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Facilities (Learning Spaces)

Did You Hear Me?

By Andrew LaRowe | May 1st, 2016

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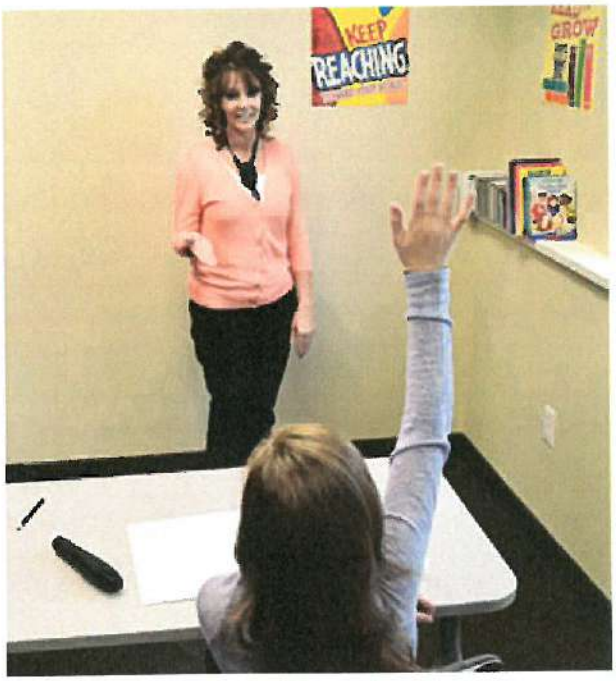
Based on gains in student achievement and teacher effectiveness many school districts across the country now include audio reinforcing technology in every classroom.

Most of us can relate to conferences in large hotel rooms where the presenter fumbles with a wireless microphone questioning "Can you hear me now?" until someone in the back of the room acknowledges the volume is satisfactory. We have all been frustrated when a member of the audience states a question that no one hears and the presenter answers without repeating it. As adults we ask for presenters to speak up, adjust equipment or repeat the question because we are there for a purpose and the information is important to us.

Though the audience in a school classroom knows the information is just as important, the confidence and skill set needed to speak up and ask the teacher to do anything different is not likely to exist. If there is background noise, if the teacher speaks in low tones, speaks while facing the board, has an accent or talks fast, or if some children are hearing impaired; it is possible some students will not receive the information. Unlike adults, it is unlikely the child will complain they cannot hear or make a request for the teacher to repeat information they did not hear.

In the early 80's, educational facility planners began using audio enhancement, or sound field systems in classrooms to address this issue. With nearly 40 years of technological innovations, the equipment side of the puzzle has come a long way. Many districts have long since made a decision to include audio enhancement as standard equipment for all new construction and in many cases, all classroom spaces across the entire district. Lauren Roth, facilities communications manager for Orange County Schools in Florida, stated, "For several years now we have included sound

enhancement technology in in our construction specifications. As a result, over half of Orange County's 257 schools are now equipped with this well-liked and simple technology."



Typically a sound amplification system for classrooms consists of a pendant worn around the teacher's neck containing a microphone. There is a wireless receiver that distributes the voice signal to a number of audio speakers mounted in the ceiling throughout the classroom. The teacher is able to speak in a normal tone of voice and the sound is distributed evenly throughout the space. Most systems are also capable of utilizing microphones for student use. Denton Anderson, vice president and director of sales for Audio Enhancement Inc., described his company as a pioneer in the industry. The company was founded by Claudia Anderson in 1978, when she developed sound equipment to be used in the classroom for two of her hearing impaired sons. Since that time, product development has seen many changes, most notably a groundbreaking move in 2000 from RF (radio frequency) to IR (infrared) technology to increase overall efficiency with transmission of the audio signal.

Extensive research on the use of audio enhancement consistently indicates significant benefits for education, particularly with academic achievement and test scores. Beginning with the Mainstream Amplification Resource Room Study (MARRS) in 1981, numerous studies have shown that aside from academic performance there are other benefits as well. Teachers are less likely to strain their voices during the school day as they address the classroom in a normal tone. Because they do not have to raise their voices to reach students in the back of the room, teachers are perceived as less threatening. They report being less tired at the end of the day and more efficient due to not having to continuously repeat their statements. Having equivalent sound levels in all areas of the learning environment reduces the need for scheduling or seating of children based solely on their ability to hear.

