INTRODUCTION

The better children can hear, the more they are able to learn (Ross, 1995). This is precisely the premise of the IMPROVING CLASSROOM ACOUSTICS (ICA) project. Listening and learning opportunities for young children are often compromised when they are subjected to less than optimum acoustical educational environments. This is particularly disturbing because young children spend 45% to 60% of their school day involved in the listening process (Butler, 1975). Among the most devastating acoustical barriers are internal and external classroom noise, reverberation, speaker-listener distance, and poor acoustical treatments in the classroom.

For maximum learning to occur in the educational environment, the teacher’s voice must be highly intelligible to all children (Crandell & Smaldino, 1995). This is vitally important for young learners with less sophisticated language systems. For pediatric listeners to achieve adult-like speech recognition, the acoustic signal must be approximately 10 dB louder than the background noise level (Berg, 1993). Speech recognition in noise and reverberation reaches adult-like performance at 13 to 15 years of age (Fior, 1972; Elliott, 1979, 1982; Neuman & Hochberg, 1983; Crandell & Bess, 1987).

Over the past 15 years research has shown that FM soundfield amplification is an effective way to produce significant change in students’ listening behaviors and academic achievement (Sarff, 1981; Ray, Sarff & Glassford, 1984; Crandell & Bess, 1987; Berg, Bateman & Viehweg, 1989; Gillman & Danzer, 1989; Blair, Myrup & Viehweg, 1989; Jones, Berg & Viehweg, 1989; Flexer, 1989, 1992; Osborn, VonderEmbse & Graves, 1989; Allen & Patton, 1990; Benafield, 1990; Flexer, Millin & Brown, 1990; Neuss, Blair & Viehweg, 1991; Schermer, 1991; Ray, 1992; Crandell, 1993; Flexer, Richards & Buie, 1993; Zabel & Tabor, 1993).

An FM soundfield system is a miniature public address system that allows the teacher’s voice to be amplified approximately 5 to 10 dB above the classroom noise level. This brings the teacher’s voice to all students at approximately the same intensity level. In addition, FM soundfield classroom amplification is a low cost means to improve the listening and learning environment for students and teachers. It is a method of controlling one very important variable in the classroom environment — the intensity of the teacher’s voice.

The FM soundfield system helps all of the students some of the time and some of the students all of the time (Ross, 1995). The benefits of FM soundfield amplification are numerous. However, the most notable positive effects for students are:

- improvement in academic achievement
- improvement in speech recognition skills
- improvement in attending and learning behaviors
- increased seating options for students with hearing loss
- improvement in listening and learning environments for “at risk” learners (e.g., severely language impaired, developmentally delayed, ESOL, minimally hearing impaired, etc.)
- increased self esteem.

Benefits have also been identified for teachers and they include:

- reduced vocal strain and voice fatigue
• increased ease of teaching
• increased versatility of instructional techniques
• increased teacher mobility.

The IMPROVING CLASSROOM ACOUSTICS (ICA) project has been an exciting undertaking that has distinguished the State of Florida as a leader in the implementation of a successful FM soundfield amplification project in general education classrooms. The 1993-1995 ICA project was funded by the Florida Department of Education, Division of Public Schools, Bureau of Student Services and Exceptional Education, through federal assistance under the Individuals with Disabilities Education Act (IDEA), Part B, as a special project. The School Board of Sarasota County served as fiscal agent. The ICA project was comprised of a pilot project and two continuation projects.

PURPOSE

The IMPROVING CLASSROOM ACOUSTICS (ICA) special project was designed to determine if students’ listening and learning behaviors and skills improved as a result of an enhanced acoustical environment when using FM soundfield classroom amplification.

PROJECT SUMMARY

Student Participants

The project involved 2054 students in 94 kindergarten, first, and second grade general education classrooms in 33 elementary schools in Florida. FM soundfield amplification was provided in the 64 experimental (amplified) classrooms and the remaining 30 classrooms served as control (unamplified) classes. Observation data on 1850 students was analyzed to determine if the FM soundfield classroom amplification produced significant changes in students’ listening and learning behaviors and skills. Hearing screenings were performed on 1252 students involved in the 1994 ICA continuation project. Otologic history information was provided by parents of 1450 students using an adaptation of the Ear and Hearing History from (Anderson, 1991).

