The Role of Sound Field Amplification for English Language Learners

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Research on sound field amplification has shown positive effects on hearing and speech perception for many students, including English Language Learners. This qualitative study investigated benefits beyond improved speech perception from the perspective of classroom teachers. Unstructured interviews were conducted with 11 elementary teachers who used sound field amplification in their classrooms in a high needs urban school with a high percentage of English Language Learners (ELLs). Using qualitative data analysis procedures, 3 primary themes emerged, describing benefits of sound field systems in Enhancing English Language Learning, Enhancing Teacher Effectiveness, and Enhancing Student Engagement. The key finding related to Enhancing English Language Learning was the role of sound field amplification in enhancing and refining the spoken English language model provided to students, particularly under difficult listening environments. Teachers noted that use of their sound field system allowed them to highlight subtle morphological and syntactic markers in English for which students were unaccustomed to listening in their first language. Teachers also reported innovative uses of the technology to create more dynamic classrooms and improve student engagement.

INTRODUCTION

Anderson (2004) coined the term "learning to listen in a sea of noise" to describe the situation in which children are required to spend a large part of their day engaged in listening under less than optimal acoustic conditions. Noise is a problem for everyone, but some students experience more difficulty than others. These include young children with immature listening skills, students with temporary hearing loss from recurrent ear infections, students with auditory processing, language or learning disabilities, and English Language Learners. Research shows that children are less able than adults to listen and understand effectively in the presence of background noise (Crandell & Bess, 1986, Crandell & Smaldino, 2000; Evanston & Elliott, 1979). Research with children indicates better ability to discriminate words and spoken language more accurately with the use of a sound field amplification system than without (Arnold & Canning, 1999; Sockalingham, Pinard, Cassie & Green, 2007). Studies have found improved scores in dictated spelling tests (Zabel & Taylor, 1993) and better standardized test scores in reading (Millett & Purcell, 2010). A longitudinal study by Gertel, McCarty & Schoff (2004) found that students in amplified classrooms scored 10% better on a standardized achievement test than students in unamplified classrooms. Outcome measures from the Mainstream Amplification Resource Room Study Project (MARRS) indicated better scores on standardized tests of listening and language skills for kindergarten students, and better scores in the areas of math concepts, math computation and reading for grade 2 and 3 students (Ray, 1992). Massie & Dillon (2006) reported statistically significant improvements in ratings of attention, communication and classroom behaviour in amplified classrooms, and noted that teachers considered that "sound-field amplification facilitated peer interaction, increased verbal involvement in classroom discussion, and promoted a more proactive and confident role in classroom discussion" (p. 89). Allcock (1999) found improvements in standardized test scores of phonological processing, with 74% of children in amplified classrooms achieving an improvement of 1 stanine or more, versus 46% in unamplified classrooms (Allcock, 1999). Rubin, Aquino-Russell, & Flagg- Williams (2007), in a study of 60 Canadian classrooms, found statistically significant increases in student responses to teacher statements, decreases in the number of teacher repetitions, and fewer student-initiated communications with peers during instruction (i.e. fewer instances of students speaking amongst themselves during teacher instruction) in the amplified classrooms.

A small body of literature has indicated that understanding spoken language in the presence of background noise is even more problematic for adults and children learning English as a second language (Crandell & Smaldino, 2000; Mayo & Florentine, 1997; Nabelek & Nabelek, 1994; Nelson, Kohnert, Sabur, & Shaw, 2005). Mayo & Florentine (1997) found that children acquiring English at an older age had more difficulty with speech discrimination in noise than younger bilingual children. Nelson at al. (2005) in a study of speech perception in noise by children who were monolingual versus children who were English Language Learners, found that the average decrease in performance accuracy was four times greater for the ELLs than for the children who spoke English only. This difficulty with speech understanding in noise was not postulated to be related to differences in hearing levels between English Language Learners and children with English as a first language. Rather, when individual words or speech sounds are missed because of high levels of background noise, listeners must rely on their knowledge of the language, contextual cues, and metalinguistic and metacognitive strategies to make sense of a distorted or partially missing message. This is a difficult task for a child, who is still learning a new language while expected to be able to access the curriculum in often difficult listening environments.