Audio enhancement systems in today's classrooms have survived the test of time. The industry has initiated numerous design improvements and cost efficiencies that offer a product selection that can easily meet the school district's design requirements at a reasonable price. Most systems can be installed within a price range between $1,000 and $2,000 per classroom. Equipment providers have developed a variety of additional features currently available with sound amplification systems that enable the equipment to interact with audio distribution used for other instructional technology systems in the classroom. There is also an option allowing a teacher to activate a duress notification to the office by pressing a button on the pendant microphone.

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Proven Benefits of Sound Enhancement Systems

(Validated by the U.S. Department of Education)

Immediate Benefits (First Days/Weeks)

The quality of teaching is noticeably enhanced as each child responds openly throughout the day to clear, intelligible instruction, regardless of class size, background noise, seat location or if a child has a mild hearing loss, a common daily occurrence at the elementary level.

Improves student attention (particularly with ADD students) resulting in easier classroom management, less student distraction, less need to repeat instructions and higher listening skills test scores.

Results in less stress for all, and reduces teacher absences due to vocal strain and voice fatigue from a measured 15% down to 2-3% in one year.

Short Range Benefits (Several Weeks)

Overall classroom management is improved markedly, discipline problems are reduced, student on task times are more consistently on schedule, and test-taking time is reduced.

Increased student motivation, participation, and speaking confidence results from better hearing, increased speech & language growth, and improved voicing capabilities.

Long Range Benefits (Months/Years)

Results in improvement in reading & language test scores in the early months, notable for all students at all levels.

Statistically significant gains are made in overall composite test scores, evident in less than one full school year, and have been maintained in research study periods for up to three years.

Research has confirmed where early K-6 classroom sound enhancement has been introduced, numbers of students placed in special education referrals has been reduced by up to 43% over five year periods.

High Performance Schools Equals High Performing Students

By Steven J. Gertel, Paul J. McCarty EdD, and Lorenz Schoff PE

Classroom acoustical design and the use of sound enhancement systems are discussed in light of their impact on student academic achievement as well as teacher health and welfare. The results of a multi-year study conducted by Orange County Public Schools in Orlando, Florida, which introduced sound enhancement systems into many of their elementary and secondary schools are reviewed.

Across the United States, architects, planners and facility professionals are championing a wide range of facility "solutions" to address the education crisis in our schools. This includes adopting sustainable building practices; utilizing life-cycle cost analysis; increasing indoor air quality; introducing technology into the classroom; developing community centered schools; and designing small schools or schools-within-schools. The crisis for facility professionals centers on school buildings. Unfortunately, school administrators see the crisis differently. They are looking for ways to improve the quality of the educational environment. This means improving student performance and addressing a huge assortment of inter-dependent problems and diffuse objectives that seem insurmountable such as school board accountability, reduced construction funds, standards and testing, teacher attendance, low salaries, student attendance, rising dropout rates, low parental involvement, reading scores, school day length, local control, school choice, community involvement, whole-school curriculum, computers, student mobility, benchmarking, student culture, security, project based learning, and differentiated learning modes.

Facility professionals speak a jargon that most school administrators do not understand, and provide solutions that seem to have little relevance to the day-to-day challenges administrators face. At the same time, school administrators have tried every new pedagogical technique to address this crisis, but with minimal success. They have experimented with redesigning curriculum, eliminating non-academic electives, increasing professional development, hiring more teachers, lengthening the school day, lengthening the school year, improving food services, etc. Research, however, shows that changes in the physical environment have the most immediate impact on learning. Improvements in classroom acoustics, in particular, may have the greatest impact on student learning (Rittner-Heir 2001).

The optimum acoustical learning environment

The optimum learning environment is critically based on auditory-verbal responses. Children spend 45 percent of their day engaged in listening activities (Berg 1987). Teachers spend most of their time talking, while students ask questions, and listen to both the teacher and other students (Palmer 1997). But if students cannot hear, no learning can take place. Research has shown that the ability of students to learn, and thus their overall academic performance, is negatively impacted when the teacher's communications are muddled or blocked by reverberation or background noise. The standard response is for teachers to raise their voice over the din and project it to the farthest ends of the classroom. After six hours of straining, the teacher invariably leaves school physically exhausted. Over time, this physical effort takes its toll on teacher effectiveness and longevity. Student's inability to listen or hear the teacher inevitably leads to their "tuning out" the lecture. Above all, the student's desire and ability to learn diminishes due to the student's incapacity to distinguish directions or failure or lack of desire to stay on task (Palmer 1997). Poor listening also requires increased effort to learn, and thus reduces the energy available to perform other higher-order cognitive functions.

