Classroom Voice and Audio Reinforcement Systems

Why implement them, How to choose

When you go to a concert, a movie or most professional conferences the sponsors always provide a sound system capable of projecting the sound throughout the space so that you can hear clearly. Why do we not do that for students in a classroom? Most classrooms are rectangular in shape, have tile floors, flat walls with little soundproofing and ceiling tiles that are not acoustic. Then there are the internal sounds like the fans of computers, projectors, air conditioning, and chatting students. Externally we often have sounds from other classrooms, lawn mowers, cars, airplanes and loud people. This is about the worst possible scenario for making sure everyone in the class hears equally.

One solution is for the teacher to just raise his/her voice to compensate for the poor acoustics and noise. But if they do this they may very well end up with a vocal health issue. Another solution is to improve the acoustics and soundproofing in the classroom. This is an excellent solution but can be extremely expensive.

Another solution is a voice reinforcement system that consists of a high quality wireless speaker and wireless microphone. The speaker should be omnidirectional and high quality. The microphone should be small, lightweight and also high quality. The entire system should be extremely easy to use, easy to install and, if possible, optionally portable. No teacher has time to learn a new system just for voice reinforcement.

"Excessive noise and reverberation interfere with speech intelligibility, resulting in reduced understanding and therefore reduced learning. In many classrooms in the United States, the speech intelligibility rating is 75 percent or less. That means that, in speech intelligibility tests, listeners with normal hearing can understand only 75 percent of the words read from a list. Imagine reading a textbook with every fourth word missing, and being expected to understand the material and be tested on it. Sounds ridiculous? Well, that is exactly the situation facing students every day in schools all across the country." [1]

[1] Acoustical Society of America (ASA) (2000). Classroom Acoustics. Benjamin Seep, Robin Glosemeyer, Emily Hulce, Matt Linn, and Pamela Aytar.

All Students Can Benefit from Classroom Voice Reinforcement Systems

Historically, classroom voice and audio reinforcement research and application of technologies have been focused on deaf and hard of hearing students. But now it is finally recognized that all students can benefit from a good classroom voice and audio reinforcement system. Studies have shown that children should be within approximately six feet of a teacher to receive maximum speech intelligibility. Unfortunately achieving this distance for most students is impossible due to class sizes and changes in the teachers' location as they move about the room.[2] Crandell and Smaldino (1995) reported a systematic decrease in speech recognition as the speaker-listener distance increased for a group of children, ages 5 to 14 years, in an acoustically good classroom. Word recognition scores of 95 percent, 75 percent, and 60 percent were found at distances of 2, 4, and 8 meters, respectively.[3] Leavitt and Flexer (1991) found that even at the optimal six feet distance between student and teacher, students still exhibited a 17 percent loss in critical speech recognition.[4] Now all of this sounds like common sense but these studies help to legitimize our own real life experiences.

"The brain's auditory network is not fully developed until about the age of 15. Therefore, children listen differently than adults and require a quieter environment and louder auditory signal in order to learn."[5] [6] [7] [8] The Mainstream Amplification Resource Room Study, a three-year longitudinal project, was conducted in the Wabash and Ohio Valley schools in southern Illinois. The project achieved national validation status in 1981 as part of the National Diffusion Network of the United States Department of Education and was recertified in 1992.[9] (A synopsis of the MARRS Study is included at the end of this white paper). The study concluded that students who can benefit from classroom amplification, in addition to students with hearing loss, include:

- children younger than age 15
- students sitting in the back of the class, who may miss up to 30 percent of what their teacher says
- students struggling academically
- students in a noisy classroom environment
- students in a team learning environment
- students with a soft-spoken teacher
- learning disabled students
- students who are in a school where teaching is conducted in a language other than their native tongue
- foreign language students

Every teacher can add other examples from their own experiences over the years. When any student can hear clearly they are going to be more engaged and all of us must be engaged to learn. **Without clear hearing there is no engagement** - and - **without engagement there is no learning**.

