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IMPROVING THE CLASSROOM ENVIRONMENT: CLASSROOM AMPLIFICATION SYSTEMS

At A Glance

Recent research has demonstrated that students with normal hearing ability benefit from the use of classroom amplification systems. Amplification systems allow teachers to control, stabilize, and equalize the classroom acoustical environment so their voices are clearly audible over background noise at all locations within the classroom. Studies have found positive effects for students in amplified classrooms, including improved academic achievement and speech perception and increased on-task behavior. Positive outcomes using amplification systems can only be achieved when the existing classroom instruction is effective. In other words, if students are not being provided with strategic instruction, the introduction of classroom amplification systems will not increase their levels of academic achievement or classroom engagement. Teacher benefits include reduced vocal strain and voice fatigue and the ability to move more freely about the classroom. Schools using classroom amplification systems have reported significant decreases in teacher absences due to voice-related problems. School staff, students, and parents have responded positively to the use of amplification systems.

Although classroom amplification systems have long been used to help hearing impaired students, recent research has demonstrated that, as a support to an effective classroom teaching and learning environment, students with normal hearing ability also benefit from the use of these systems in their classrooms. The rationale underlying the use of classroom amplification systems in general education classrooms is simple: how well children hear their teacher affects how well they learn (Cole, 2006; Ross & Levitt, 2002). Dahlquist (1998) estimated that 75 percent of the school day is spent engaged in listening activities. Students can achieve at higher levels when they can hear clearly and don't have to strain and guess at what the teacher is saying. Positive outcomes using amplification systems can only be achieved when the existing classroom instruction is effective. In other words, if students are not being provided with strategic instruction, the introduction of classroom amplification systems will not increase their levels of academic achievement or classroom engagement. While this information is not intended to restructure our understanding of the developmental learning sequence, it can certainly be a foundation for the delivery of good instruction.

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Description of Classroom Amplification Systems

Classroom amplification systems include loud speakers (typically mounted on the walls or in the ceiling), a receiver/amplifier, and a wireless microphone that transmits the teacher's voice throughout the room. Some systems come with an additional "pass around" microphone designed to be used by the students as they ask or answer questions. The systems produce an almost uniform speech level throughout the classroom and can be adjusted to raise the teacher's voice significantly above the background noise. While not actually making the classroom louder, amplification systems let the teacher control, stabilize, and equalize the acoustical environment so his or her voice is clearly audible above the background noise at all locations within the classroom (Mainstream Amplification Resource Room Study, 2005a; Gertel et al., 2004; Flexer, 2002; Ross & Levitt, 2002).

Two types of amplification systems are available: radio frequency and infrared. Radio frequency systems are based on the bands commonly used for radio and television. Infrared systems use infrared light to send signals between a microphone and receiver. Decision makers should be aware that each system has limitations. For example, when multiple radio frequency units are used in close proximity, signals can overlap and interfere with each other. Infrared systems are not susceptible to interference between classrooms or from outside sources (because the signal is contained within the classroom), but their signal is transmitted through a line of sight. Therefore, additional receivers may be needed to transmit to all areas of the classroom, especially larger or unusually shaped rooms (Smith, 2006).

Classroom amplification systems can be set up by an educational audiologist. Researchers agree that teachers in amplified classrooms must be provided with training and ongoing monitoring and support so they are able to use the systems successfully. Microphone techniques must be demonstrated to teachers and replacement parts, such as batteries, must be readily available (Flexer, 2002). The typical cost of the system is approximately $1,500 per classroom. Over the expected life of the system (an estimated 10 years), classroom amplification costs pennies a day per student (Cole, 2006; Rosenberg, 2004).

Sources of Noise in the Classroom

The Improving Classroom Acoustics study concluded that unoccupied classroom noise levels exceeded the recommended acoustical standards in 97 percent of the 94 classrooms studied (Rosenberg et al., 1999). It is often difficult to distinguish problems caused by poor classroom acoustics from those caused by students' learning difficulties. Unacceptable noise levels can be produced by:

- 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. Additionally, teachers' voice levels often decrease over the course of the teaching day as voice fatigue sets in.