There are a small number of studies on benefits of sound field amplification for English Language Learners. Sound field amplification has been shown to produce improvements in speech perception scores of up to 30% for children learning English as a second language when noise is present (Crandell, 1996). Vincenty-Luyando (2000) compared monolingual school children and English Language Learners in their speech perception accuracy in a real classroom with typical classroom noise levels introduced, with and without sound field amplification. English Language Learners had significantly poorer phoneme discrimination abilities in the presence of noise (63% vs. 76% for children with English as

a first language). Under the highest noise conditions, all children's scores combined improved by 19% with the introduction of sound field amplification. Reel & Hicks (2011) suggested that there may be improvements in auditory selective attention with use of sound field amplification for students exposed to a second language at home.

There is no doubt that the primary benefit of sound field amplification is to make the teacher's voice clearer, more consistent and easily heard by students wherever they are located in a classroom. However, many studies have also reported anecdotal comments or questionnaire responses by teachers which suggest that sound field amplification also impacts less easily quantifiable, but equally important aspects of classroom learning such as teacher effectiveness, classroom management and overall listening skills. These findings include less need to repeat instructions (Dairi, 2000; Edwards, 2005; Rosenberg, Blake-Rahtner, Heavner, Allen, Redmond & Phillips, 1999), better student attention and on-task behaviours (Allen & Patton, 1990; Cornell & Evans, 2001; Dockrell & Shields, 2012), fewer teacher absences due to vocal problems (Allen, 1995), a reduction in vocal effort by teachers (Sapienza, Crandell & Curtis, 1999), and better listening skills (Dowell, 1995; Edwards, 2005; Rosenberg et al., 1999). These studies suggest that sound field amplification may impact more than just speech perception.

Other than a few studies which include anecdotal teacher comments, there is an almost complete lack of research focused on describing the experiences of the primary user of sound field amplification technology, the classroom teacher. The rationale for this study, then, was twofold – through interviews, to explore teacher experiences with sound field amplification, and to explore whether this impact might differ for students who were English Language Learners than for monolingual English speakers.

METHOD

Context

This study took place in a kindergarten to Grade 5 school located in a low income area in a large urban Canadian city. Of the approximately 275 students in the school, 65% were non-native English speakers, 98% had parents who were born outside Canada, and 40% of students had Individualized Education Plans (IEPs). Family income was quite low in many cases, with 37% of families classified as low income families (personal communication, school principal). As a school-based initiative, SMART Board interactive whiteboards interfaced with Front Row Pro D sound field systems had been installed one year previously in 9 grade 1 to 5 classrooms, as well as the library and computer lab (for a total of 11 rooms outfitted). This study took place after approximately one year of sound field system use by teachers. This study was approved through the university Human Participants Research Committee, and consent forms were signed by all participants prior to interviews. Informed consent forms for interviews were signed by teachers, and informed consent forms for hearing screenings of students were signed by parents.

Participants

Unstructured interviews were conducted with 11 teachers of grades 1 to 6. Participants included three kindergarten teachers, one grade 1 teacher, two teachers of split grade 1/ 2 classes (ie a class including both grade 1 and grade 2 students) , one grade 2 teacher, one grade 4 teacher and one grade 6 teacher, as well as the French teacher (who taught French to all students in grades 4, 5 and 6), and the librarian. Each teacher was initially asked an open-ended question "what do you think about your sound field system?"; follow-up questions regarding observations about vocal fatigue or difficulties managing technical aspects were sometimes asked, but generally, teachers required little encouragement or prompting to provide their thoughts. Each interview was conducted in the teacher's own classroom, lasted approximately 20 minutes and was audio taped for later transcription and analysis. The school principal was not interviewed formally, but her comments during meetings and presentations throughout the course of the study were considered as well.

Student hearing screening. At the beginning of the study, hearing screenings were conducted for all students from junior kindergarten to grade 2, using pure tone audiometry (presented at 20 dB for the frequencies 1000, 2000, and 4000 Hz), as well as tympanometry, in accordance with the American Academy of Audiology (2011) guidelines for hearing screening. Due to resource limitations and in consultation with the school principal, the decision was made to focus the hearing screening initiative on younger students. envA second hearing screening was conducted 2 weeks later for students who did not pass the original screening. A total of 120 students received hearing screenings by the researcher, a licensed audiologist. Of the 120 students screened, eight students had a refer result on the first screening, decreasing to six students on the second screening, all with evidence of middle ear dysfunction. Results were conveyed to parents with recommendations for medical follow-up where appropriate.

