White Paper

Why Classroom Amplification Systems Help Teachers Teach and Students Learn

Preventing teacher vocal disorders and helping students hear in the classroom

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Listening to Learn

Despite many changes in classroom technologies and practices, the basis of classroom teaching is still speaking and listening. The difference between today's classroom and one of 20 years ago is a matter of degree. The student of 1987 would have spent 45 percent of classroom time listening (Berg, 1987) to teachers, audio-visual media and student presentations. For today's student, that estimate rises to 75 percent (Research Services, 2007). The emphasis may be less on listening to teachers and more on group partners and multimedia content, but listening remains a foundation of learning.

When students can hear lesson content clearly in the classroom, they are more successful at listening tasks, and at learning in general. But many classrooms offer a substandard acoustic environment, forcing teachers to strain their voices while students struggle to hear and follow the lesson. Classroom amplification systems offer a simple, affordable way to improve classroom acoustics, save teachers' voices, and enhance student engagement and performance.

"Could you repeat that, please?"

Deaf and hard-of-hearing students overcome hearing difficulties with a number of classroom accommodations, such as individual amplifying devices, sign-language interpreters, captioned audio-visual material and notetakers. Educators might assume that students without hearing impairments, on the other hand, will have no difficulty with classroom listening tasks. But this assumption does not take into account many changes that have occurred in classrooms in the last 20 years, notably the addition of technology products and a shift from lecture-based to student-centered learning, both of which have changed the acoustical environment of the classroom. Listeners in today's classroom must contend with the cooling fans of computers, printers, copiers and projectors; the clicking of keyboards and mouse devices; music, voices and sound effects from multimedia content; and the voices of fellow students collaborating, questioning, problem solving and presenting – not to mention noise from hallways, adjacent classrooms, HVAC systems, and outside traffic and activity.

Background noise diminishes the acoustic environment of the classroom and the ability of students to hear and comprehend spoken information. Other factors that can compromise students' ability to hear the teacher

include *signal-to-noise ratio*, *reverberation time* and the distance from the teacher to the child.

Signal-to-Noise Ratio

The relationship between spoken signals and background noise is a better indicator of the quality of an acoustic environment than a measure of background noise alone. Signal-to-noise ratio (SNR) is a measurement of that relationship in decibels, with a positive number indicating a more audible signal. The American Speech Language Hearing Association recommends a classroom SNR of +15 dB. In reality, reports of classroom SNRs range from +5 dB to -7 dB (Palmer, 1997). When the classroom SNR is too low, background noise may dominate the acoustic environment, especially for those farthest from the teacher.

Reverberation

Reverberation is the persistence of sound in an enclosed space caused by sound waves reflecting off hard surfaces. In a classroom with few sound-absorbing surfaces (for example, a room with bare walls, uncarpeted floors and curtainless windows), reverberation can render speech sounds significantly less intelligible. This effect is measured as reverberation time (RT), which is the time in seconds it takes for a sound signal to decrease by 60 dB. In a classroom with high RT, each sound uttered by a speaker may be blurred or masked by a preceding sound.

Classroom distances

The negative effects of background noise, low signal-to-noise ratio and reverberation are greater for those students farthest from the teacher. As Crandell and Smaldino explain, “Direct sound pressure follows the principle of the inverse square law, which states that sound level decreases 6 dB for every doubling of distance from the sound source” (Crandell & Smaldino, 2000, p. 366). Students sitting closest to the teacher are in the direct sound field – three or four meters from the teacher in a typical classroom (Crandell & Smaldino, 2000). Beyond that distance, the indirect, or reverberant, sound field dominates, the teacher’s speech is blurred as it rebounds off classrooms surfaces and students’ speech perception suffers.

Tuned Out, Turned Off

In good classroom-acoustic environments, with minimal background noise and reverberation and a high signal-to-noise ratio, students with good hearing still recognize only 71 percent of the speech they hear. In poor listening environments, auditory processing falls to less than 30 percent (Crandell & Smaldino, 2000). Children in poor listening

environments are at a double disadvantage compared to adults: their auditory network will not be fully developed until they are 15, and they lack the life experience to fill in the sounds they don't hear. Students who do not understand key words or instructions may find it difficult to catch up, leading to frustration and off-task behavior (Palmer, 1997). A three-year study of UK primary schools shows that students sitting in some areas of classrooms – acoustic dead zones – can miss entire lessons (BBC News Online, 1999).

Dealing with Poor Classroom Acoustics

Speak up!

Teachers cope with competing background noise by raising their voices – a strategy that poses health risks. A study by researchers at Heriot-Watt University in Edinburgh revealed a link between poor classroom acoustics and higher rates of staff illness (BBC News Online, 2000). Likewise, a French survey revealed that teachers were twice as likely as other workers to suffer vocal disorders. These problems ranged in severity from sore throats to vocal fold swelling (Sage, 2007). And these ailments are costly: A U.S. study found that teachers take an average of two days' sick leave per year because of vocal disorders, and the cost for healthcare and substitute teachers is $638 million (£315 million). Because teachers with high voices are more likely to strain their vocal cords in order to be heard, women teachers are at higher risk for vocal disorders than their male colleagues (Sage, 2007).

Both the U.S. and French studies note that noisier classrooms are more stressful for teachers, who worry that their lessons are not heard and that they are suffering vocal damage. The resulting tense posture exacerbates vocal strain. As Professor Antoine Giovanni, head of the Laboratory of Clinical Audiology-Phonology in Marseille notes, "Someone who does not feel they are being heard gets taut, leans forwards and strains the tone of the voice" (Sage, 2007).