[2] Fickes, M. (2003). The Sounds of a Sound Education. School Planning and Management.
[3] Crandell, C., & Smaldino, J. (1995). The Importance of Room Acoustics. In R. Tyler & D. Schum (Eds.), Assistive Listening Devices. Allyn & Bacon: Needham Heights, MA.
[4] Leavitt, R., & Flexer, C. (1991). Speech Degradation as Measured by the Rapid Speech Transmission Index (RASTI). Ear & Hearing, 12, 115-118.
[5] Cole, W. (2006). Now Hear This. Time Magazine, October 16, 2006. (Cole, 2006; McCarty & Ure, 2003; Flexer, 2002; Rosenberg et al., 1999)
[6] McCarty, P.J., & Ure, A. (2003). The Effect Audio Enhanced Classrooms Have on Student Achievement and Teacher Instruction. Collaborative of High Performance Schools.
[7] Flexer, C. (2002). Rationale and Use of Sound Field Systems: An Update. The Hearing Journal, 55(8), 10-17
[8] Rosenberg, G.G., Blake-Rahter, P., Heavner, J., Allen, L., Redmond, B.M., Phillips, J., et al. (1999). Improving Classroom Acoustics (ICA): A Three-Year FM Sound Field Classroom Amplification Study. Journal of Educational Audiology, 7, 8-28
[9] Rosenberg, G. (2004). Sound Field Amplification: A Comprehensive Literature Review. In C. Crandell, C. Flexer, & J. Smaldino (Eds.), FM Sound Field Amplification: A Practical User's Guide (2nd Ed.). Clifton Heights, NY: Thomson-Delmar Learning.

Classroom Noise

The Improving Classroom Acoustics study concluded that unoccupied classroom noise levels exceeded the recommended acoustical standards in a surprisingly 97 percent of the 94 classrooms studied. [10] It is often difficult to distinguish problems caused by poor classroom acoustics from those caused by students' learning problems.

Unacceptable noise levels can be produced by[11] [12] [13] [14] [15]:

- sources within the classroom, such as students talking, scuffling of shoes on the floor, chairs scraping, pencil sharpeners, loud or intermittent air conditioning and ventilation systems, and audiovisual and electronic equipment.
- sources within the school building, including adjacent classroom activity and noise from hallways, the cafeteria, and the gymnasium.
- sources outside of the school building, such as traffic, aircraft, playgrounds, and construction.

Some classroom noise can be controlled but most cannot. It is something that teachers, students and school administrators have had to learn to live with. Creating soundproof classrooms is usually unrealistic, especially for existing school buildings. The only realistic and cost effective method of dealing with the issue of classroom noise is to increase the volume, sound distribution and quality of the teacher's voice and the multimedia audio used.

Student Benefits

Studies have shown that the use of voice and audio amplification systems lead to improved classroom environments and improved student performance. Following are just a few examples of some of this research.

The Mainstream Amplification Resource Room Study found that the use of classroom amplification systems led to increased student attention and decreased discipline problems, resulting in easier classroom management, less student distraction, and less need to repeat instructions. Findings held in both general education classes and in classes of students with mild hearing loss.[16] [17]

Flexer (2005) reported that first grade students in amplified classrooms in Ohio demonstrated increased participation, productivity, and on-task behaviors.[18]

In Iowa, Allen & Patton (1990) found that students in amplified elementary classrooms showed an average 17 percent increase in their overall on-task behavior. Under amplified conditions, students were found to be less distracted and required fewer repetitions by the teacher.[19]

Florida's Improving Classroom Acoustics project found that teachers were in at least 96 percent agreement that students in amplified classrooms were more attentive and demonstrated increased listening behaviors. [20]