Research has shown that a typical classroom provides an inadequate environment when auditory learning is the primary tool of instruction (Palmer 1997). As many as one-third of all students miss 33 percent of verbal communication in a typical classroom. Transient external noise generated by children at play, aircraft, vehicular traffic, and ground-mounted air conditioning equipment all penetrate the building envelope and disrupt learning. Internal noise generated by desks and chairs moving, student groups, children moving about, equipment in the classroom, air conditioning and ventilation systems, electrical humming, adjacent classroom activity, and students changing classes in the corridor also penetrate the classroom. The problem of noise has become so important that the American National Standards Institute (ANSI) has developed background 35 decibel, A-weighted thresholds for the maximum sound level within a classroom. Yet, interestingly, ANSI neglects to address not only noise generated in the classroom, but also the signal-to-noise ratio. In order to be properly heard, the teacher's voice must be at least 15 decibels higher than the ambient noise. The higher the ambient noise level, the greater the strain on the teacher and the higher the probability that words are neither heard nor understood. This coupled with the acoustical characteristics of a classroom (which is often assumed to be adequate), designing a proper acoustical environment becomes a formidable task.

Why is this so important?

Information in speech is contained in consonant sounds. The human voice is not designed to project consonant sounds, and because of their frequency range, they are difficult to transmit over the ambient sound level. For those students who come from homes where a second language is spoken, their inability to hear the language clearly in the classroom demands that they either assume what is being said or learn an incorrect pronunciation. The inability to hear clearly also leads to inattentiveness and behavioral problems (Flexer 2002a and 200b). Often, these "attitudinal" problems are a reflection of the student's frustration with not being able to hear, rather than their desire to be disruptive. Students are not small adults; their auditory brains are not fully developed until the age of fifteen (Crandell 1998). In a noisy environment, an adult can fill in the missing words, finish a train of thought, or understand the underlying meaning of the teacher due to past knowledge or experience. A student does not have the experience or familiarity to make these associations.

Sound enhancement systems and classroom acoustical design

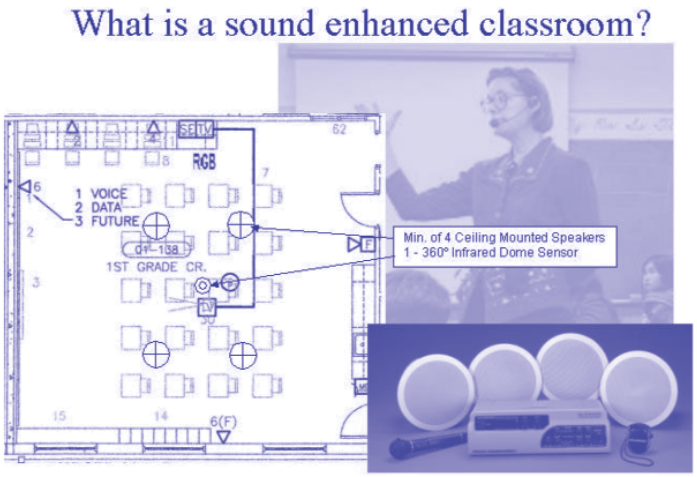
A recent Cornell University study (Evans 2001) suggests that classroom noise not only interferes with the student's ability to hear the teacher, but it may contribute to a state of *learned helplessness*. In this state, the student feels powerless over the classroom environment and gives up trying to learn, thus putting them at even greater risk for failure. Common everyday noise also functions as a stress factor, raising systolic blood pressure, increasing heart rate, and raising cortisol levels and psychological stress.

Room reverberation time can be corrected by increasing the amount of absorptive surface materials, decreasing the volume of the room or increasing the directionality of the sound. To reduce ambient noise, the school can re-route air conditioning systems, place furniture on felt pads, install insulating windows, gasket door openings, change teaching habits, or require students to be completely silent.