Teacher Interviews Data Analysis

Analysis of the data was approached from the grounded theory perspective described by Creswell (2009). Creswell describes the methodology as "a strategy of inquiry in which the researcher derives a general, abstract theory of a process, action or interaction grounded in the views of the participants". Interviews were transcribed from audio recordings, and transcripts were read carefully, code words and phrases were identified, and comparisons between subject transcriptions were made. Source codes were attached to each comment to identify the location of data within the transcript. Theme codes were then developed for the data segments. Once themes were identified, category codes were developed so that similar themes could be combined and analyzed together.

RESULTS AND DISCUSSION

As summarized in Table 1, several themes regarding benefits of sound field system use emerged from interview analysis that were surprisingly consistent across teacher interviews. These were given the descriptors "Enhancing English Language Learning", "Teacher Effectiveness", and "Enhancing Student Engagement".

Enhancing English Language Learning

Every teacher with the exception of the librarian commented on the fact that the sound field system allowed them to provide a better spoken English model to their students, and more specifically, enabled the students to hear the subtle phonological differences that result in differences in meaning. This was expressed differently by different teachers, but the core underlying concept seemed to be that English Language Learners needed an English language model that was not just simpler in terms of grammar and vocabulary, but that individual speech sounds and words needed to be acoustically clearer.

Many languages are represented at this school, all of which have different phonological and syntactic features from English. Teachers emphasized that the development of English oral language skills is a key focus for them during all teaching and learning activities. The importance of students being able to hear the teacher's spoken language model as clearly as possible was highlighted again and again by the teachers in their interviews. The grade 6 teacher noted that when he was teaching geometry, "there's a big difference between 'side' versus 'size' in geometry but I have to use both words all the time and without the sound field, sometimes students had misunderstandings about things like that".

In addition, learning French as a second language is required in Canadian schools. While most teachers referred to the importance of a clear language model for learning English, the French teacher highlighted the challenges inherent in adding the requirement for students to learn French as well. She noted that even for native English speakers, there are confusing differences between English and French. For example, in French, plural nouns are often marked with a final /s/ in print which is silent, but denoted in spoken French by the preceding article (such as the use of "les" instead of "le" or "la" to indicate a plural noun). Nouns are also characterized by gender which is reflected in the articles and adjectives used with them (for example, "intelligent" in its masculine form has a silent final /t/; "intelligente" in its feminine form requires articulating the final /t/). This is not so in English, which does not characterize gender in nouns, and where plurality is frequently indicated by use of an audible final /s/ or /z/ plus auxiliary verb agreement (e.g. "The boy is going home" vs "The boys are going home"). In Spanish, by contrast, the subject of the sentence is generally missing because it is identified by the verb ending (for example, 'tengo' meaning 'I have' versus 'tenemos' meaning 'we have'). These are confusing and subtle syntactic differences denoted by phonological features between languages with which students are relatively unfamiliar, and which they may be unaccustomed to listening for in their native language. One teacher commented that at this school, in fact, French may represent a third, fourth or fifth language for some students.

Teachers commented many times that the sound field system allowed them to reinforce morphological markers, auxiliary verbs, and other difficult-to-hear aspects of English syntax and to provide a consistent, clear English model. Teachers consistently identified English grammar as being the most problematic for their English Language Learners, primarily because morphological markers vary so widely across spoken languages.

As well as hearing a clearer English model from the teacher, the sound field amplification was also described as providing a better opportunity for students to hear their own, and peers', pronunciation. For example, one teacher recounted an incident in which she had recorded a guest storyteller through the sound field system, and then allowed the students to play it back to practice their own reading. One student heard for the first time that his articulation of /r/ and /l/ were incorrect, and asked the teacher for help with this.

Teacher Effectiveness

Teachers consistently reported positive effects on vocal health. Several commented on fewer sore throats, stronger voices at the end of the week and generally less vocal strain and overall fatigue; one teacher noted "My throat used to be very sore by Friday". However, they also noted benefits of the sound field systems to their teaching practices which went beyond simply providing them with stronger and healthier voices. Several commented that they were able to be more dramatic and effective storytellers; they were able to vary their vocal intensity, intonation patterns, and vocal sound effects while reading a story and students could hear these subtle nuances. The principal and several staff members also noted the effectiveness of the sound field system in the library, where the kindergarten through grade 3 students gather during indoor lunch/recess periods in inclement weather. The significant time, energy and vocal effort saved when bringing students in, monitoring behavior and dismissing students was noted in this situation. The minute or two saved in getting students' attention, or providing an instruction only once instead of multiple times may seem inconsequential as an individual event, but over the course of a day, these minutes add up to significant time devoted to instruction rather than classroom management. One teacher commented "it doesn't mean that you never have to repeat yourself, but it makes your teaching strategies a lot more effective". Another teacher noted "I love it. My kindergarten class is noisy, it's noisy even when they're working productively and when it's activity time and it's time to tidy up, I don't have to scream and yell to get their attention. It's wonderful. Story time, even again, when they're sitting on the carpet, even when they're quiet, it's noisy."

