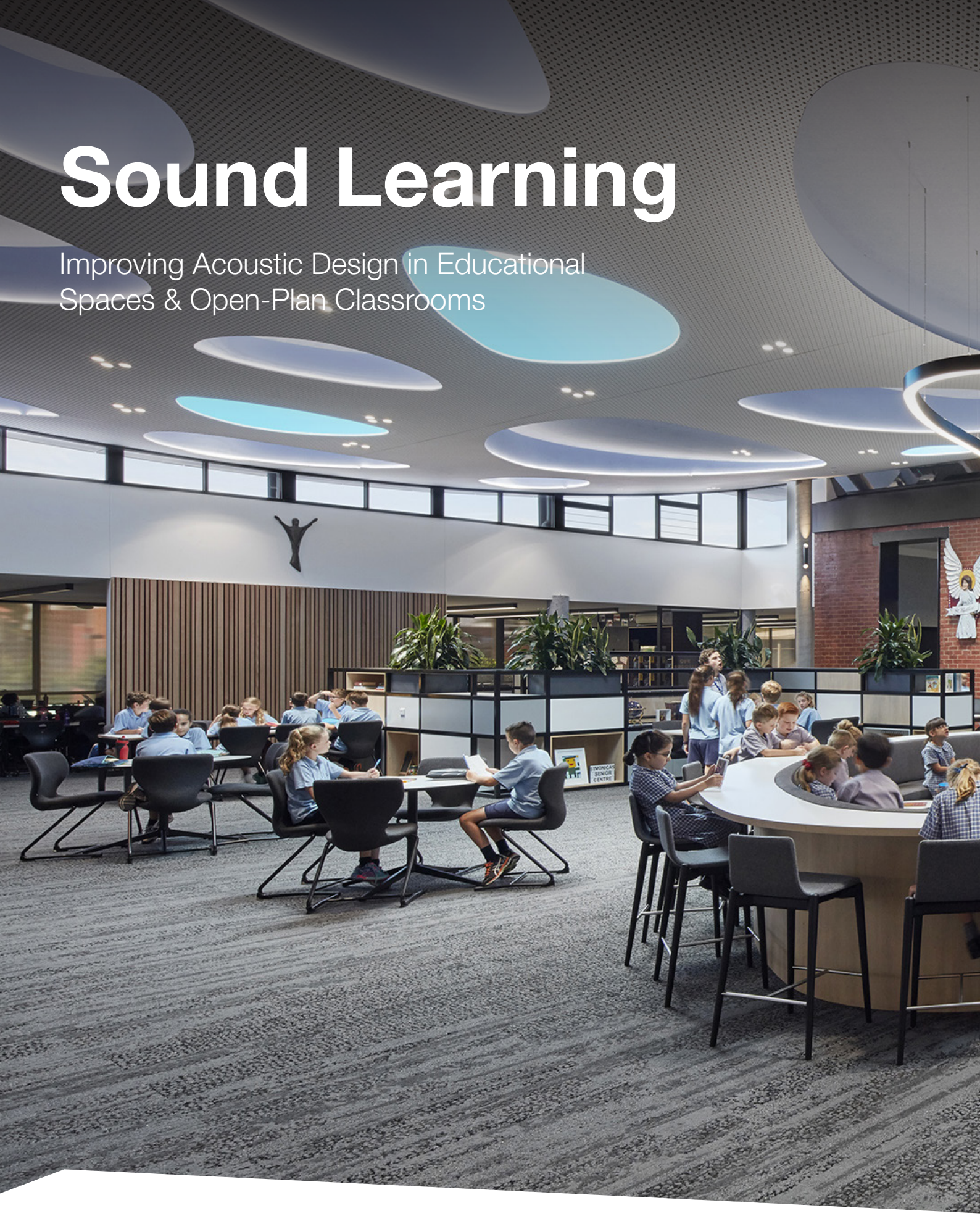
Sound Learning

Improving Acoustic Design in Educational Spaces & Open-Plan Classrooms



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INTRODUCTION

Uncontrolled noise in classrooms is a growing problem that can impact the development and wellbeing of students. Yet, despite numerous studies confirming the adverse effects of uncontrolled noise on learning and teaching outcomes, acoustic quality is an often overlooked aspect in the design of education environments.

In fact, recent design trends in the education sector have actually contributed to acoustic issues rather than solving them. Take, for example, the recent rise of open-plan collaborative learning spaces that are inherently ‘noisier’ than traditional, enclosed classrooms.

