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Acoustic Factors

Setting the physical stage for high quality teaching and learning environments

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The teachers' perspective on noise in the classroom

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Studies suggest that the physical classroom environment—views, lighting, daylighting, air quality, overcrowding, thermal comfort, and furnishings—meaningfully impacts student performance (Earthman, 2002; Heschong, 1999, 2003; Jacobs, 2009). Specific to acoustics, at least 13 studies over 34 years have linked the aural environment to student cognition, concentration, and achievement (as well as teacher fatigue) (Bronzaft & McCarthy, 1975; Dockrell & Shield, 2005; Hygge, Evans & Bullinger, 2002; Jaramillo & Ermann, 2012; Maroko & Shwe, 2005; Nelson & Soli, 2000; Ronsse & Wang, 2009; Shield & Dockrell, 2007; Siebein & Likendey, 2004; Stansfeld et al., 2005; Vilatarsana, 2004; Zentall & Shaw, 1980; Zusman, 2007). The effect is most pronounced on the youngest students, non-native English speakers, and those with hearing difficulty (including children with colds and ear infections) (Bradley, 2002; Elliot, 1982). Young brains do not properly "fill-in-the-gaps" when they've missed a word in a sentence, leaving them deprived of the meaning of the sentence and absent ownership of school content. And while poor room acoustics is a common problem in classrooms, it is background noise that typically deviates farther from the ideal (Bradley, 2002).

Researchers have documented mechanical heating and cooling equipment noise as the prime contributor to classroom noise, (Siebein et al., 2000; Nelson et al., 2005) and the type of cooling system determines, in large part, the level of the mechanical noise in the classroom (in temperate and warm climates). Mechanical cooling noise sources may be categorized into one of three classifications: (1) remote fan and remote compressor, (2) local fan and remote compressor, and (3) local fan and local compressor. Of the three types, the quietest typology involves air systems with distant, centralized, air handling units (AHUs) and remote chillers and cooling towers. Next loudest, AHUs and fan-coil units that serve only one space may feature remote chiller equipment but fans that are either located in the room being served, or just adjacent to it in a ceiling plenum, over a corridor, or in a closet. Finally, the loudest system typology, through-thewall units, features both compressors and fans located in the rooms served. These are sometimes referred to as unitary systems, direct expansion systems, or DX systems, and are colloquially termed "window units" (Siebein et al., 2000)

The teacher survey results presented here complements a prior study by the same authors (Jaramillo & Ermann, 2012). That investigation surveyed 73 of the 129 elementary schools in Orange County, Florida school district and their mechanical systems were analyzed statistically against third grade school achievement test scores over eight years. The analysis found, not surprisingly, that test scores were overwhelmingly influenced by the socio-economic profile of the school's students; schools populated by higher-income children out-performed those populated by poorer children. But when the data were culled into three groups, each corresponding to a different type of mechanical system, the results suggested that, for a given student income level, achievement scores drop in schools with the noisiest systems (Jaramillo & Ermann, 2012). What do the teachers in that school district think about noise in their classrooms?

Background Noise Levels and Reverberation Times in Unoccupied Classrooms: Predictions and Measurements

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Classrooms are often filled with deterrents that hamper a child's ability to listen and learn. It is evident that the acoustical environment in classrooms can be one such deterrent. Excessive background noise and reverberation can affect the achievement and educational performance of children with sensorineural hearing loss (SNHL) and children with normal hearing sensitivity who have other auditory learning difficulties, as well as elementary school children with no verbal or hearing disabilities. The purpose of this study was to evaluate the extent of the problem of noise and reverberation in schools. To that end, we measured reverberation times and background noise levels in 32 different unoccupied elementary classrooms in eight public school buildings in central Ohio. The results were compared with the limits recommended in the American National Standards Institute standard for acoustical characteristics of classrooms in the United States (ANSI S12.60–2002). These measurements were also compared to the

external and internal criteria variables developed by Crandell, Smaldino, & Flexer (1995) to determine if a simple checklist can accurately predict unwanted classroom background noise levels and reverberation. Results indicated that most classrooms were not in compliance with ANSI noise and reverberation standards. Further, our results suggested that a checklist was not a good predictor of the noisier and more reverberant rooms.

New generation learning environments: creating good acoustic environments - policy to implementation

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"'A poor acoustical environment is an architectural barrier to students with hearing loss as much as a set of stairs might be a barrier for a child in a wheelchair." Roy (2006) (58) The introduction of new technologies in schools has resulted in a paradigm shift in the way educational spaces are created and used. Today's learning environments are flexible speaking and listening spaces where collaboration, group work, complex problem solving, digital information gathering and publishing occur. Changes in technology and legislation have highlighted the need for equitable access to learning environments. Good acoustic design is essential. This cross-disciplinary paper co-written by an acoustical engineer and an educator discusses the importance of good acoustic design within new generation learning environments to promote inclusive teaching and learning. This paper argues that design of open plan learning environments in schools and government policy implementation must address issues of acoustic design and noise control in an effort to comply with the Australian Disability Discrimination Act 1992, the Building Code of Australia, the Disability Standards for Education 2005, and Australian Education Bill 2012. Recommendations are provided on policy changes, which will help reinforce this position across all educational spaces, from early learning centres to adult education.