Participating Districts

1993-1994 Multi-District FM Soundfield Classroom Amplification Pilot Project
Districts: Escambia, Orange, Pinellas, Sarasota
Student Participants: 855 students in 20 control (N = 425) and 20 experimental (N = 430) classrooms
Observation Period: 12 weeks (pre-treatment, mid-treatment, and post-treatment observations)

1994 Multi-District FM Soundfield Amplification Continuation Project
Districts: Brevard, Escambia, Orange, Pinellas, Sarasota, Volusia
Student Participants: 1319 students in 30 control (N = 656) and 30 experimental (N = 663) classrooms
Observation Period: 12 weeks (pre-treatment, mid-treatment, and post-treatment observations)
Additional 30-Week Observation: 804 students in 20 control (N = 399) and 20 experimental (N = 405) classrooms; observations at pre-treatment, 6 weeks, 12 weeks, 21 weeks, and 30 weeks.

1994-1995 Small District FM Soundfield Classroom Amplification Project
Student Participants: 735 students in 34 general education classrooms; pre- and post-observation data available on 431 students
Observation Period: 4 weeks (pre- and post-treatment observations)
Classroom Environment

School facility age where the 94 classrooms were located was 23.38 years (R = 3-59 years). Teachers completed the ICA Classroom Description Worksheet, providing information about the classroom setting, acoustical treatments, noise measurements, classroom design, noise sources, etc.

FM Soundfield Classroom Amplification

The initial bid was in effect for purchase of FM soundfield systems for the 1993-1994 pilot project and the 1994 continuation project. A new bid was advertised for the 1994-1995 project because the initial bid's duration had terminated. The Easy Listener Free Field System™ by Phonic Ear, a narrowband FM soundfield system with a four-speaker arrangement, was purchased for 64 general education classrooms in the 23 districts that participated in the project. An additional 27 systems were purchased for use in the six districts involved in the 1994 project.

Teacher Inservice Training

More than 100 general education classroom teachers and project support persons participated in inservice training provided at 10 district sites. Inservice training for the pilot project and the 1994 continuation project teachers was provided by the six district audiologists who coordinated the project in their respective districts. The ICA project manager conducted four regional inservice training seminars during the 1994-95 small district project. Additional training sessions are described in the TRAINING section. Materials developed for inservice training included the ICA Inservice Training Manual and accompanying ICA Inservice Training Transparency Master Manual. These manuals have been published by the Florida Department of Education and are available through the Clearinghouse/Information Center.

Sound Level Measurements

Sound level measurements were taken during the 1993-94 ICA pilot project and the 1994 ICA continuation project. Classroom sound level measurements (dBA and dBC scales) were taken using the Quest 2400 sound level meter according to protocol identified in the ICA Classroom Description Worksheet. Unoccupied measurements were taken before and after normal school hours with the HVAC systems in operation because this is a component of typical classroom noise in Florida's schools. Occupied measurements were taken during regular classroom activities. Teachers' vocal intensity was measured on the dBA scale at a distance of six inches from the mouth. Unamplified measurements were taken for all teachers (N = 60) and amplified measurements for all experimental teachers (N = 30). These measurements were used to determine the amount of amplified difference and unamplified measurements were used to set the intensity level of the amplifier.

Student Observations

The Listening and Learning Observation (LLO) was developed for use in the project and the Evaluation of Classroom Listening Behaviors (ECLB) (VanDyke, 1985) was adapted for use as an additional student observation instrument. The LLO includes four sections: Student Data, Listening Behaviors, Academic/Pre-Academic Behaviors, and Academic/Pre-Academic Skills. The ECLB is a 10-item observation focused on discrete listening tasks. Additional information about these student observation instruments may be found in the PRODUCTS section of this report and in the ICA Inservice Training Manual.

Project Evaluation

FM soundfield amplification was evaluated by students, teachers, parents, and school administrators. Copies of evaluation forms may be found in the ICA Inservice Training Manual.
Information from the evaluations is reflected in the following Summary of Results. A more detailed description of these evaluations and their respective findings may be found in the PROJECT REPORTS section. In summary, evaluations were completed by 1221 students, 55 general education classroom teachers, 630 parents, and 27 school administrators.

Summary of Results

- Students in early grade general education amplified classrooms demonstrated significantly greater change in listening and learning behaviors and skills and at a faster rate than their grade-alike peers in unamplified classrooms.

- Younger students showed the greatest improvement in listening and learning behaviors and skills.

- Unoccupied classroom noise levels ($M = 47.48$ dBA) exceeded the recommended acoustical standard of 35 dBA for 96.67% of classrooms in the 1994 ICA continuation project ($N = 60$).