Poor acoustic environments affect students and teachers alike. For students, being unable to clearly hear their teacher or other students or concentrate without disruption can affect listening comprehension, reduce cognitive function and limit language development. Younger students especially require optimal acoustic conditions to hear and understand speech. For teachers, trying to speak loudly over background noise causes stress and physical discomfort, and limits their ability to communicate and teach effectively.

Achieving the best acoustic environment for a learning space is a complex field that requires professional planning. It takes more than simply choosing products with high sound absorption ratings. Designers and specifiers must understand the physical characteristics of the space, the types of learning and teaching activities that need to be supported, and the ability and age of the students – and tailor acoustic solutions to meet those requirements.

In this whitepaper we explore common acoustic issues in modern learning spaces and the key considerations for designing high-quality acoustic environments in this sector.

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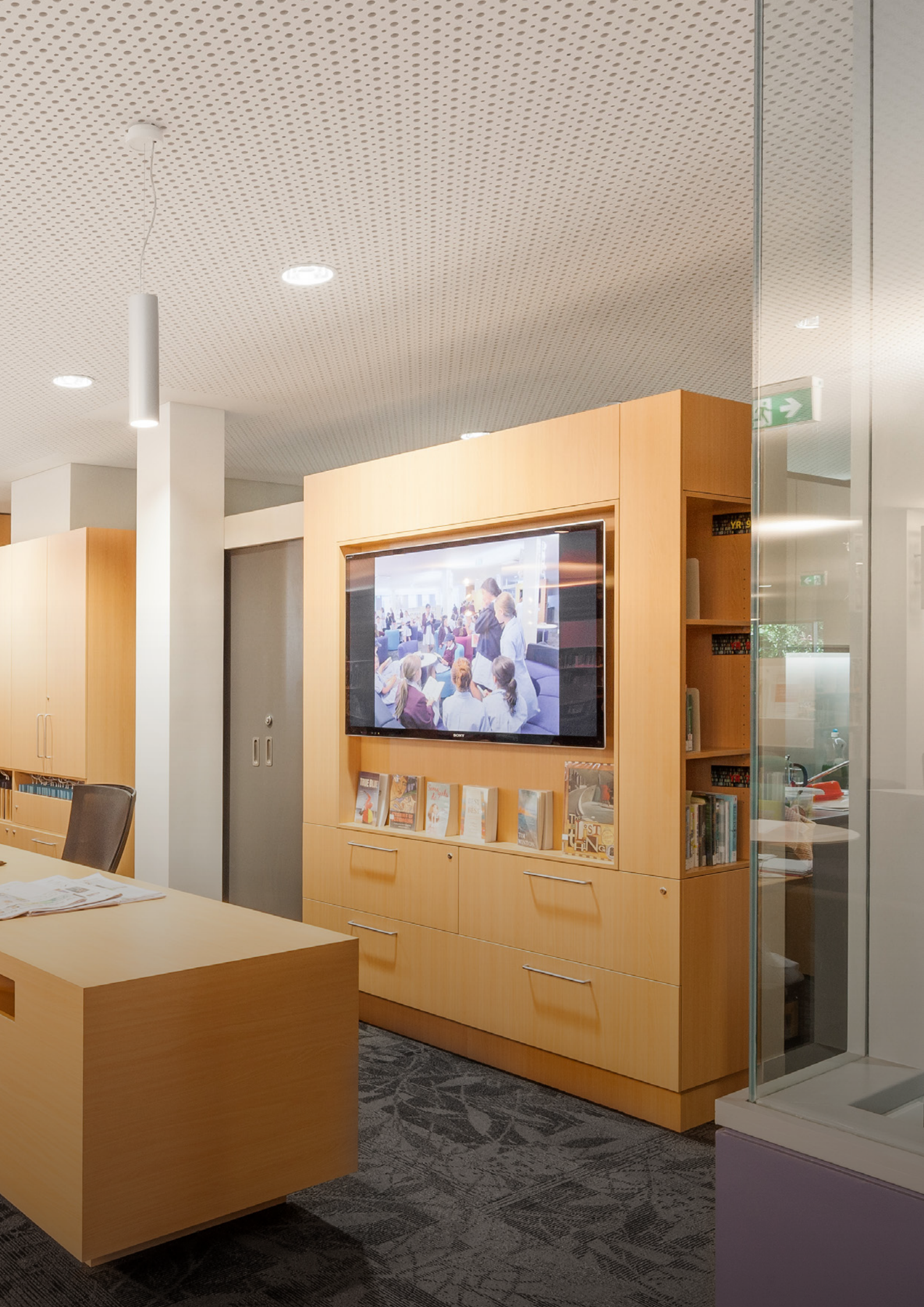

