Classroom Microphone Technology and the benefits for Students & Teachers

Across the United States, architects, facility professionals and school administrators are looking for ways to improve the educational environment. This means improving student performance, while addressing many challenges such as reduced construction funds, standards and testing, low salaries, rising dropout rates and differentiated learning modes.

"Sound is half the picture"

If you have ever been at the movies and the soundtrack cuts out, this idea becomes extremely apparent. The two most information-intensive experiences that humans have are seeing and hearing. There has been a trend in the last few years towards expenditures for high ***"Visual Wow Factor"*** technologies such as video projectors, flat screen displays, document cameras, interactive whiteboards and such.

While these visual displays are eye-catching, classrooms are auditory-verbal environments with listening serving as the cornerstone of the educational system. It has been estimated that 75% of the school day is spent engaged in listening activities. Nearly all our new multimedia technology depends on the student's listening abilities for its successful implementation.

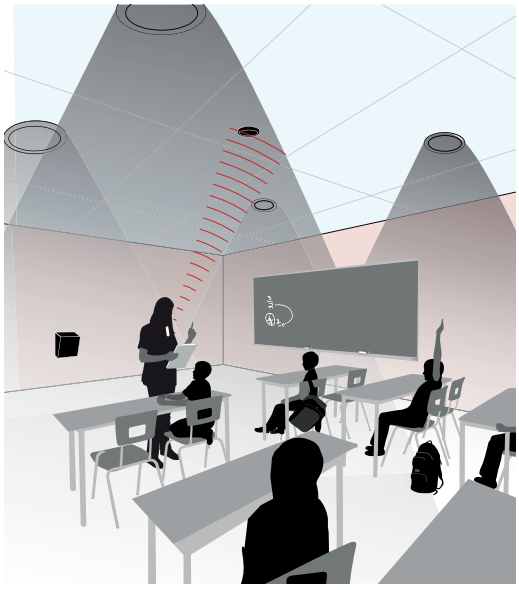
In the case of students with known hearing loss, we are quick to provide special devices to make the sound intelligible to them. But we have typically left the normal of hearing on their own to increase their knowledge with less than ideal listening conditions.

What is a Classroom Soundfield System?

A Soundfield (or sound reinforcement system), is essentially a small public address sound system designed for the confines of a typical 1000 square foot classroom of 25–35 students.

These systems utilize a wireless microphone, a receiver to capture the wireless transmission, a mixer to add other microphones or media sources (DVD MP3), a power amplifier, and at least four strategically located ceiling mounted speakers in the classroom to distribute the teacher's voice down onto the student's ears.

Quite often, a second microphone is added to the system for use by an assistant teacher, or more commonly, by the students. Engaging students is so critical for complete learning, and most students today really enjoy their turn at the microphone.



Quality Soundfield systems utilize several distributed overhead loudspeakers to achieve smooth, even coverage, similar to the lighting effect achieved using several overhead recessed lighting panels.

A very critical part of a Soundfield system is the array of overhead speakers. The key to really making a Soundfield system work effectively is creating a consistent layer of sound across the entire classroom. This layer should be 3 to 6 ft above the floor level and contains the higher frequencies (2kHz–16kHz) associated with consonants.

When these Soundfield systems are properly installed and used, every student feels as if they are in the front row of the classroom, or the teacher is speaking directly in front of them.

Most Soundfield systems incorporate infrared technology for their transmission. Since infrared transmission is based on pulsating light, the transmission of the wireless mics will ***not*** penetrate the walls of a classroom and interfere with other rooms. This allows us to set up dozens or even hundreds of classrooms very close to each other with no interference from the other classroom's systems.

"They may hear you more, but understand you less"

There is always the teacher, resistant to voice enhancement technology, who claims that all children can hear her because he/she has such a loud pervasive voice.

One of the most misunderstood areas of verbal communication is the negative effect of speaking loudly.

"It's all about the consonants"

The main job of a Soundfield system is to get even distribution of high frequency (soft consonant sounds) throughout the room. "Th", "s", "f", ph do not carry and spread around the room like the vowel sounds of "ahh", "ohhh", "ehhh".

When any human being raises their voice in level, they begin to change the ratio of vowel sounds over consonants. When the vowels begin to mask the consonants, it is harder to understand exactly the true meaning of the word being spoken. Therefore, the louder the teacher talks, the less intelligible her/his words become.