- 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 (Mainstream Amplification Resource Room Study, 2005a; Mainstream Amplification Resource Room Study, 2005b; Gertel et al., 2004; Flexer, 2002; Rosenberg et al., 1999).

All Children Can Benefit from Classroom Amplification Systems

Studies have demonstrated that children should be within approximately six feet of the teacher in order to receive maximum speech intelligibility; however, achieving this distance for all students is impossible due to typical class sizes and changes in teachers' location relative to each student as they move about the room (Fickes, 2003; Palmer, 1997). 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 6, 12, and 24 feet, respectively. 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.

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 (Cole, 2006; McCarty & Ure, 2003; Flexer, 2002; Rosenberg et al., 1999). The Mainstream Amplification Resource Room Study (2005b; 2005c), 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 (Rosenberg, 2004). 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 teaching environment;
- students with a soft-spoken teacher;
- learning disabled students; and
- English language learners.

Research Studies on the Impact of Classroom Amplification Systems

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 found that the use of classroom amplification systems results in an improved classroom environment, as evidenced by increased student attention, fewer distractions, and increased on-task behavior. Schools using classroom amplification systems have reported significant decreases in teacher absences due to vocal strain and voice fatigue. Researchers have found support among school staff, students, and parents for the use of classroom amplification systems. Results summarized in this report are based on students with normal hearing ability, unless otherwise noted.

Academic Achievement

Flexer (2002) studied three Utah first grade classrooms in which 85 percent of the children were Native American. In the five years prior to the installation of classroom amplification systems, only 44 to 48 percent of the students scored at the basic level or above on the Utah State Core Reading Test. After seven months of classroom amplification, 74 percent of the students in the study scored at the basic level or above.

McCarty and Ure (2003) studied the impact of classroom amplification systems on urban, at-risk fourth and fifth grade students in Utah. Classroom amplification systems were found to successfully reverse a two-year downward trend in achievement test scores. The scores of students in amplified classrooms were 10 to 15 percent higher than students in unamplified classrooms on the Stanford Achievement Test (including reading, language, math, science, and social studies subtests, as well as the total battery) and the state's criterion-referenced reading, math, and science tests. Some of the greatest gains were noted for English language learners. Their average gain on criterion-referenced subtests was 16 percent.

Chelius (2004) compared the standardized test scores of first, third, fourth, and fifth grade students in amplified and unamplified Oregon classrooms. She found that first grade students in the amplified classroom scored an average of 35 percent higher on the Dynamic Indicators of Early Literacy Skills (DIBELS) and an average of 21 percent higher on the Developmental Reading Assessment (DRA) than students in the unamplified classroom. Third grade students in amplified classrooms scored an average of 21 percent higher on Oregon's Technology Enhanced Student Achievement test and increased by an average of 32 percent in words per minute in reading fluency. Fourth and fifth grade students' words per minute averaged 35 percent higher than students in unamplified classrooms on a reading fluency test.

Osborn, VonderEmbse, and Graves (1989) studied the effect of amplification systems in kindergarten to grade 3 from nine rural school districts in Ohio. Students with classroom amplification systems achieved higher scores on selected Iowa Test of Basic Skills subtests: listening and language (kindergarten and first grade), vocabulary (first grade), math concepts (second and third grade), and math computation (third grade), with greater gains made by younger students. During the second year of the study, significant findings were reported on selected subtests for amplified classrooms at three of the four grade levels: word

analysis (kindergarten and first grade), math concepts (first and third grade), math problem solving (first grade), and math computation (third grade). A general trend showed that the younger the student, the greater the difference between the scores of students in amplified and unamplified classrooms. It should be noted that significantly higher scores were not reported for students in amplified classrooms in reading, science, or social studies at any of the four grade levels tested.