- Unoccupied classroom noise levels and acoustical treatments in elementary classrooms have not changed over the past decade.

- FM soundfield amplification provided teachers with an average increase of +6.05 dBA to +8.67 dBA in vocal intensity ($M = +6.94$ dBA).

- Students gave a positive evaluation for the use of FM soundfield amplification ($N = 1221$). More than 95% of the students agreed that the FM soundfield system made it easier for them to hear their teacher, helped them listen better, and helped them to hear when their teacher was writing on the board. At least 94% of students agreed that their teacher's voice was loud and clear when using the FM system and at least 92% agreed that they wanted to use the FM system in their class again the following year.

- Classroom teachers unanimously identified a decrease in vocal strain as the foremost benefit from using FM soundfield amplification ($N = 55$).

- Classroom teachers used the FM soundfield system an average of 4.18 hours per day ($N = 55$).

- Teachers were in 100% agreement that the FM system enabled their voice to reach all students no matter where they were seated ($N = 55$). Teachers also were in 100% agreement that they enjoyed using the FM soundfield system in their classrooms.

- Teachers were in at least 92% agreement that they experienced less emotional strain and fatigue during teaching and the need to repeat directions and information decreased when using the FM soundfield system. They were also in at least 92% agreement that the FM system was easy to use, they felt comfortable using it, and would like to use it in their classroom again the following year ($N = 55$).

- Teachers were in at least 96% agreement that students' behaviors related to attentiveness, listening, and comprehension seemed to improve when using the FM system ($N = 55$).

- At least 85% of parents agreed that their child would like to continue using the FM soundfield system in their classroom the following year and at least 83% agreed that their child enjoyed using the system ($N = 630$).

- Parents were in at least 46% agreement that their child's grades improved when using the FM system and at least 44% agreed that their child's behavior improved at school when the FM system was in use ($N = 630$).
• School administrators were in 100% agreement that teachers seemed to enjoy using the FM soundfield systems (N = 27).

• There was at least 92% agreement by school administrators that the FM soundfield system enhanced class instruction and management (N = 27).

• School administrators were in at least 53% agreement that there was a decrease in the number of behavior referrals from amplified classes (N = 27).

• Correlations are strong (.788 to .837) for the Listening and Learning Observation (LLO) and the Evaluation of Classroom Listening Behaviors (ECLB) observation instruments developed for the project, suggesting that they are sensitive tools for observing students' listening and learning behaviors.

• FM soundfield amplification is a cost effective instructional delivery equipment based on a $0.14 daily cost per person for a typical class (1 teacher and 25 students). The cost would decrease to a $0.03 per person daily rate by adding a minimal five year longevity factor.

Further investigation of the benefits of FM soundfield amplification is needed with other "at risk "populations. These groups include special preschool classroom, ESOL classrooms, and teachers with history of vocal pathology.

STUDENT, TEACHER, PARENT, AND ADMINISTRATOR COMMENTS ABOUT FM SOUNDFIELD CLASSROOM AMPLIFICATION

Student comments.
• The microphone helps me hear better because my teacher has a soft voice and you can't always hear her.
• When my teacher turns off the speakers we cannot hear that good.
• It helps a lot of people who sit in the back and can't hardly hear without the microphone.
• Our teacher lets us read with it and that's good for shy people.
• When other kids tell stories to the class we can all hear real good.
• The speakers make us all pay attention better than we used to last year.
• I hope we get to have it in our classroom next year to hear better some more.

Teacher comments.
• Students could hear and understand better.
• The system encourages shy children to speak and share information in front of the class; it builds confidence in all students when they use the microphone.
• It helps students follow directions and enhances listening skills, especially low ability students.
• More seating options are available to students with hearing loss.
• It decreases teacher's voice problems, reduces vocal strain, produces a more relaxed feeling when teaching, and teachers feel less tired at the end of the day.
• It improves student attention; the system assists in getting and holding student's attention.
• It improves rate of learning phonics because students listen and understand better.
• It is an effective tool for chalkboard writing, giving tests, and playing tapes in class.
• Everyone benefits by using the FM system in the classroom. Every class should have one.

Parent comments.
• It improves the student's ability to hear the teacher more easily and clearly.
• It improves the student's ability to understand the teacher more easily.
• It makes learning easier.
• It increases self-confidence when students use the microphone in front of the class.
• It improves the attention and focus of students.
• It improves the student's ability to hear the teacher from any location in the room, when writing on the chalkboard, when speaking softly, and above classroom noise.
• It improves student's ability to concentrate and ignore classroom noise.
• It improves student's behavior.
• It is easier on the teacher when using the FM system.
• Students enjoy using the FM soundfield classroom amplification system. Every classroom should have one.