Second, it is nearly impossible to convey a "nurturing" voice (which is more conducive to learning) if someone is constantly speaking in a very loud manner.

Without additional amplification, the teacher's voice diminishes 6 decibels in consonant range every time the distance is doubled to the listening student.

With properly located overhead ceiling speakers, the teacher's voice appears to be never more than 5–6 feet from each of the student's ears.

Frequently Encountered Challenges

Distance

While the typical, modern classroom is only about 1000 sq ft, the distance from the front of the room to the back can attenuate sound quite significantly, at least in the upper mid and high frequencies. These frequencies are in the "consonant" region where most of the information of speech resides. Lower frequencies (bass notes for example) do not follow this same attenuation, and can actually tend to "muddy" the sound, when it rolls around a classroom and can't be absorbed.

The simple rule (right from the physics lab) is called ***"Inverse Square Law".*** It means that when a sound wave, especially in the high frequency area, travels from its original source (the teacher's mouth), it loses 6 decibels of its power every time the distance is doubled. Thus, a word spoken by the teacher may be 80 decibels when listening at 1 foot from the teacher, will actually be attenuated to 56 decibels at 16 feet from the teacher's voice.

Ambient Noise

Modern classrooms, especially in the K-6 area, are increasing in ambient noise every year. The addition of air conditioning, computer fans, clicking keyboards, and such, make it even more difficult for younger students to really hear the teacher's information at all times. Children need the teacher's voice to be at least 15 decibels louder than the background noise for intelligible comprehension. This is known as the ***Signal-to-Noise Ratio*** (SNR). In this age of iPods and headphones, massive car stereos and very loud movie theatre systems, most young learners do not give much attention to sounds and signals less than 63 decibels.

Reverberation and Acoustics

Excessive reverberation and ambient noise diminish a child's ability to fully understand what he/she is hearing within the classroom. Ideally, sound-absorbing materials on the walls and ceiling of a classroom can reduce substantial amounts of outside noise entering the room. These materials can be rather costly, but they can also reduce echoes and noises generated inside the classroom. Unfortunately, that absorption of sound creates an even larger version of the "distance/inverse square law" problem by absorbing most all sounds... even some of the teacher's instructions.

Second Language Learners

Nearly every school district in the U.S. is seeing a constant increase in the number of students where English is a second language. For these students, it is a dual challenge. They must not only learn English and the basic meaning of words, but also must quickly grasp the concepts being taught to them. For these students a 10-20% loss of information can be devastating to their educational growth.

Increased Class Size

It is an unfortunate fact of life that class sizes are getting bigger and will probably continue to do so for years to come. When classrooms have 50% more students, the ambient noise of more students (coughs, sniffles, etc) also rises at nearly the same level.

On Task Behavior

Possibly the most fascinating aspect of Soundfield systems is the increase of positive on task behavior with students. Teachers have been commenting for years how simply holding or speaking into the microphone gets immediate positive attention from their students. Even as an adult society, we have been somewhat conditioned to stop talking once we hear someone speaking on a microphone and a sound system.

The Soundfield Solution

Student Achievement Benefits

Possibly the most well known aspect of Soundfield systems is their extraordinarily consistent results of increased student achievement, especially in the areas of math and reading.

Students in a 21st century classroom, typically have a myriad of visual technology items to work with. While most of these technologies are exciting to view, there are very few substantial studies that have been conducted to determine whether these products actually increase learning for the student.

The MARRS study was the first investigation that reported on the use of Soundfield amplification in the US, and is the only study noted on the U.S. Department of Education's clearinghouse web site for what truly works in schools.

In 1977, the U.S. Dept. of Education conducted a study in Sarasota Springs, Florida referred to as the MARRS project (Mainstream Amplification Resource Room Study). They found that when the teacher's voice was amplified, all students regardless of hearing ability showed significant (10-15%) gains in academic achievement, and were noted to achieve in reading and language arts at a faster rate, and to a higher level.

Literacy and math gains were very substantial in classrooms utilizing Soundfield systems during a multiple year study in Anaheim, California. The data released in 2002 showed that 3rd and 4th grade students showed over 15% gains in Reading, Math, Language Arts and spelling over a three year period as measured by Stanford-9 Achievement Tests.