[10] Rosenberg, G.G., Blake-Rahter, P., Heavner, J., Allen, L., Redmond, B.M., Phillips, J., et al. (1999). Improving Classroom Acoustics (ICA): A Three-Year FM Sound Field Classroom Amplification Study. Journal of Educational Audiology, 7, 8-28
[11] Mainstream Amplification Resource Room Study. (2005a). Tuning Up Our Classrooms.
[12] Mainstream Amplification Resource Room Study. (2005b). Classroom Amplification FAQ.
[13] Gertel, S.J., McCarty, P.J., & Schoff, L. (2004). High Performance Schools Equals High Performing Students. Educational Facility Planner, 39(3), 20-24
[14] Flexer, C. (2002). Rationale and Use of Sound Field Systems: An Update. The Hearing Journal, 55(8), 10-17
[15] Rosenberg, G.G., Blake-Rahter, P., Heavner, J., Allen, L., Redmond, B.M., Phillips, J., et al. (1999). Improving Classroom Acoustics (ICA): A Three-Year FM Sound Field Classroom Amplification Study. Journal of Educational Audiology, 7, 8-28
[16] Mainstream Amplification Resource Room Study. (2005d). The MARRS Project: Mainstream Amplification Resource Room Study.
[17] Mainstream Amplification Resource Room Study. (2005e). Measurable Classroom Amplification Results.
[18] Flexer, C. (2005). Turn on Sound: An Odyssey of Sound Field Amplification. Mainstream Amplification Resource Room Study.
[19] Allen, L., & Patton, D. (1990). Effects of Sound Field Amplification on Students' On-Task Behavior. Paper presented at the American Speech-Language-Hearing Convention, Seattle, WA, November 1990.
[20] Rosenberg, G. (2004). Sound Field Amplification: A Comprehensive Literature Review. In C. Crandell, C. Flexer, & J. Smaldino (Eds.), FM Sound Field Amplification: A Practical User's Guide (2nd Ed.). Clifton Heights, NY: Thomson-Delmar Learning.

Dairi's (2000) study comparing amplified and unamplified first grade classrooms in Florida's Broward County Public Schools found that teachers in amplified classrooms reported positive changes in students' attentiveness and classroom participation.[21]

A survey of Montana teachers revealed that 84 percent agreed classroom amplification systems helped their students listen and understand better and that their students were more attentive. Sixty-eight percent agreed there was a decreased need for clarification and reinstruction following an assignment.[22]

Teacher Benefits

Because of the perpetual competition with classroom noise, a teacher's voice level often decreases over the course of the teaching day as voice fatigue sets in. Teachers often report symptoms of hoarseness, dry throat, pain, or fatigue when speaking, as well as temporary loss of voice. [23] The Mainstream Amplification Resource Room Study, found that teacher absences due to vocal strain and voice fatigue in amplified classrooms decreased **from 15 percent to an average of 2 to 3 percent in one year**.

Iowa teachers in amplified classrooms had a 36 percent decline in teacher absenteeism. Teachers in amplified classrooms reported taking fewer sick days per year due to vocal health issues, such as voice, jaw, or throat problems.[24] Florida teachers in Improving Classroom Acoustics amplified classrooms reported decreased vocal strain and fatigue and a multi-year study of amplified classrooms in Florida's Orange County Public School District found a 25 percent decrease in teacher absenteeism in amplified classrooms.[25]

Researchers have also found and concluded that classroom voice amplification systems allow for increased teacher mobility while maintaining a stable acoustical environment. *Teachers are able to move about the classroom freely and students can hear them clearly, regardless of the student's seat assignment or where the teacher is located in relation to where the student is seated*. [26] [27]