Sound enhancement systems utilize a wireless microphone (infrared), a receiver, and at least four strategically located ceiling mounted speakers in the classroom to distribute the teacher's voice down onto the students. These systems are not sound amplification systems, which only increase loudness and are normally uni-directional. When these sound enhancement systems are used, every student feels as if they are in the front row of the classroom; each can hear the words of the teacher distinctly and at the same time. The student is immediately involved in the learning process. While not actually making the classroom louder, the teacher controls, stabilizes, and equalizes the acoustical environment, thus ensuring instructions are heard

by all students. Hearing the higher frequency sounds that carry the sounds and nuances of word boundaries and consonants enables the student to hear the difference between "night rate" and "nitrate". Speaking in a normal, comforting voice reaches out to students, giving them the sense of a one-on-one relationship, regardless of their distance from the teacher. Sound enhancement systems also have a positive effect on teacher performance, attitude, and health. The teacher is able to talk over any interfering background noise. As subtle as the system is, students fail to notice the ease of listening until the system is turned off.

Research has shown a direct correlation between the implementation of classroom sound enhancement systems and improved academic performance (10-15 percent gains per year) regardless of class size, individual learning needs, socio-economic status, and English Language Learner proficiency. The effect sound enhancement had on teacher absenteeism was equally impressive. One study showed a 36 percent drop in teacher absenteeism in sound enhanced classrooms.



Why Teachers Have Voice Problems

Most cases of voice problems among teachers are ultimately attributed to poor acoustical conditions in schools. These voice problems are often a major cause of physical "burn-out", vocal fatigue, and other related illnesses that have a profound effect on teacher retention. When sound enhancement systems are installed in classrooms, teacher absenteeism declines. This saves school districts thousands of dollars in substitute teacher costs and vital student-learning hours. The fact is, teachers are not educated or trained in healthy vocal use and they often lack the knowledge of sound enhancement systems. It is estimated that 75 percent of voice difficulties experienced by teachers can be prevented or self-managed. The National Institute of Health has taken initial steps to address this critical but often-overlooked health issue by underwriting a no-cost website devoted entirely to educating teachers about their speaking voices. The site, called the Voice Academy (www.voiceacademy.org), includes information about the use of enhancement systems.

Schools can be a vocal health hazard zone for teachers. A recent study found that teachers are thirty-two times more likely to be plagued with voice problems compared with other professionals (Sapir 1993). Teachers frequently report symptoms of hoarseness, pain, or fatigue when speaking, as well as temporary loss of voice. These problems also restrict the student's ability to learn and impair the teacher's quality of life and attitude toward teaching. They may progress to the point where skilled teachers leave the profession permanently (Smith 1998).

In 1996, Dubuque Community School District in Iowa reported teachers in classrooms without sound enhancement averaged fifty-two sick days per year due to voice, jaw, or throat problems (0.93 sick days per teacher). However, teachers in sound enhanced classrooms took only nineteen sick days per year (0.34 sick days per teacher) for the same problems. The Iowa teachers reported sound enhanced "equipment was user friendly and made it easier for them to project their voice throughout the classrooms" (Laurie Allen, Keystone Area Education Agency, Dubuque, Iowa, 1996). In addition to fewer teacher sick days, the increased use of sound enhancement equipment in schools resulted in substantial annual savings for the school districts in substitute teacher pay. "The Dubuque Community Schools employ approximately 650 full time teachers. Their substitute teacher pay is approximately $62 per day. Every 12-14 sick days saved by the District would cover the cost of another classroom system" ((Laurie Allen, Keystone Area Education Agency, Dubuque, Iowa, 1996).

Students in a sound enhanced classroom learn at a faster rate, at a higher level of complexity, and with less repetition of information. The use of this technology not only fulfills the technological criteria of the No Child Left Behind Act, but also creates an optimum acoustical environment essential for effective learning and teaching. Sound enhancement systems compensate for inadequately designed room acoustics and are ideal for retrofitting existing classrooms to immediately improve learning.