COMMON ACOUSTIC ISSUES IN SCHOOLS

Not long ago, Australian students sat at fixed desks, their attention focused squarely on the teacher who stood at the front of the classroom in front of a large blackboard. Over several decades, government policy, changing expectations and the emergence of new teaching styles have affected the way classrooms are designed and configured. Today, students are 'active learners' who have greater choice in how they learn in spaces that are designed to be 'mobile, flexible, varied, and connected'.[1]

To support new modes of flexible learning, open-plan classroom designs have gained popularity, creating noise and concentration issues for both teachers and students. In open-plan designs, several classes will share the same space, and students are given opportunities to learn independently and in small and large groups.

With other classes sharing the same space, open-plan classrooms tend to be noisier than your traditional classroom. A recent study of four different-sized Sydney schools found that most children were annoyed by the noise, and 50-70% of children surveyed said they could not hear their teacher very well, or at all, when the other classes were doing noisy group work activities.[2] In addition, teachers were having difficulty communicating with their class, sometimes experiencing vocal strain and voice problems.[3]

In modern classrooms, the main acoustic issue is often reverberation, which describes the reflecting or bouncing around of sound waves within the interior environment. High reverberation levels force your brain to work harder to make sense of the noise within the environment, and make it difficult to pinpoint where sounds are coming from. Conversely, reverberation levels that are too low generally indicate an environment that is 'acoustically dead' with poor sound clarity.

High levels of noise transmission between classrooms and external noise from the outside environment are also common issues. Noise can be transmitted through floors, doors, ceilings, and through the HVAC (heating, ventilation, and air conditioning) system. Excessive noise from other classrooms or from external noise sources can be disruptive for students, breaking their concentration and reducing their productivity.

THE IMPACT OF POOR ACOUSTICS

Children, especially younger children and children with learning disabilities, are more sensitive than adults or older peers to noise and reverberation when performing tasks that involve listening comprehension and speech perception.[4] Numerous studies confirm that academic performance is impaired by noise due to increased difficulties in concentrating, understanding speech and communicating with other students.[5]

Children in noisy open-plan classrooms display significantly lower speech perception accuracy and slower response times than children in an enclosed classroom. Recent studies demonstrate that children's speech perception scores were consistently high (approximately 80%) in quieter, enclosed classrooms, whereas children's scores dropped from 75% at the front of the classroom to less than 25% at the back in the noisiest open-plan environments.[6]

The impact is not just on students – teachers reported being more distracted by noise, found speech communication significantly more difficult, and thought children had more difficulty hearing them.[7] Teachers in noisy open classrooms need to elevate their voices and experience vocal strain and voice problems more often than teachers in quieter, enclosed classrooms.[8]

Beyond learning performance, the impact of poor acoustics includes a broader concept of student and teacher wellbeing. High levels of noise can cause irritation, encourage aggressiveness, and cause discomfort. Research has found that noise is associated with stress-related factors in children's mental health,[9] and an increased prevalence of symptoms such as fatigue and headaches.[10]

ACOUSTIC DESIGN REQUIREMENTS

The National Construction Code details the minimum sound insulation requirements of walls and ceilings between different rooms and buildings, but there is no specific Australia-wide regulation or standard that encompasses all aspects of the acoustic design of educational facilities. There are several design guidelines that are available to assist designers including:

- AS/NZS 2107:2000 "Acoustics—Recommended design sound levels and reverberation times for building interiors", which provides design recommendations regarding sound levels and reverberation times inside classrooms; and
- Association of Australasian Acoustical Consultants' (ACCC) Guidelines for Educational Facilities (available here), which aims to improve the acoustic environment in educational facilities with a particular emphasis on classroom acoustics.

Designing for good acoustics is a complex field requiring a deep understanding of different acoustic descriptors, performance categories and calculations. A holistic approach is needed that considers acoustical performance criteria for background noise (external noise intrusion and sound insulation) and reverberation time, which must both be satisfied to achieve a suitable learning environment.[11]

According to the AAAC, reverberation times of 0.4s or less in small and mid-sized classrooms, and 0.6s or less in larger classrooms, will not degrade speech intelligibility excessively provided that speech levels greater than background noise (signal-to-noise ratio) of 10-15 dB or better are maintained.[12] The requirement for good speech intelligibility will be satisfied when the background noise is sufficiently low, approximately 35 dBA, for typical classroom speech.[13]

Not every educational space is the same, so AAAC provides a list of recommended internal noise levels and reverberation times for a wide range of educational spaces. Note that for open-plan teaching spaces, the recommended performance values are 40 LAeq (dB) or below for internal ambient noise, and a reverberation time of 0.6 seconds or less.[14] The Guidelines also include airborne and impact sound insulation requirements. Increasingly stringent criteria are recommended for rooms with higher acoustic requirements, such as teaching spaces for the hearing impaired.