Since the first research project on these systems some 20 years ago, there have been more than 50 additional studies testifying to their ability to increase student achievement.

In 2003, An Urban "At Risk" elementary school in Utah improved English Mastery and learning with limited English language proficiency students. This study tested classroom Soundfield system effectiveness in raising student test score with a cohort of English Language learners (ELL). The results showed highly significant gains in Sanford Achievement Test and Utah's Criterion Reference Test scores with an average improvement of over 16%.

Teacher Benefits

"The voice is the most effective tool of the teacher's trade"

Today, there are scores of "high technology" products available to teachers. However, in many cases, the more access students have to computers and digital curriculum, the less access they have to teachers.

Soundfield systems have the unique ability to not only raise student test scores and increase on task behavior, but ***it is the only "technology" product that gives a direct health benefit to the teacher.***

K-12 teachers speak an average of 6.5 hrs per day in their school facility, and at least 50-60% of all teachers have experienced voice problems

The voice problems of U.S. cost the U.S. economy more than 2 billion dollars annually. (Verdonlini and Ramig 2001)

Teachers comprise only 3% of the working population, but they constitute 20% of hospital voice clinic patients diagnosed with a voice disorder. Not surprisingly, voice fatigue and throat infections account for 11% to 16% of teacher absenteeism.

Teachers using Soundfield amplification report significantly lower teacher absenteeism due to voice and throat problems. In 1996, Dubuque Community School District in Iowa reported teachers in classrooms without Soundfield systems averaged 52 sick days per year due to voice, jaw and throat problems (0.93 sick days per teacher). However, teachers in classrooms with Soundfield systems took only 19 days per year (0.34 sick days per teacher) for the same problems. By decreasing the need for substitute teachers, every 12–14 sick days saved by the District would cover the cost of another classroom system.

Quite simply, Soundfield systems make the teacher's job easier by:

- Increasing on task behavior management
- Increasing in student's comprehension of oral directions
- Increasing mobility for teachers
- Decreasing number of requests for repetition
- Decreasing voice fatigue

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FOR SOUND LEARNING

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TeachLogic was founded in 1993 and has continually developed audio products for education.
It is truly our belief that technology should enhance the educator but not diminish their role.

Cost, Funding and Grant Sources

Average cost per pupil, per day (assuming 25 students per class) is about 18 cents. Cost savings in reduced Special Education referrals have seen up to a 43% decline when Soundfield systems are put into use.

Soundfield systems should easily have a 10 year duty cycle, which is nearly double the typical life cycle of a computer or video projector.

Possible Grant Sources:
www.fndcenter.org
www.ed.gov/funding.html
www.schoolgrants.org
www.nea.org/grants
www.fconline.fndcenter.org/index.html
www.donorschoose.org
www.iste.org
www.digitalwish.com/dw/digitalwish/grant_awards
www.wellsfargo.com/donations

References

Flexer, C. 2002b. Rationale and use of Soundfield systems: An update. *The Hearing Journal 55(8):10-18*

Sapir, S., A. Keidar and B. Mathers-Schmidt. 1993. Vocal attrition in teachers; survey findings. *European Journal of Disorders of Communication 28:177-185*

Smith, E., J. Lemke, M. Taylor, H. Kirchener and H. Hoffman, 1998. Frequency of voice problems among teachers and other occupations. *Journal of Voice 12(4):480-8*

Neil Starkman, *"Sound Solutions"* T.H.E. Journal, 6/1/2007 http://thejournal.com/articles/20758

(MAARS Project, 2005/b Mainstream Amplification Resource Room Study 2005/b *The Benefits of Classroom Amplification.* Retrieved from http://www.marrs-study.info/student-benefits.html

Crandell, C.C., Smaldino, J.J. & Flexer, C. (1995)
Soundfield Amplification: *Theory and Practical Applications*. San Diego: Singular Publishing Group

(Allen, L., 1996/b) Allen, L. Dubuque, Iowa Public Schools 1996/b

(Ross, M. 2005) Ross, M. *Soundfield FM Amplification Theory and Practical Applications.* 2nd Edition, 2004, Clifton Height, NY. Thompson-Delmar Learning

(Dahlquist, 1998) Dahlquist, L. Classroom Amplification: *Not Just for the Hearing Impaired Anymore.* Paper presented at the CUSN, March 1990, Los Angeles, California