A 2005 study of ten Title I third and fifth grade amplified classrooms in the Washoe County School District (Reno, Nevada) found that students' average reading and math standardized test scores increased more than the average scores of students districtwide in unamplified classrooms. Grades 3 and 5 average reading scores in amplified classrooms increased, while the average reading scores of students in unamplified classrooms districtwide decreased. The grade 3 average math score of students in amplified classrooms increased more than the average score of students districtwide. Finally, the grade 5 average math score of students in amplified classrooms increased, while the average score of students districtwide remained stable (Audio Enhancement, n.d.)

Florida's Orange County Public Schools introduced classroom amplification systems into selected elementary and secondary schools. The results of a multi-year study showed that students in amplified classrooms scored, on average, 10 percent higher on the Florida Comprehensive Assessment Test than students in classrooms without sound enhancement (Gertel et al., 2004).

Dairi (2000) compared first grade students in four amplified classrooms with students in four unamplified classrooms in Florida's Broward County Public Schools. A comparison of mid-year and end-of-year scores on the Informal Reading Inventory indicated that students (and especially bilingual and special education students) in amplified classrooms achieved greater literacy gains than comparison group students.

Second grade Minnesota students' reading, math, and spelling skills were tested three times during a six-month period in one amplified and one unamplified classroom. Significantly greater gains were posted by students in the amplified classroom in reading and spelling, but no significant difference was found between the gains in the two groups' math scores (Loven et al., 2003).

In Colorado, classroom amplification systems were shown to have a significant impact on high achieving students. Students who had previously scored in the eighth and ninth stanines on the Colorado Student Achievement Test increased an average of 3.6 percentage points during the first year of amplification. The school's principal attributed the increased test scores to the installation of classroom amplification systems since no other significant changes were made to the school's instructional program or staff (Audio Enhancement, 2006).

The Mainstream Amplification Resource Room Study (2005d, 2005e) researched classroom amplification systems in southern Illinois schools. The study's authors reported that the number of students referred to special education in kindergarten through grade six decreased by 43 percent in amplified classes of students with and without hearing impairment. Similarly, Long and Flexer (2001) found that special education referral rates in kindergarten to fifth grade general education classrooms in Wisconsin decreased by almost 50 percent after classroom amplification systems were used in 37 classrooms over an eight-month period.

Speech Recognition and Listening Abilities

Flexer, Biley, Hinkley, Harkema, and Holcomb (2002) studied the impact of classroom amplification systems on students' phonological and phonemic awareness. Students were divided into three groups: classroom amplification with phonological and phonemic awareness instruction; phonological and phonemic awareness instruction only; and a comparison group. The study started in the second semester of students' pre-school year and continued to the end of the first semester of their kindergarten year. The authors found that the group receiving both classroom amplification and phonological and phonemic awareness instruction had the highest percentage of children scoring above the mean (78 percent) on the posttest administration of the Yopp-Singer Test of Phonological and Phonemic Awareness. Fifty-seven percent of the group that received phonological and phonemic awareness instruction without classroom amplification and 17 percent of the comparison group scored above the mean. A low score of 5 on the Yopp-Singer Test indicates that a child may be at risk for reading problems. In the group that received classroom amplification and phonological and phonemic awareness instruction,

only 9 percent of the children scored 5 or below. In the group that received phonological and phonemic awareness instruction only, 44 percent scored 5 or below. Fifty-seven percent of the comparison group scored 5 or below.

The Improving Classroom Acoustics project studied 94 kindergarten through second grade classrooms in 33 Florida elementary schools from 23 Florida school districts. (Note: Miami-Dade County Public Schools did not participate in this study.) Based on classroom observations and administrations of the Listening and Learning Observation Form and the Evaluation of Classroom Listening Behaviors, students in amplified classrooms demonstrated a significantly greater change in listening behaviors, and at a faster rate than their peers in unamplified classrooms. The greatest gains were made by younger students in amplified classrooms (Rosenberg et al., 1999).