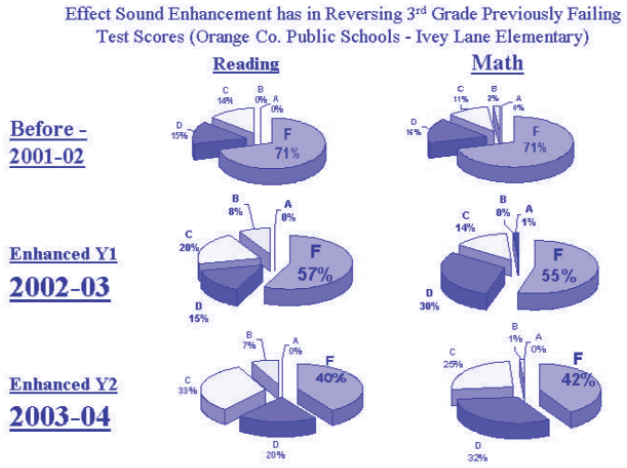
Orange County Public Schools

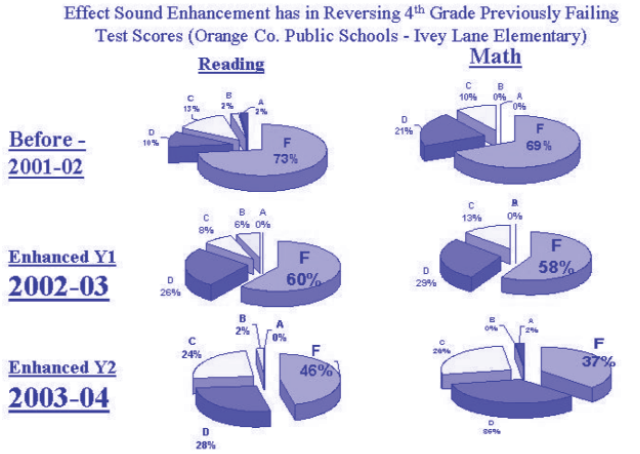
Some of the nation's largest school districts are beginning to believe that a key to urban school reform is improving the acoustics of the instructional environment. In these days of continuous high stakes testing and federally mandated accountability standards, urban school districts are concerned with the following two major challenges:

- How to improve test scores for No Child Left Behind (NCLB) targeted students
- How to increase teacher retention

Orange County Public School District (OCPS) in Orlando, Florida, may have found the answer to both challenges. OCPS recognized that the classroom listening environment is key to improving urban school test scores and introduced sound enhancement systems into many of their elementary and secondary schools. The results of a multi-year study showed

that students in sound enhanced classrooms scored 10 percent higher on average on the Florida Comprehensive Achievement Test (FCAT) than students in classrooms without sound enhancement. Teacher absenteeism was also 25 percent less in the sound enhanced classrooms. An example of this dramatic student improvement is Ivey Lane Elementary in Orlando, Florida. Principal Darryl Weathers was given the assignment of turning around a failing, Title One school with a high minority population. Motivated by OCPS's infectious can-do attitude and district support, Weathers installed sound enhancement equipment (about $1600 per classroom) that contributed to the school moving from a "F" to an "A" school. The teachers also experienced less vocal fatigue.





Analysis of student FCAT scores in other district secondary schools in the Orange County Public Schools showed similar student achievement and improvement. Student comprehension increased and discipline problems in the classroom decreased while teachers experienced less fatigue at the end of the school day.

Today, OCPS requires sound enhancement systems in every new and renovated school. This requirement is an important part of the Orange County Public Schools $2.7 billion school construction program that will extend through 2015. The Orange County Public Schools school design standard has become a model for other school districts throughout the nation. For example, Ohio has adopted Orange County's sound enhancement concepts for their construction standards for new and renovated schools *(Ohio School Design Manual 2003)*.

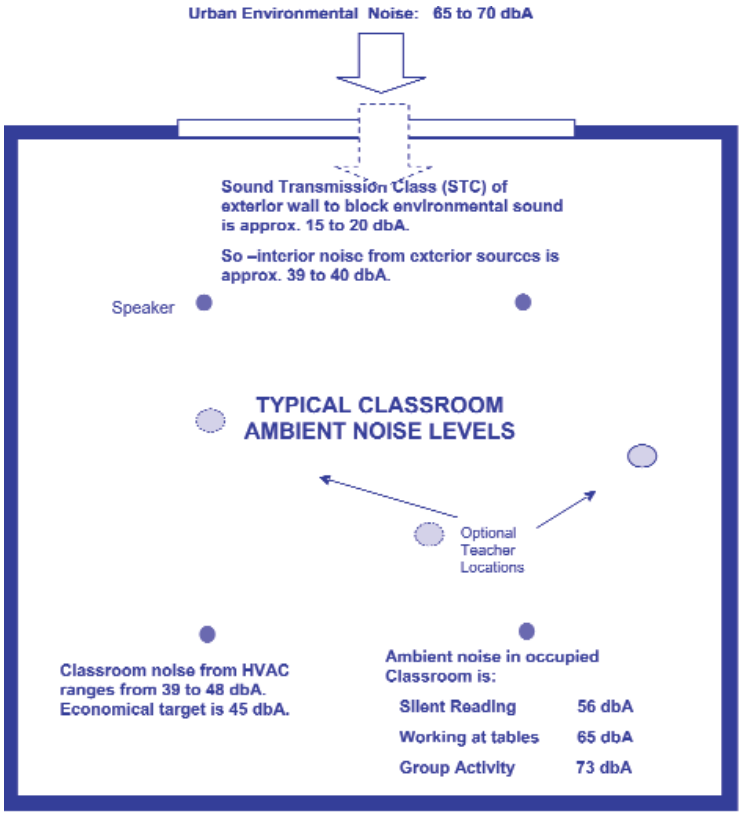
Denver Public Schools is another national leader in implementing sound enhanced classrooms. It recently passed a bond to purchase sound enhancement equipment for its schools after conducting extensive pilot studies that showed improved student achievement and on task behavior. The infrared microphones and ceiling speakers helped teachers speak in normal, comforting voices that reached out to each student. Schools that used audio enhancement have also seen an equally impressive improvement in teacher instructional performance and attitude, as well as less voice fatigue. "It's sort of a no brainer," said Allen Balczarek, Program Manager for the Denver Public Schools. "The 'back row' is eliminated, so to speak. And, the teacher can save her voice, and consequently her career!"