Enhancing Student Engagement

A change consistently noted by teachers and principal was improvements in student engagement. Student engagement is an important topic in education and been shown to be strongly linked to increased academic success and decreased dropout rates (Fredericks, Blumenfeld & Paris, 2004). The explanation offered by both the principal and several teachers was that the SMART Board provided visual engagement, and the sound field system provided

auditory engagement. The sound field system was described as providing opportunities for teachers to use audiovisual materials in more interesting and engaging ways for students, and to make classrooms more dynamic learning environments as a result.

The SMART Board, in combination with wireless Internet, allowed access to a variety of interesting materials and activities which would otherwise be difficult or impossible to use, and the sound field system allowed the accompanying audio to be heard clearly and consistently. When the SMART Board was not in use, however, teachers still used the sound field system to add audio to classroom activities in innovative ways. One teacher arranged to have a visiting Aboriginal storyteller work with her students, and audio recorded the story. She then played the recording through the sound field system to allow students to listen to the recording and practice reading the same story, matching her inflections and style. Another teacher, in conjunction with a doctoral student from a nearby university, was engaged in a project where students did interviewing and role-playing, and used the sound field system to replay the audio part of the recording during student editing, to allow them to hear more clearly.

Another teacher played classical music through her iPod during quiet seatwork and Halloween music and sound effects during reading of a Halloween story. She noted that music helps set the tone for a variety of classroom activities, and music is clearer through the sound field system than through her own CD player. Another teacher kept an active link on the SMART Board to an eagle nesting site in British Columbia over the course of 6 weeks so students could monitor the baby eagles both visually and auditorally.

Every teacher mentioned the effectiveness of the passaround microphone in increasing student interest and willingness in speaking in front of the class. A frequent comment was that shy or quiet students were more willing to speak in front of the class when the passaround microphone was available. One teacher commented "I can be dramatic without being loud, it makes them far more engaged. So that's why I like it. The microphone – amazing. I have some very very very quiet children who don't want to speak. When they get that microphone in front of them for show and tell or when they're being one of Five Little Pumpkins, and they're saying their lines, the quiet ones are speaking. It's really really bringing them out."

Another noted that when a student was using the passaround microphone, other students afforded him/her the respect and courtesy of listening. Classroom management is facilitated, since the use of the passaround microphone is a clear signal that a student (and only that student) is speaking, and only upon being handed the microphone, can the next student speak.

Table 1. Summary of Key Findings from Interviews

Theme	Key findings on use of sound field system	Sample teacher comments
Enhancing English language learning	Provides a better quality spoken language model for English Language Learners (ELLs) ELLs are better able to hear subtle syntactical and morphological information which differ in English from their own first language Use of passaround microphone allowed ELLs to hear their own, and peers' pronunciation of English words more clearly	"There's a big difference between 'side' versus 'size' in geometry but I have to use both words all the time and without the sound field, sometimes students had misunderstandings about things like that".
Enhancing teacher effectiveness	Positive effects on teacher vocal health Positive effects on student behavior and classroom management	"It doesn't mean that you never have to repeat yourself, but it makes your teaching strategies a lot more effective"
Enhancing student engagement	Enhances use of audiovisual materials in creative and engaging ways Use of the passaround microphone increases students' interest and willingness in speaking in front of the class	"When they get that microphone in front of them for show and tell or when they're being one of Five Little Pumpkins, and they're saying their lines, the quiet ones are speaking."

CONCLUSIONS

This study found three benefits of sound field amplification that have not been discussed or explored in previous research focused on speech perception and academic outcomes. Teachers clearly described the very specific need for English Language Learners of the provision of clear English phonology. Intuitively, learning a new language is easier when the message is simple, short, clear and uses simple vocabulary and grammar. However, the teachers in this study were also convinced that hearing all of the individual speech sounds and words was critical, since even if the individual speech sounds of English are the same as in one's first language, English uses speech sounds to convey meaning (such as plurality and verb tense) in ways that are different from other languages. This finding is consistent with research by Bradlow & Alexander (2007), found that the speech perception in noise of non-native listeners improved when acoustic enhancement of word final consonants was provided.