Speech Transmission Index (STI) describes the clarity of speech in a space, and takes account of the space's acoustic characteristics, the background noise level and other noisy activities which may be occurring. STI is expressed as a number on a scale from 0 (bad) to 1 (excellent). An STI rating of 0.7 is required for open-plan teaching and study spaces.[15]

IMPLEMENTING ACOUSTIC TREATMENTS

Acoustic treatments help to absorb or diffuse sound to improve the acoustic quality of a space, and are the most effective methods for controlling reverberation and noise transmission. Sound insulation is needed to reduce background noise, whereas sound absorbing materials help lower reverberation times. These solutions can come in the form of acoustic wall panels, acoustic ceiling panels, ceiling clouds, acoustic foam and so on. All these products absorb or insulate sound and prevent it from transmitting back into the room or into an adjoining space.

Shortening reverberation times is an important aspect of creating an optimal acoustic environment, but it is not the only factor. Walls and ceiling surfaces that both reflect and absorb sound provide early reflection of the sound followed by suppression. This effect achieves the best of both worlds by achieving good speech intelligibility while reducing unwanted noise.

To preserve speech quality, it is important to adjust sound across all the individual frequencies because, for example, if absorption is too effective in the higher frequencies, then speech intelligibility will be lost. Resonator absorbers, such as panels with perforations, work across the entire frequency range, from low and mid-range frequencies to high frequencies.

Note that in open-plan learning spaces, there are often conflicting demands for speech and privacy. While high STI is often used as an indicator of good acoustic design, it may be detrimental in an open-plan classroom where small groups of students are trying to communicate with each other. The placement of acoustic treatments and furnishings should be strategically considered to maintain areas of privacy without impacting the overall level of speech intelligibility in the room.

CHOOSING THE RIGHT ACOUSTIC PRODUCTS

Noise Reduction Coefficient (NRC) is a common measurement used to estimate a product's acoustic performance. NRC is calculated by averaging out a material's sound absorption coefficients at four octave band frequencies ranging from 250 Hz to 2000 Hz, and is measured on a scale from 0 (the product absorbs no sound or reflects all sound) to 1 (the product absorbs all sound or reflects no sound).

Weighted sound absorption coefficient (α_w) is another way to evaluate the sound absorption efficiency of materials that is considered more representative of how the human ear interprets sound. This measure illustrates the material's performance across all of the important frequencies ranging from 200Hz to 5000Hz by comparing sound absorption coefficients to a standard curve. Rather than an average, this measure is governed by the lowest performing value in the frequency range of concern. When assessing an acoustic product, the focus should not be just on a high α_w but how evenly the material absorbs sound across all of the important frequencies.

Simply choosing products with a high NRC rating can result in unsatisfactory results. The product may provide uneven absorption across the frequencies and fail to achieve the desired results if other factors, such as the best placement and combination of products, are not part of the planning process.

In spaces where the sound of a voice is key, it is imperative to get the balance right between the space being too 'reverberant' or too 'dry'. Erring on the side of too much sound absorption can lead to spaces that are acoustically 'dead', which can make speech muddy and less intelligible, and adversely impact learning and teaching outcomes. An acoustic consultant should be involved early in the planning phase to ensure all the relevant factors that contribute to acoustic quality are considered.

SINIAT

Acoustic solutions for the modern classroom

Siniat offers a range of specialty acoustic plasterboard linings with unique performance features ideal for educational settings, including supporting the current trend for open-plan teaching and study spaces. The brand offers perforated plasterboard solutions that can achieve the desired seamless appearance in open-plan designs while improving acoustic comfort.

Perforated plasterboard not only absorbs sound, but it also deflects and resonates sound, leading to a much improved sound quality and occupier experience. It provides the perfect acoustic solution for noisy indoor environments especially where human speech needs to be clearly heard and understood.

Createx

Createx is a seamless perforated plasterboard with CAPT'AIR® technology to bring a breath of fresh air to acoustic wall and ceiling linings. Manufactured with high quality, ultra-sharp perforations in a variety of continuous perforated patterns for a seamless finish, Createx meets the high level of acoustic performance required for modern classrooms, conference halls, lecture theatres and libraries.