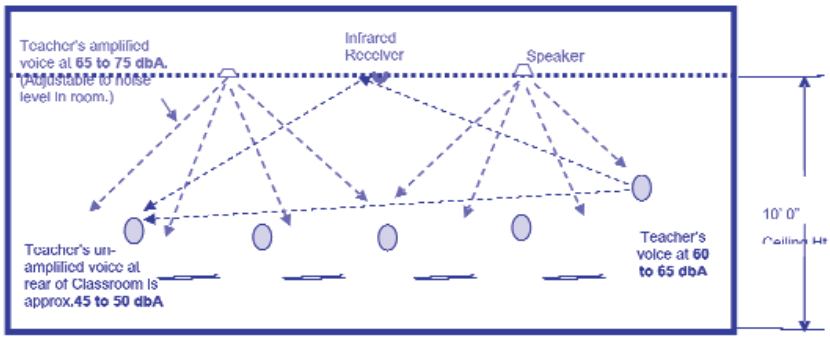
What is the effect sound enhancement has on urban secondary students?

Florida's State Demonstration Middle School, Ocoee Middle School, in the Orange County Public Schools, has also experienced dramatic increases in FCAT test scores due to sound enhanced classrooms. Ocoee's Principal, Dr. Kate Clark, and her teachers ranked sound enhancement as the number one technology at the school. Their ceiling mounted LCD classroom projector sound systems were run through the voice enhanced ceiling speakers. According to Clark, "Every child can see and every child can hear, clearly." Dr. Clark noted that with the introduction of sound enhancement systems, "the decrease in discipline problems alone was obvious." There was a 40 percent decline in discipline incidents from previous years. Dr. Clark attributed the disciplinary decrease to the increased ability of students to focus and remain on task. She added, "The impact for students and teachers has been unbelievable."

Conclusion

Studies in urban schools have shown the importance of sound enhancement in the classroom. It makes sense. If students are to understand the message, they need to hear it clearly. It is a key factor for educational facility planners and architects to consider when designing high performance schools that maximize student performance. Politicians, researchers, and educators have spent much effort, time, and money in their quest for strategies, textbooks, and methodologies to enhance learning performance. Adding sound enhancement to the initial school design will achieve dramatic results. It would be challenging to find another idea for improving student performance that has a better cost to benefit ratio. The results for all students are too dramatic and the benefits are too promising to ignore.





EFFECT OF SOUND ENHANCEMENT IN CLASSROOM

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Teacher Benefits

A teacher's voice is the primary tool of instruction; therefore, it is the teacher who sends the auditory signals and deals with the consequences when the auditory messages do not get delivered accurately or completely.

Sound enhancement systems provide many benefits to teachers as well as students; the most obvious of which is a more audible voice without the physical strain and fatigue on the vocal chords under restricted mobility conditions. Teachers report an increased energy that most likely is generated physically and emotionally. The classroom becomes a happier place to work

in, for both the students and teachers. Students need less repetition of instructions, are better behaved, more on task, and are more interactive. These improvements in the overall class demeanor result in the teacher being able to enjoy the act of teaching as opposed to experiencing the burden of classroom management. It is a win-win for everyone.