Mendel, Roberts, and Walton (2003) conducted a two-year study on the effect of classroom amplification on speech perception. Kindergarten students were randomly assigned to classrooms with or without amplification and were studied over a two-year period. Although students in amplified classrooms posted significantly higher speech perception scores during kindergarten, no significant score differences were found between students in amplified and unamplified classrooms by the end of the first grade. The authors concluded that, although students in unamplified classrooms were able to eventually bridge the speech recognition performance gap, classroom amplification led to more immediately enhanced performance.

Crandell (1996) documented the impact of classroom amplification on kindergarten English language learners' speech perception abilities. The effect of classroom amplification on the monosyllabic word perception of English language learners was evaluated at three speaker-listener distances (6, 12, and 24 feet). English language learners were found to experience more speech perception difficulties in the unamplified listening condition, particularly at distances of 12 and 24 feet. The speech perception scores of English language learners in amplified classrooms were significantly higher than the scores of English language learners in unamplified classrooms. Furthermore, while speech perception scores in the unamplified condition increased as the speaker-listener distance decreased, scores in the amplified condition remained relatively stable across each of the three speaker-listener distances.

Crandell and Smaldino (1995) compared the sentence perception abilities of English language learners and native English speaking children under quiet conditions and at noise levels commonly reported in the classroom. They found that, although both groups obtained equivalent sentence perception scores under quiet conditions, the English language learners received significantly lower scores across most of the noisier listening conditions. Performance differences in sentence perception between the two groups increased as the classroom became louder.

Classroom Benefits

Studies have shown that the use of amplification systems leads to improved classroom environments.

- The Mainstream Amplification Resource Room Study (2005d, 2005e) 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.

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

- Teachers in first grade amplified classrooms in Minnesota reported their students were more attentive, less distracted, and required fewer repetition of directions when amplification systems were introduced into their classrooms (Audio Enhancement, 2006).

- 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.

- 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 (Rosenberg, 2004).

- 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.

- 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 (Baldwin & Dougherty, 1997).

Teacher Benefits

Teachers frequently report symptoms of hoarseness, pain, or fatigue when speaking, as well as temporary loss of voice (e-School Solutions, 2005; Gertel et al., 2004). The Mainstream Amplification Resource Room Study (2005b, 2005e) 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 (Allen, 1995). 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 (Gertel et al., 2004; Rosenberg, 2004).

Researchers have also concluded that classroom 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 (Mainstream Amplification Resource Room Study, 2005d; Rosenberg et al., 1999; Clements, n.d.).

Staff, Student, and Parent Perceptions

Researchers have found support among teachers, administrators, students, and parents for the use of classroom amplification.

- Teachers in the Improving Classroom Acoustics project reported classroom amplification systems were easy to use, they felt comfortable using the systems, and would like to use them in their classrooms again the following year (Rosenberg et al., 1999).

- Allen (1993) surveyed Iowa elementary teachers regarding their perceived usefulness of different equipment used to facilitate instructional delivery in the classroom. She found that once teachers were familiar with classroom amplification systems, they ranked their usefulness above other popular equipment, such as overhead projectors, televisions, and computers.

- Nelson and Schmidt (1993) surveyed Minnesota teachers who had used classroom amplification systems in traditional and open pod classrooms. They found that teachers in open classroom environments reported greater benefits from the amplification systems than teachers in traditional classrooms.

- The majority of administrators in the Improving Classroom Acoustics schools agreed that classroom amplification enhanced class instruction and management. They also reported a decrease in the number of behavioral referrals from students in amplified classes (Rosenberg et al., 1999).

- In the Mainstream Amplification Resource Room Study (2005d), Illinois students reported that their teacher's amplified voice helped them pay attention, better understand oral directions, and hear the teacher without straining.