Once installed, the CAPT'AIR® technology in Createx actively works to decompose formaldehyde emissions found in the air, resulting in a safer environment for all.

Creason

Creason is part of Siniat's range of acoustic plasterboard, offering great acoustic performance with beautiful aesthetics and incorporates CAPT'AIR® technology for improved indoor air quality. Creason is ideal for use in a range of internal applications and it can be installed in the ceiling or at the top of internal walls where control of sound absorption and reverberation time is required.

The acoustic performance of Createx and Creason is achieved through a combination of sound diffusion (reflected sound energy is spread out) and sound absorption (sound energy is removed as it travels through the perforation holes and acoustic fleece backing). Additional optional insulation improves sound absorption. The result is a high quality sound experience with excellent speech intelligibility.

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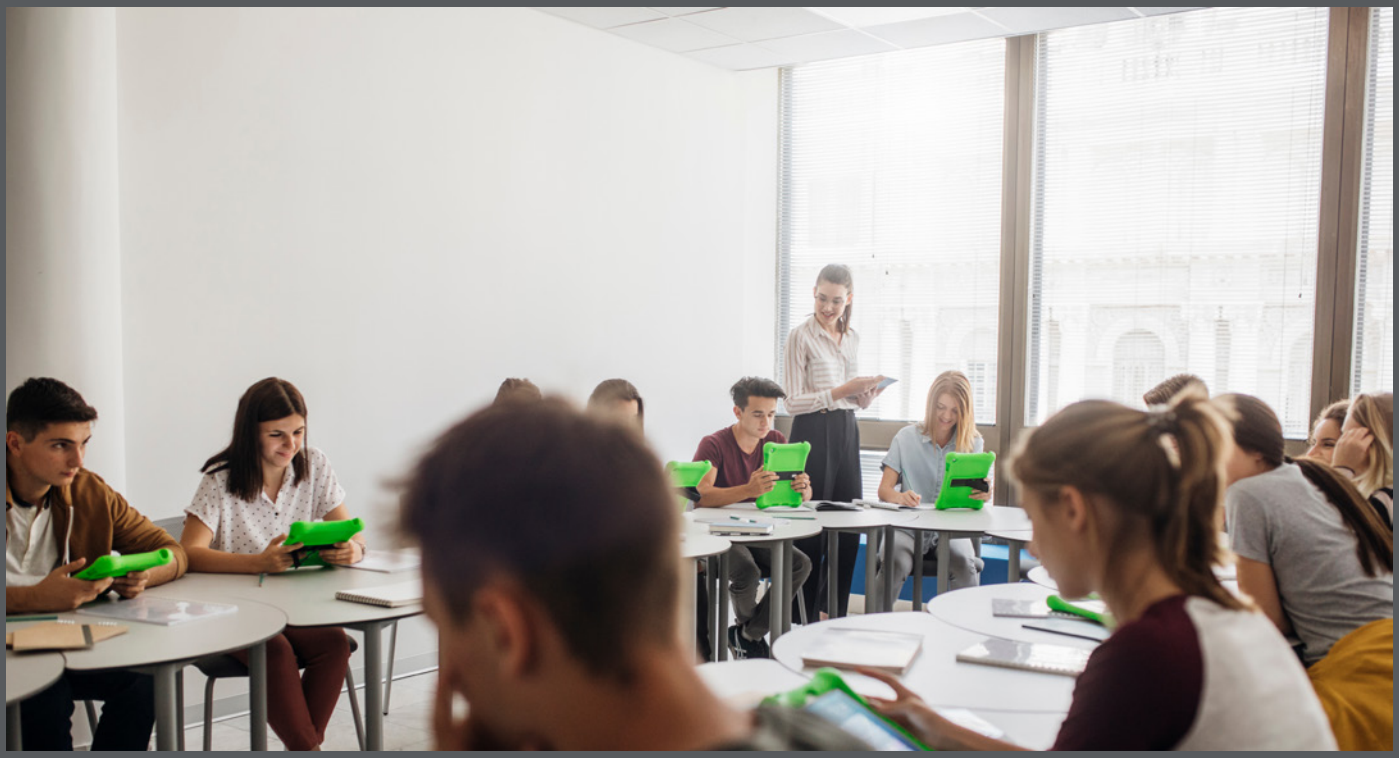

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13 Ibid.

14 Ibid.

15 Ibid.