Reduced Vocal Fatigue

When background noise is competing for a teacher's attention, the teacher automatically raises his or her voice. A conversational voice is around 65 decibels and the average background noise is approximately 50 decibels. This would provide an SNR of +15 dBA, the necessary signal to noise ratio for speech intelligibility of the normal hearing English speaking child. But, that assumes that the child is within conversational distance from the teacher, 2-3 feet; which we know is not possible for the majority of the students in the class. Therefore, with a background noise level of 50 decibels, the teacher would need to raise her voice up to 83 decibels so that children in the back row (approximately 8 feet from the teacher) can achieve a SNR of +15 dBAs.

Now realistically, teachers are not monitoring the SNR in the classroom throughout the day. Most teachers are not even aware of the required SNR for children, nor are they aware of the actual noise level in the classroom, and we know from ASHA and other research that the SNR in the back of the room is not at the minimum level acceptable for children. But teachers realize, on some level, that they need to project their voices above the noise level in the room, in an effort to have all the children hear them.

There is always the teacher, resistant to voice enhancement technology, who claims that all the children can hear her because she has such a loud pervasive voice. Some teachers even boast about their "vocal" abilities. But those teachers are unaware that sounds have different frequencies and those frequencies have varying degrees of audibility depending on whether they are high or low. For example, consonants are carried by the weak high frequencies, while vowels are carried by the stronger low frequencies. Ninety percent of the energy of speech is carried by the low frequencies, yet only 10% of the intelligibility resides in the low frequencies. Therefore, the louder the teacher talks the less intelligible becomes the sound, because loud voices power the vowels, but obscure the consonants (the softest components of language). It is the consonants that are at the beginning and ending of words and infer meaning, so parts of the word may become more audible, but the word as a whole becomes less intelligible. Loud voices as opposed to a soft nurturing voice are less conducive to learning and present health issues for the speaker. This constant excessive loud talking (even yelling at times), wears on the teacher's voice and the teacher's physical stamina, causing pain, fatigue, throat infections, laryngitis and other voice related problems.

How does this impact the teacher and how does it impact the students? The majority of verbal interaction in the classroom consists of teachers talking to students. This results in teachers talking on average 6.3 hours per day, which accounts for the fact that while teachers make up only about 4 percent of the working population, they compose about 20 percent of the patient

population in voice treatment centers (Titze et al., 1997). It simply is unnatural to speak this long and this loudly for the majority of the working day. The magnitude of teachers' voice problems and subsequent societal effects may be best illustrated by published epidemiological studies reporting that teachers are 32 times more likely to be plagued with voice problems than any other voice dependent occupation (Smith et al., 1998). Subsequently, teachers are often absent from work for a vocal related issue. According to the National Center for Educational Statistics, teachers miss an average of 2 days per year due to vocal fatigue. In fact, in a study comparing teaches to non-teachers, about 20 percent of teachers (compared to only 4% of non-teachers) said that they have missed work due to a voice problem, and 16% had actually cut-back on teaching activities as a result of the chronic adverse impact on their voice (Smith et al., 1998).

Teachers, often unaware of the significance of this "occupational hazard", don't realize what a profound deleterious effect this excessive loud talking has not only on their own health, but on education and society in general. When voice related issues become serious enough that a teacher misses school, the children and society pay for it. Even the best prepared substitute teachers are no match for the professional experience and daily rapport that teachers have with their students. The curriculum is interrupted. Students view a day with a substitute as a "vacation" day, and valuable time is wasted. There is a significant financial cost as well. While each substitute is paid a nominal fee, on average $75 to $100 per day, the summation of substitute pay for a school or school district becomes financially oppressive. The voice problems of teachers cost the U.S. economy more than $2.5 billion annually (Verdonlini and Ramig, 2001); money that could be better spent on equipment which conserves the teacher's voice AND is more effective at providing acoustic accessibility to the students.

A study in Dubuque, Iowa confirms this theory where 60% of the teachers who had ever used a sound enhancement system estimated that they took an average of .97 sick days per year due to a vocal related illness. However, the 40% who used a sound enhancement system averaged only .34 days per year per teacher for a vocal related illness (Allen 1995).i Therefore, this data supports the idea that the installation of sound enhancement equipment not only prevents vocal abnormalities and conserves the teachers' health, but also has a tremendous financial cost-savings benefit as well. At $100 per day for substitute pay, a sound enhancement system (estimated at a cost of $1500) can pay for itself by preventing 15 days of substitute pay for the teacher in that classroom.