Another theme emerging from this study which has not been previously discussed in the literature is changes in student engagement related to sound field system use. The concept of engaged learning is an important one in education, and its relationship to outcome measures such as school dropout rates has been demonstrated (Archambault, Janosz, Fallu & Pagani, 2009). Specific indicators of student engagement have been developed by Jones, Valdez, Nowalski & Rasmussen (1994), which allow educators to create a picture of what engaged learning means in a classroom, and how to evaluate and reinforce it. These indicators of a community of engaged learners emphasize collaborative learning, complex and authentic (i.e. relevant to students) activities, high levels of interaction between students and teachers, and students and peers, and an emphasis on the role of the teacher as collaborator, co-learner and co- investigator, allowing the group to construct knowledge (rather than teacher as disseminator of information). In more recent years, the concept of three types of engagement has emerged. These include behavioral (participation and involvement), emotional (positive and negative reactions to teachers, academics and school), and cognitive (willingness to engage with difficult material) (Jones, Valdez, Nowakowski & Rasmussen, 1995). The use of technology to increase student engagement, particularly for behavioral and cognitive engagement, has begun to be discussed and investigated in recent years. This study suggests that sound field amplification might appropriately be added to this list of engagement-enhancing technologies.

As with any qualitative study, generalization of results can be limited because of the small number of interviewees, and the specific context in which the participants teach. However, teacher comments from a range of grades (junior kindergarten to grade 5) and in a variety of areas (from the librarian to classroom teachers to the French teacher to the special education teacher) were remarkably consistent.

The benefits of sound field amplification for improved hearing and listening for young children and at-risk learners has long been known; however, the results of this study suggests that there may be less tangible but equally important effects for all participants in the classroom community. The staff and students of this school are likely similar to other urban public schools located in areas with high immigrant populations and low average family incomes. They face issues of poverty, the challenges of English as a Second Language (for both parents and students), an extremely multicultural community, new immigrant challenges and an aging school with less than optimal acoustics. The teachers in this study were able to expand the possibilities of sound field amplification to create not just better listening environments, but more dynamic learning environments. The last word on the use of sound field amplification should belong to the school principal "It enables children to acquire language in the best possible way. You acquire a language by hearing it, by engaging in it. If you don't hear it accurately, it is a deficit to the acquisition of it."

REFERENCES

Allcock, J. (1999). Report of FM sound field study, Paremata School, 1997. Oticon Research Draft.

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, Washington, November.

American Academy of Audiology (2011). Childhood Hearing Screening Guidelines. https://audiology-web.s3.amazonaws.com/migrated/ChildhoodScreeningGuidelines.pdf_5399751c9ec216.42663963.pdf

Anderson, K. (2004). The problem of classroom acoustics: The typical classroom soundscape is a barrier to learning. *Seminars in Hearing, 25*(2), 117–130.

Archambault, I., Janosz, M., Fallu, J-S, & Pagani, L. (2009). Student engagement and its relationship with early high school dropout. *Journal of Adolescence, 32* (3), 651-670.

Arnold, P., & Canning, D. (1999). Does classroom amplification aid comprehension? British Journal of Audiology, 33(3), 171-178.

Bradlow, A. R., & Alexander, J. A. (2007). Semantic and phonetic enhancements for speech-in-noise recognition by native and non-native listeners. *The Journal of the Acoustical Society of America, 121*(4), 2339-2349.

Cornwell, S., & Evans, C. (2001). The effects of sound field amplification on attending behaviors. *Journal of Speech Language Pathology and Audiology, 25*(3), 135- 144.

Crandell, C. (1996). Effects of sound field FM amplification on the speech perception of ESL children. *Educational Audiology Monograph, 4*, 1-5.

Crandell, C., & Bess, F. (1986). Speech recognition of children in a 'typical' classroom setting. *Asha, 29*, 82.

Crandell, C., & Smaldino, J. (2000). Classroom acoustics for children with normal hearing and with hearing impairment. *Language, Speech and Hearing Services in Schools, 31*, 362-70.

Crandell, C., Smaldino, J., & Flexer, C. (1999). An overview of sound-field FM amplification. *The Hearing Review, 6*(6), 40-2.