[21] Dairi, B. (2000). Using Sound Field FM Systems to Improve Literacy Scores. Advance for Speech- Language Pathologists and Audiologists, 10(27), 5,13.
[22] Baldwin, D., & Dougherty, C. (1997). A Montana Experience with Classroom Amplification. Journal of Educational Audiology, 5, 44-46.
[23] Gertel, S.J., McCarty, P.J., & Schoff, L. (2004). High Performance Schools Equals High Performing Students. Educational Facility Planner, 39(3), 20-24
[24] Allen, L. (1995). The Effect of Sound-Field Amplification on Teacher Vocal Abuse Problems. Paper presented at the Educational Audiology Association Conference, Lake Lure, NC.
[25] Gertel, S.J., McCarty, P.J., & Schoff, L. (2004). High Performance Schools Equals High Performing Students. Educational Facility Planner, 39(3), 20-24
[26] Mainstream Amplification Resource Room Study. (2005e). Measurable Classroom Amplification Results. Retrieved from http://www.marrs-study.info/measure-results.html
[27] Rosenberg, G.G., Blake-Rahter, P., Heavner, J., Allen, L., Redmond, B.M., Phillips, J., et al. (1999). Improving Classroom Acoustics (ICA): A Three-Year FM Sound Field Classroom Amplification Study. Journal of Educational Audiology, 7, 8-28

Choosing a Voice and Audio Sound Reinforcement System

So, most research indicates that classroom amplification systems have a positive impact on students' levels of academic achievement and speech recognition and listening abilities. Studies have also established that use of classroom voice amplification systems results in an improved classroom environment, as evidenced by increased student attention, fewer distractions, and increased task focused behavior. Schools using classroom voice amplification systems have reported significant decreases in teacher absences due to vocal strain and voice fatigue. School staff, students, and parents have responded positively to the use of classroom amplification systems. But how can you choose the best voice and audio sound reinforcement system for your classrooms?

Here are some points to consider when choosing the best system for your requirements:

- Size of rooms
- Cost of installation
- Complexity of installation
- Complexity of the system
- Number of components
- Cost of the system including installation
- Quality of the sound
- Quality of the microphone
- Ease of use
- Learning curve for using the system
- Overall cost of the system
- Portability
- Expansion and upgrades
- Support

Some of these points are subjective like quality of sound and ease of use. But some are quite straight forward.

For instance, will the system require that you install multiple speakers or sound bars in each classroom? Will you need a separate amplifier and EQ for the speakers and transceiver for the microphone? How difficult will it be to install the system? Are there any regulations that will need to be complied with? Can the system be used as a portable system so that it can be used in multiple classrooms? Can the system be easily expanded, more speakers and microphones added, as the need arises? Is the microphone comfortable to wear and simple to use? Does the manufacturer or distributor offer good support and even training? What is your budget for voice reinforcement systems?

Most importantly though is the quality of the sound and the *Engagement Factor*. Does the voice and audio sound reinforcement system help with student engagement? **When the teacher's voice sounds as though it is all around the student's head it is much more likely that the student will be engaged.** A normal speaker placed in the front, back or side of a classroom cannot create this effect. Even a stereo speaker system cannot accomplish this. A Bluetooth™ speaker from a consumer electronics shop is not going to provide the type of soundfield required for the *Engagement Factor* and connecting a microphone to such a system is problematic. Even a Karaoke machine is not going to provide the type of soundfield required.

Only a surround sound or omni-directional 360° speaker system can provide this sort of soundfield. A surround sound system is extremely expensive and not practical for normal classrooms. A 360° omni-directional speaker is quite affordable and accessible.

If you would like more help in choosing the right voice and multimedia sound reinforcement system for your school or campus just contact your local AV supplier or contact Certes Technologies directly.

About the Certes Technologies PentaClass Runa Voice and Sound Reinforcement System

The PentaClass System was developed to offer school administrators and teachers an easy and cost effective way of providing their classrooms with clear, 360° omni-directional sound for that Engagement Factor. The PentaClass System includes a wireless speaker that can easily be installed on a ceiling or wall or it can be used as a portable speaker and moved from classroom to classroom. One speaker covers an area of up to 120 square meters. Up to 3 PentaClass speakers can be daisy chained for maximum coverage in an auditorium or cafeteria. The PentaClass speaker is an all-in-one unit. It includes the amplifier, EQ and transceiver. It can also come with Bluetooth™ connectivity. No separate components are required. The little wireless microphone that comes with the PentaClass System is called the Runa. The Runa microphone is lightweight and simple to use. It charges in a few hours using a standard USB charger and the battery lasts for, at least, 7 hours of continuous use. Two microphones can be paired to the PentaClass speaker at one time.