- More than 95 percent of students in the Improving Classroom Acoustics project agreed that classroom amplification made it easier for them to hear their teacher, helped them listen

better, and helped them hear when their teacher was writing on the blackboard. At least 92 percent of students agreed that they wanted to use an amplification system in their class again the following year (Rosenberg et al., 1999).

- Parents whose children were placed in amplified classrooms as part of the Improving Classroom Acoustics project gave the system high ratings. The majority of parents indicated that their children would like to continue using the system in their classroom the following year (at least 85 percent) and that their children enjoyed using the system (at least 83 percent). Parents were in at least 46 percent agreement that their children's grades improved when using the system and at least 44 percent agreed that their children's behavior improved at school (Rosenberg et al., 1999).

Summary

Although classroom amplification systems have long been used to help hearing impaired students, recent research has demonstrated that, as a support to an effective classroom teaching and learning environment, students with normal hearing ability also benefit from the use of these systems in their classrooms. Classroom amplification systems produce a uniform speech level throughout the room and allow teachers to control, stabilize, and equalize the acoustical environment so their voices are clearly audible above background noise at all locations within the room. Positive outcomes using amplification systems can only be achieved when the existing classroom instruction is effective. In other words, if students are not being provided with strategic instruction, the introduction of classroom amplification systems will not increase their levels of academic achievement or classroom engagement.

Studies have demonstrated that children should be within approximately six feet of the teacher in order to receive maximum speech intelligibility; however, achieving this distance for all students is almost impossible due to typical class sizes and changes in teachers' locations relative to each student as they move about the room. Furthermore, the brain's auditory network is not fully developed until about age 15. Children listen differently than adults and need a quieter environment and louder auditory signal in order to learn. Therefore, researchers have concluded that all children, not only those with hearing impairment, can benefit from classroom amplification.

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 found that use of classroom amplification systems results in an improved classroom environment, as evidenced by increased student attention, fewer distractions, and increased on-task behavior. Schools using classroom 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.

At the present time, although classroom amplification systems are used sporadically throughout the district, there is no districtwide usage of the systems in Miami-Dade County Public Schools' general education classrooms.

All reports distributed by Research Services can be accessed at http://drs.dadeschools.net by selecting "Research Briefs" or "Information Capsules" under the "Current Publications" menu.

References

Allen, L. (1993). Promoting the Usefulness of Classroom Amplification Equipment. *Educational Audiology Monograph, 3*, 3-34.

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.

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.

Audio Enhancement. (2006). *Research Review (2003) of Audio Enhanced Classroom Technology.* Retrieved from http://www.audioenhancement.com/ae/SiteDefault.aspx?pgid=55.

Audio Enhancement. (n.d.) *What Happens When Students Can't Hear?* Retrieved from http://www.audioenhancement.com/ae/DesktopModules/ViewDocument.aspx?DocumentID=179.

Baldwin, D., & Dougherty, C. (1997). A Montana Experience with Classroom Amplification. *Journal of Educational Audiology, 5,* 44-46.

Chelius, L. (2004). *Trost Amplification Study.* Canby, OR: Unpublished Manuscript, Canby School District.

Clements, J. (n.d.) *Classroom Amplification Equipment: Not Just for the Hearing Impaired Anymore*. Framingham Public Schools. Retrieved from http://www.framingham.k12.ma.us/mccarthy/clements.htm.

Cole, W. (2006). Now Hear This. *Time Magazine,* October 16, 2006.

Crandell, C.C. (1996). Effects of Sound Field FM Amplification on the Speech Perception of ESL Children. *Educational Audiology Monograph, 4,* 1-5.

Crandell, C., & Smaldino, J. (1995). The Importance of Room Acoustics. In R. Tyler & D. Schum (Eds.), *Assistive Listening Devices.* Allyn & Bacon: Needham Heights, MA.

Dahlquist, L.H. (1998). *Classroom Amplification: Not Just for the Hearing Impaired Anymore*. Paper presented at the California State University Northridge Center Conference, Los Angeles, CA, March 1998.