If schools are serious about achieving federally mandated student achievement goals and school accountability standards, they must prioritize the vocal needs of their teachers to realize educational improvement and school reform. Quite simply, vocal communication is the primary occupational tool of the teacher who is most directly involved in the student learning process. When the teacher's voice is hampered by pain, hoarseness, or low volume, students' learning is placed at risk and interrupted, and causes a profound financial burden to society as well.
Relief from vocal strain is the most obvious benefit to teachers from use of sound enhancement systems. However, integrating this technology in the classroom produces changes in the temperament of the students, which provides a secondary benefit to teachers.

Improved Classroom Management

A Brigham Young University (BYU) study found that the problem with student learning today could be attributed more to the learning environment than to the teacher, the curriculum, textbooks, or educational software. This study supported an earlier Cornell University study that found if students can't focus on the teacher's spoken word, they lose not only the desire, but also the ability to learn (Evans 2001). Consequently, introducing a sound enhancement system into the classroom, changes the learning environment for the student and the teaching environment for the educator.

When the school facilities do not support auditory learning, boredom and fatigue are likely to result, fostering an environment of inappropriate and inattentive behavior; possibly contributing to the excessive diagnosis of ADD in America. "Up to 19% of school age children have behavioral problems, with up to one half of them displaying attention or hyperactivity problems." ii

Modifying the acoustic environment with a sound enhancement system, allows the students to easily hear and understand their teacher, conserving energy that would otherwise be spent on processing sounds and trying to decipher their meaning. More energy to the student means less "tuning-out" from exhaustion and fatigue. The student is able to focus on the lesson or the task and becomes an active participant engaged in discussion, activities, and learning. This in-turn changes the total dynamics of the classroom and reduces the burden of disciplinarian for the teacher. Teachers are allowed more time to teach due to the reduction in time needed to "manage" the classroom and get students back on task.

The findings from a New Zealand study support this theory. An 8 week observation of sound enhanced classrooms, alternating 2 weeks on and 2 weeks off using the system, found that with the sound enhancement system on, on-task behavior ranged from being 14% less on task to 50% more on task, with a mean of 18% more on-task time than when the system was off. Findings were similar for children with normal hearing and those with a hearing loss (Allcock, 1999).

Children's desire to learn is returned when the frustration of learning is eased; frustration that previously manifests itself in many forms including disciplinary problems. Sound enhancement technology improves student behavior; a theory supported by numerous research studies and by the principal at Florida's State Demonstration Middle School in Orange County, Florida.

Principal, Dr. Kate Clark noted a 40% decline in discipline incidents over a one year period after the classrooms were sound enhanced. It makes sense that if a student can focus their attention on learning; they become more interested in learning, more engaged in the classroom, and less apt to become distracted or unruly.

Teachers who use sound enhancement equipment report that students are more attentive, less distractible, and require fewer direction repetitions (Allen & Patton, 1990).iii This all lends itself to a calmer classroom environment more conducive for learning and more apt to retain good teachers that will not "burn-out" too quickly.

Greater Mobility

Reduced teacher vocal strain is not the only benefit of verbal instruction. Sound enhancement systems allow the teacher greater mobility in the classroom, because the teacher no longer has to be concerned about acoustical barriers and interrupted speech signals. With speakers strategically placed throughout the classroom, every child is within a short distance of the teacher's voice, ensuring that all students have a signal to noise ratio of +15 dBA. This means that teachers can talk while writing on the chalk boards and not be concerned about children who previously needed preferential seating for a hearing problem or learning disorder. In essence, all children in the class have "preferential seating" without the stigma or formality of qualifying for it. This takes a tremendous burden off the teacher, so that she can concentrate on what she wants to say, rather than where she needs to say it.

Cost Effectiveness

Finances are a reality and more often than not determine which initiatives will be implemented. They are especially relevant in school districts and political venues where budgets are scrutinized for programs considered essential. While those who have educated themselves on the benefits of sound enhancement understand the NEED for improving the auditory learning environment to ensure fairness to ALL children in the classroom, others ignorant of the topic may look at this technology as a "luxury item". Therefore, when opportunities are limited to fully educate those making the educational decisions; it is helpful to emphasize the financial as well as the social and moral return on this investment.

Sound enhancement systems cost on average under $900 per classroom. However, the cost may be offset in financial savings resulting from declines in teacher absenteeism and declines in special education referrals. These savings alone may be significant enough to completely recover the initial cost in two to five years. This may be why sound enhancement was named number four out of the top ten "Returns on Investment" by Learning Technology (Nov. 2004) magazine!

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