For much more detailed information about the PentaClass System contact your AV supplier or go to www.certestechnologies.com.

The MARRS Synopsis

According to the often quoted Mainstream Amplification Resource Room Study (MARRS), unified sound field amplification *"enhances the clarity of oral instructions, promotes student attention, lessens teacher voice fatigue, and increases academic achievement scores, particularly for students with mild hearing loss.*"

The following is a summary of the MARRS Project from 1978 - 1994

THE MARRS PROJECT: Mainstream Amplification Resource Room Study

THE CONCEPT: MARRS was a US Department of Education, National Diffusion Network (NDN) project that used a wireless FM microphone system for soundfield amplification of the classroom teacher's voice in order to enhance oral instruction, lessen teacher voice fatigue, and improve student academic achievement. Amplification of the teacher's voice above background noise was provided to all students in the classroom so that those in the back row could hear as clearly as those in the front of the class.

THE INTENDED POPULATION: The MARRS Project was primarily intended as a means of helping students with mild or minimal fluctuating hearing losses compensate for poor classroom acoustics enabling them to remain in the mainstream without expensive referral and identification procedures. Data obtained by MAARS Project staff has revealed that 20–25% or more of the current school population have academic difficulties co-existing with minimal hearing loss (defined as 15-40 dB). If episodes of this degree of hearing loss are frequent, children can miss significant language experience and academic instruction which can cause them to develop learning difficulties that may subsequently require special education services. Education benefits of improved classroom listening via amplification of the teacher's voice have been repeatedly illustrated for thousands of students with normal hearing as well as those students with hearing loss.

SUMMARY OF BENEFITS: The quality of oral instruction is enhanced with amplification since all children receive a clear audible instructional signal throughout the classroom, regardless of interfering noise and where they are seated. Teachers using amplification report improved student attention, fewer distractions, and less need to repeat instructions. Classroom management is enhanced and discipline problems are diminished because the teacher has better voice-control of every student in the classroom. Almost all students comment the amplified voice helps them pay attention, better understand oral directions, hut out distracting noises and hear the teacher without straining. The evidence for improved teaching and quality of instruction is reflected in the statistically significant gains in reading and language achievement test scores for K-^ students included in classrooms using amplification (students with and without hearing loss). These improvements were evident after only one year of use and the improved academic scores have been maintained for as much as 3 years. The amplification was found to be more cost effective than supplementary resource room instruction in: 1) staff utilizations (requiring fewer personnel to achieve the same or superior academic growth), 2) lower initial and continuing educational costs and 3) personal costs to students who avoided the stigma, segregation and restrictions of special placement.

RESEARCH RESULTS – in brief:

1) In 1981, at the end of the original 3 year MARRS study, data was analyzed for three treatments of identified target students. The MARRS study found that approximately 30% of children in grades 3-6 failed a 15 dB hearing screen. These target students were divided into three groups: 1) typical classroom settings, 2) regular classroom instruction with supplemental resource room instruction, and, 3) regular classroom instruction with sound field amplification of the teacher's voice. Amplification of the teacher's voice resulted in significant improvement (>.05 level) in academic achievement test scores of the minimal hearing loss students. These gains

were achieved at a faster rate, to a higher level at a lesser cost than gains achieved by students in the more traditional resource room model typically utilized for students requiring special help. Increases in test scores ranged from 1/3 or over 1 standard deviation. The significant increases were not observed in scores of students in there source room in the same time interval.. The significance of the findings in the MARRS study is that for some students with minimal hearing losses, significant educational instruction effects can be achieved by sound field amplification. Furthermore, these gains can be cost effectively realized within the regular classroom without the need for stigmatizing labeling and segregation as well as expensive and scheduling complications of special class placement. National Diffusion Network recognition of the MARRS Project as an exemplary educational program was granted in 1981.

