

New research proves key acoustical changes improve learning environments

By Tobin Cooley, P.E., C.T.S.

STUDENTS TODAY ARE UNABLE TO UNDERSTAND 25 PERCENT TO 30 PERCENT OF WHAT TEACHERS SAY due to excessive noise and reverberation (Acoustical Society of America, 2001). Nationally, 28 percent of schools list noise as their number one problem. CBS News reports, "Schools have tried everything to improve: smaller classes, more teachers, more homework, more computers. One solution was right under their noses—well, ears, actually: improve the classroom listening environment."

A focus on classroom acoustics has emerged based on some intriguing research into how children learn and a new American National Standards Institute (ANSI) Classroom Acoustics standard. Recently, I participated on a

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panel presenting research and applications in classroom acoustics. Team members included Dr. Paul McCarty, a professor specializing in childhood learning at Brigham Young University, and Paul Rising, a principal at BLRB Architects in Tacoma, Wash. who specializes in K-12 learning environments. This article shares a summary of information presented and provides insight into its application for educational buildings.

Compelling Research

A Cornell University study (Evans, 2001) proves that if students cannot focus on spoken words, they not only lose the desire to learn, but also the ability to learn. Research indicates a child's auditory neurological network is not fully developed until age 15, preventing them from learning when they cannot hear. Children require quieter listening environments and louder signal (voice levels) to learn.

The results of good acoustics in classrooms are significant: increased verbal and math test scores, decreased teacher fatigue and absenteeism, and decreased discipline problems (Educational Facility Planner, Vol. 39, Issue 2). Recent research demonstrates significant improvements in test scores by improving speech intelligibility: sustained 10



percent to 29 percent improvements in math and reading during a two-year period (Orange County, FL Schools). No Child Left Behind student populations gain the most improvement in test scores (up to a 31 percent increase) when they can hear effectively (McCarty, 2004). This is especially true for schools in urban environments and English as a Second Language (ESL) students. Higher test scores in this population are key since not meeting federally mandated testing requirements under the No Child Left Behind Act means severely reduced funding.

The New ANSI Standard

The American National Standards Institute (ANSI), in conjunction with the Acoustical Society of America, publishes a standard for classroom acoustics, S12.60-2002. The standard's intent is to upgrade the learning environment by improving classroom acoustical performance. Several school districts and state governments are adopting parts of it into their educational standards. The International Building Code General Committee is considering adding the ANSI standard to the code, which could significantly impact educational facility design.

The essence of the ANSI standard is improving the intelligibility of speech in classrooms. It specifies a signal-to-noise ratio of at least 15 dB, which means the teacher's voice needs to be 15 dB higher than the background noise. For typical classrooms the target is a maximum 35 dB of background noise and a reverberation time of 0.6 seconds or less.

The standard describes in detail how to create excellent classroom acoustics. A copy of this standard can be downloaded at <http://asastore.aip.org/>. Based on the standard's recommendations, here's a summary of the practical applications:

Practical Changes for Improving Classroom Acoustics

- 1. Outside to inside:** Locate schools away from noisy areas and improve exterior sound potentially coming in
- 2. Between classrooms:** Utilize higher walls
- 3. Mechanical noise:** Move heating and air conditioning units away from classrooms
- 4. Plumbing noise:** Reduce vibration-induced noise
- 5. Classroom noise:** Carpet classrooms and locate computers and fan devices away from students
- 6. Decrease reverberation time to 0.6 seconds for typical classrooms:** Add ceiling and wall absorptive panels
- 7. Increase the source level (teacher's voice) and evenness across the classroom:** Add voice enhancement systems that make overall sound level, even at all seats

Challenges with the ANSI Standard

A 2003 Wall Street Journal article estimated the cost for implementing the ANSI standard nationwide at up to \$400 million. Also, the Air Conditioning and Refrigeration Institute (ARI), Modular Building Institute and Association of Building Managers oppose the classroom code change. They claim complying with the standard would significantly increase new construction and renovation costs, particularly for HVAC-related noise control.

The standard ideally requires some level of interpretation or oversight by a professional acoustical engineer to be effective. Classroom acoustics have not changed much since the 1950s, but new research is proving that a few key changes can result in dramatically better learning improvements. Test scores have improved, teacher absenteeism has been reduced and compliance with the No Child Left Behind Act has been facilitated—all as a result of good acoustics. ■

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