In today's collaborative classrooms, teachers are not the only ones straining to be heard. Students, too, are required to question, discuss and present. Some may lack the vocal development or confidence to speak audibly in a room with loud background noise.

Better buildings

Architectural interventions, both in new building design and retrofits of existing buildings, are helpful in combating excessive classroom noise. ANSI's *Acoustical Performance Criteria, Design Requirements and Guidelines for Schools* (2002) describes how buildings can be designed

to reduce background noise, reverberation time, sound transmission through walls and impact noise transmission through floors and ceilings.

Architects can reduce background noise in classrooms in new buildings by specifying low-noise HVAC systems and light ballasts, and by isolating plumbing systems from learning spaces. Separating quiet learning spaces from noisier environments such as gyms, cafeterias and music rooms is also effective at reducing background noise and sound transmission class (STC) levels. Absorptive material such as carpet can limit reverberation. Appropriate floor–ceiling systems, and carpet on upper floors, can improve the impact insulation class (IIC) rating between levels.

New buildings that meet ANSI standards go far in reducing classroom noise from background sound and reverberation, but architectural interventions cannot address larger class sizes and more collaborative teaching and learning styles – trends that defy the one-speaker, many-listeners model of traditional classroom practices, and that contribute greatly to classroom noise problems.

Buildings constructed before the approval in 2002 of the ANSI *Acoustical Performance Criteria, Design Requirements and Guidelines for Schools* may require extensive retrofitting to meet classroom acoustics guidelines for RT and SNR. The Acoustical Society of America estimates that the cost of acoustic retrofitting can be up to ten times that of new design and construction that meets the same performance goals (ASA, 1998).

Turn up the volume

Increasingly, educators are turning to classroom amplification systems to overcome challenges associated with classroom acoustics. A classroom amplification system can spare teachers' voices, overcome hearing problems associated with distance and improve the signal-to-noise ratio in a classroom.

A typical classroom amplification system comprises a teacher microphone, student microphone, wireless signal sensors, audio receivers and speakers. Some systems have wires, while others are wireless and use infrared (IR) or radio frequency (RF) signal technology. The typical system works like this:

1. The teacher speaks into a microphone worn around the neck or on the lapel (or a student speaks into a handheld microphone)
2. The microphone's transmitter sends voice signals to a sensor connected directly to an audio receiver

3. The receiver broadcasts sound via the speakers

Classroom amplification systems are an affordable solution to the problems of low student engagement, participation and achievement caused by poor sound quality in classrooms. A good system can benefit both students and teachers because it

- Ensures teaching material is heard clearly by all students, wherever they are in the classroom
- Facilitates better student-to-teacher and student-to-student communication
- Encourages and supports student participation
- Minimizes teacher vocal strain, fatigue and vocal-cord related ailments
- Reduces teacher absenteeism

Numerous studies show that classroom amplification systems also improve standardized test scores; decrease referrals to special education services; improve reading fluency and literacy skills; increase participation, productivity and on-task behavior; improve attentiveness and reduce teacher absences due to vocal strain and related ailments (Research Services, 2007).[1]

Who benefits from classroom audio systems?

- Teachers, especially those who are soft-spoken or who have high voices
- Students with permanent or temporary hearing loss
- Students under 15
- Students with learning disabilities
- ESL students
- Students who might otherwise be referred to special education services

How to Choose a Classroom Amplification System

The best classroom amplification systems do not require a significant investment of money, installation time or training. Look for a system that is affordable and easy to install and use. Your system should be flexible enough to use in a variety of classroom situations, integrate with existing and future technology and offer excellent sound quality.

[1] For a broad review of US-based research on classroom amplification systems, see Research Services, Miami-Dade County Public Schools, "Improving the Classroom Environment: Classroom Amplification Systems," *Information Capsule* Vol. 0607, March 2007. Accessed from http://drs.dadeschools.net/InfoCapsules/IC0607.pdf on November 21, 2008.

Low-cost and easy installation

- Low cost (comparable in price to a new computer)
- Rechargeable batteries and built-in battery charger included
- Ceiling- or wall-mounted speakers

Ease of use

- Lightweight, wearable microphone and transmitter
- Wireless technology to allow free movement
- Intuitive use requiring little training

Integration

- Integration with existing classroom technology, e.g., PC, interactive whiteboard, lesson activity software
- Simple USB connection between audio system and computer

Flexibility

- Ability to record lessons to a computer for future playback
- Ability to broadcast audio files over system's speakers
- Simultaneous student and teacher microphone participation
- Multimedia device compatibility to incorporate audio files from USB-compatible computers, PDAs, DVDs or VCRs

Superior sound quality

- Multiple speakers for even sound distribution
- Feedback suppression and tone control for high-quality sound customizable to your classroom's acoustic environment

SMART Audio classroom amplification system

SMART Audio is a classroom amplification system designed to optimize teaching and learning by helping students and teachers overcome acoustic barriers. It installs easily, with only a receiver, one IR sensor and four speakers to mount on the ceiling or walls. The lightweight, wearable microphones are wireless, enabling users to move freely around the classroom. The system can be used with SMART Board software's SMART Recorder to record lessons and broadcast audio files over the speakers. SMART Audio also offers exceptional sound quality.

To find out more about SMART Audio classroom amplification, visit www.smarttech.com.

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