Dairi, B. (2000). Using Sound Field FM Systems to Improve Literacy Scores. *Advance for Speech-Language Pathologists and Audiologists, 10*(27), 5,13.

e-School Solutions. (2005). *Sound Enhanced Classroom Technology.* Retrieved from http://www.eschool-solutions.com/audioenhancement.htm.

Fickes, M. (2003). The Sounds of a Sound Education. *School Planning and Management.* Retrieved from http://www.peterli.com/archive/spm/535.shtm.

Flexer, C. (2002). Rationale and Use of Sound Field Systems: An Update. *The Hearing Journal, 55*(8), 10-17.

Flexer, C. (2005). Turn on Sound: An Odyssey of Sound Field Amplification. *Mainstream Amplification Resource Room Study*. Retrieved from http://www.marrs-study.info/turn-on.html.

Flexer, C., Biley, K.K., Hinkley, A., Harkema, C., & Holcomb, J. (2002). Using Sound-Field Systems to Teach Phonemic Awareness to Pre-Schoolers. *The Hearing Journal, 55*(3), 38-44.

Gertel, S.J., McCarty, P.J., & Schoff, L. (2004). High Performance Schools Equals High Performing Students. *Educational Facility Planner, 39*(3), 20-24.

Leavitt, R., & Flexer, C. (1991). Speech Degradation as Measured by the Rapid Speech Transmission Index (RASTI). *Ear & Hearing, 12,* 115-118.

Long, S., & Flexer, C. (2001). Sound Field Amplification For All. *Advance for Speech-Language Pathologists and Audiologists, 11*(27), 10-11.

Loven, F., Fisk, K., & Johnson, S. (2003). *Classroom Amplification Systems on Early Academic Achievement and Attention*. Poster session presentation at the American Speech-Language-Hearing Association Annual Convention, Chicago, IL.

McCarty, P.J., & Ure, A. (2003). *The Effect Audio Enhanced Classrooms Have on Student Achievement and Teacher Instruction.* Collaborative of High Performance Schools. Retrieved from http://www.chps.net/links/pdfs/Abstract_BYU_Research6-031.pdf.

Mainstream Amplification Resource Room Study. (2005a). *Tuning Up Our Classrooms.* Retrieved from http://www.marrs-study.info/tuning-up.html.

Mainstream Amplification Resource Room Study. (2005b). *Classroom Amplification FAQ.* Retrieved from http://www.marrs-study.info/classroom-faq.html.

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

Mainstream Amplification Resource Room Study. (2005d). *The MARRS Project: Mainstream Amplification Resource Room Study.* Retrieved from http://www.marrs-study.info/marrs-study.html.

Mainstream Amplification Resource Room Study. (2005e). *Measurable Classroom Amplification Results.* Retrieved from http://www.marrs-study.info/measure-results.html.

Mendel, L., Roberts, R., & Walton, J. (2003). Speech Perception Benefits from Sound Field FM Amplification. *American Journal of Audiology, 12*, 114-124.

Nelson, D., & Schmidt, M. (1993). Take Anything Else, But Leave My Classroom FM System! *Perspectives, 12*(1), 8-11.

Osborn, J., VonderEmbse, D., & Graves, L. (1989). *Development of a Model Program Using Sound Field Amplification for Prevention of Auditory-Based Learning Disabilities.* Unpublished Study, Putnam County Office of Education, Ottawa, OH.

Palmer, C.V. (1997). *Hearing and Listening in a Typical Classroom*. American Speech-Language-Hearing Association, Rockville, MD.

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.

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.

Ross, M., & Levitt, H. (2002). *Classroom Sound-Field Systems*. Rehabilitation Engineering Research Center on Hearing Enhancement. Retrieved from http://www.hearingresearch.org/Dr.Ross/classroom_sound_field_systems.htm.

Smith, M. Can You Hear Me Now? (2006). *TechLearning.* Retrieved from http://www.techlearning.com/showArticle.php?articleID=188702534.