Creswell, J. (2009). *Research Design (3rd edition)*. London: Sage.

Dairi, B. (2000) Using sound field FM systems to improve literacy scores. *Advance for Speech Language Pathologists and Audiologists, 10*(27), 5, 13.

Dockrell, J. E., & Shield, B. (2012). The impact of sound-field systems on learning and attention in elementary school classrooms. *Journal of Speech, Language, and Hearing Research, 55*(4), 1163-1176.

Dowell, J. (1995). Trial of sound-field amplification system. Proceedings of the Otitis Media NSW Conference 1995-Its Implications for Aboriginal and Torres Strait Islander People. New South Wales Department of Health, New South Wales Department of School Education, New South Wales Board of Studies.

Edwards, D. (2005). A formative evaluation of sound field amplification system across several grade levels in four schools. *Journal of Educational Audiology, 12*, 59- 66.

Evanston, IL. Elliott, L. (1979). Performance of children aged 9 to 17 years on a test of speech intelligibility in noise using sentence material with controlled word predictability. *Journal of the Acoustical Society of America, 66*, 651-653.

Flexer, C. (2000). The startling possibility of sound field. *Advance for Speech Language Pathologists and Audiologists, 10*(36), 5, 13.

Fredericks, J., Blumenfeld, P., & Paris, A. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59-110.

Gertel, S., McCarty, P., & Schoff, L. (2004). High performance schools equals high performing students. *Educational Facility Planner, 39*(3), 20-24.

Jones, B., Valdez, G., Nowakowski, J., & Rasmussen, C. (1995). Plugging in: Choosing and using educational technology. Washington, DC: Council for Educational Research and Development, and North Central Regional Educational Laboratory.

Massie, R., & Dillon, H. (2006). The impact of sound-field amplification in mainstream cross-cultural classrooms: Part 2. Teacher and child opinions. *Australian Journal of Education, 50*(1), 78-95.

Mayo, L., & Florentine, M. (1997). Age of second- language acquisition and perception of speech in noise. *Journal of Speech and Hearing Research, 40*(3), 686-693.

Millett, P., & Purcell, N. (2010). Effect of sound field amplification on grade one reading outcomes. *Canadian Journal of Speech-Language Pathology and Audiology, 34*(1), 17-24.

Nabelek, A., & Nabelek, I. (1994). Room acoustics and speech perception. In J. Katz (Ed.), *Handbook of Clinical Audiology* (4th ed., pp. 624-37). Baltimore, MD: Williams & Wilkins.

Nelson, P., Kohnert, K., Sabur, S., & Shaw, D. (2005). Classroom noise and children learning through a second language: Double jeopardy? *Language, Speech and Hearing Services in Schools, 36*(3), 219-29.

Ray, H. (1992). Summary of Mainstream Amplification Resource Room Study (MARRS) adoption data validated in 1992. Norris City, IL: Wabash and Ohio Special Education District.

Reel, L., & Hicks, C. B. (2011). Development of Selective Auditory Attention: Effects of the Meaning of Competing Speech and Daily Exposure to Soundfield Amplification. *Journal of Educational Audiology, 17*, 36-52.

Rosenberg, G., Blake-Rahtner, P., Heavner, J., Allen, L., Redmond, B., & Phillips (1999). Improving classroom acoustics (IAC): A three-year FM sound-field classroom amplification study. *Journal of Educational Audiology; 7*(3). 8-28.

Rubin, R., Aquino-Russell, & Flagg-Williams (2007). Evaluating sound field amplification technology in New Brunswick Schools. Paper presented at the annual conference of the Canadian Association of Speech- Language Pathologists and Audiologists.

Sapienza, C. M., Crandell, C. C., & Curtis, B. (1999). Effects of sound-field frequency modulation amplification on reducing teachers' sound pressure level in the classroom. *Journal of Voice, 13*(3), 375-381.

Sockalingham, R., Pinard, L., Cassie, R., & Green, W. (2007). Benefits of sound field amplification for elementary school children with and without hearing loss. *Asia Pacific Journal of Speech, Language and Hearing, 10*(3), 145-155.

Vincenty-Luyando, M. (2000). The effect of noise and sound-field FM amplification upon the speech perception abilities of bilingual and monolingual students. PhD dissertation, The University of Connecticut.

Zabel, H., & Taylor, M. (1993). Effects of sound-field amplification on spelling performance of elementary school children. *Educational Audiology Monograph 3*.