2) In 1982, a study investigated the effects of sound field amplification on the test taking performance of 131 second and third grade children having either a minimal hearing loss or normal hearing. Also, a behavior rating scale completed by the classroom teacher was correlated with the two groups. The results indicated improved performance on a dictated spelling test for students having minimal hearing loss. The behavior scale had a negative correlation, indicating students with a minimal hearing loss were viewed by the classroom teacher as impulsive, overactive and having a weak attention span.

3) In 1983, the listening ability of kindergarten students under close, distant and sound field amplification was explored. Students with minimal hearing loss (15-40 dB) were identified. A high fidelity tape recorder was placed on the teacher's desk and presented words that students were to identify from 25 multiple choice items by placing an X on the appropriate picture. When the teacher's desk was at the front of the room (average of 12 feet from students), the normal hearing children achieved an average listening accuracy of 91% and the children with hearing loss had an average score of 81%. With the teacher's desk in the center of the classroom (average of 6 feet from the students), scores improved to 98% and 96% for the normal and hearing loss groups respectively. When word were presented via sound field amplification, scores for both groups averaged 98%. Reported results indicated: 1) students with minimal hearing loss do not listen as effectively as normal hearing students from a distance in a kindergarten classroom with "good" acoustical conditions, and 2) listening problems may be alleviated wither by a teacher moving up close to students or using amplification equipment.

4) in 1986, data were gathered from 40 public school classrooms in grades K-6 from sites in Illinois, Kentucky, Minnesota and Missouri. Students with minimal hearing loss were identified at each site and placed at random in amplified classrooms or control (non-amplified) classrooms. Data from each site contained the pre-test and post-test for each target student from the amplified and control groups. It was found that students achievement tests of reading and language ($P<.05$). This was true across the site, grade, and measurement scale used. Subjective results revealed 85-90% of teachers found the system beneficial to themselves and to students judged the system to be beneficial to them in improving their ability to hear and to help in their schoolwork and 90% of administrators surveyed had positive responses to questions assessing the effectiveness of amplification use.

5) In 1990, after 60 sound field amplification units had been phased in over a 5 year period it was found that the number of students placed in LD programs had declined nearly 40%. Also, findings indicated that 43% of students had minimal hearing loss on any given day and approximately 75% of primary-level children attending LD classes also did not have normal hearing. Using the Iowa TBS to evaluate achievement the following was noted: the amplified Kindergarten shoed the most dramatic results with significantly higher scores on listening, language, and work analysis. The amplified Grade 1 classes showed superior performance on work analysis and vocabulary. The amplified Grade 2 classrooms showed better scores on math concepts and computation, and the amplified Grade 3 classrooms showed superiority on math computation concepts and reading. Formal classroom observations indicated that students in

amplified classrooms had better student production and on-task behaviors. Principals also noticed fewer teacher absences due to fatigue and laryngitis.

6) In 1990, children with developmental disabilities in a primary-level class utilizing sound field amplification made significantly fewer errors on a word identification task than they made without amplification. Children were observed to be more relaxed and responded more quickly in the amplified condition.

7) In 1993, children with ongoing hearing loss and histories of chronic ear problems were identified in 12 classrooms. The teachers, who were unaware of the target students, completed S.I.F.T.E.R. educational screening forms for all students in 6 amplified and 6 un-amplified classrooms. Results showed that about on-third of the children have early and continuing hearing problems. Most important, children benefit from classroom amplification, whether or not they have hearing problems.

8) In 1994, the listening abilities of children show have learned English as a second language were studied under amplified and non-amplified conditions. Results indicated that ESL students experienced significant difficulty understanding spoken English in a typically noisy classroom environment. Significant improvement in understanding ability of ESL students was revealed under amplified classroom conditions."[28] [29]

[28] Blazer, C., Improving the Classroom Environment: Classroom Amplification Systems (2007). INFORMATION CAPSULE.

[29] The Use of Sound Field Amplification of the Teacher's Voice in the Regular Education Classroom - A Summary of Studies. Institute for Enhanced Classroom Hearing, n.d.)