Administrator comments.
• It saves the teacher's voice and they are less fatigued at the end of the day.
• Students could hear the teacher equally as well from any point in the classroom and able to hear the teacher clearly at all times.
• Students seemed to listen better.
• Students seemed to focus more quickly and consistently.
• Students were more in tune with the teacher.
• Students like using the amplification and felt important.
• Class time was saved because instructions did not have to be repeated.

PROJECT REPORTS

Abstracts from the three ICA investigations are included in this section.


The IMPROVING CLASSROOM ACOUSTICS (ICA) multi-district pilot project was designed to improve listening and learning behaviors and skills of students in general education classrooms in four Florida school districts. The 12-week pilot project initiated in the fall of 1993 involved 855 kindergarten, first, and second grade students in 20 experimental (amplified) and 20 control (unamplified) classrooms. The Easy Listener Free Field Sound System™ by Phonic Ear was used with a four speaker arrangement in experimental classrooms. None of the 40 classrooms in the pilot project met the recommended 35 dBA ambient noise acoustical standard for unoccupied classrooms. Teachers in experimental classrooms showed an average gain of +7.52 dBA when using the FM soundfield amplification system to amplify their voices. Results of the pilot project study showed that students in amplified classrooms demonstrated a significantly greater change in listening behaviors, academic/pre-academic behaviors, and academic/pre-academic skills and at a faster rate than their grade-alike peers in unamplified classes. Kindergarten students in experimental classrooms showed the greatest gains in listening behaviors, academic/pre-academic behaviors, and academic/pre-academic skills over the 12-week observation period. Students, teachers, parents, and school administrators agreed that use of the FM classroom amplification systems produced changes in students' listening and learning behaviors and skills, improved the signal-to-noise ratio in the classroom, decreased other deleterious effects of classroom noise, and decreased teacher's vocal strain during teaching.

ICA Continuation Project (1994)

Listening and learning are often compromised in classrooms due to noise, reverberation, and speaker-listener distance. Young students spend as much as 60% of their school day involved in the listening process (Butler, 1975). The ICA continuation project was designed to determine if students' listening and learning behaviors and skills improved as a result of an enhanced acoustical classroom environment provided by using FM soundfield classroom amplification. Data was collected on 1319 kindergarten, first, and second graders in 30 experimental (amplified) and 30 control (unamplified)
general education classrooms in 14 schools in six Florida school districts. The Phonic Ear Easy Listener Free Field Sound System™ produced a mean +6.94 dBA increase in teachers' voices. Students in 30 amplified classrooms, showed greater change in listening and learning behaviors and skills, and at a faster rate than peers in unamplified classes. For these measurements the greatest change was shown by first grade students in experimental classes on the Listening and Learning Observation (LLO) and by experimental kindergarten students on the Evaluation of Classroom Listening Behaviors (ECLB). Data on 804 students continuing from the ICA pilot project showed that students in experimental classes demonstrated significant change in listening and learning behaviors compared to peers in control classes over a 30-week observation period. Teachers unanimously identified decreased vocal strain as the primary benefit from using FM soundfield amplification in their classrooms. The project also provided for development of the ICA Inservice Training Manual and accompanying ICA Inservice Training Transparency Master Manual for use during inservice training and as a project implementation reference.

ICA Continuation Project (1994-1995)

Noise, reverberation, and speaker-to-listener distance in classrooms often diminish students' listening and learning opportunities. Young students spend as much as 60% of their school day involved in the listening process (Butler, 1975). The 1994-95 ICA continuation project was designed to determine if listening and learning behaviors and skills for students in small and rural districts improved as a result of an enhanced acoustical classroom environment provided by using FM soundfield amplification. Fifteen small and two middle-sized Florida school districts participated in this project. The Phonic Ear Easy Listener Free Field Sound System™ with a four-speaker arrangement was provided for 34 general education kindergarten, first, and second grade classrooms in 19 schools. Observational data collected on 431 of the 735 students showed significant change in listening and learning behaviors and skills from pre- to post-observation at four weeks. First grade students demonstrated significantly greater change in listening and learning behaviors and the least improvement was noted for second grade students. Teachers unanimously identified decreased vocal strain as the primary benefit from using FM soundfield amplification in their classrooms. Students, parents, teachers, and administrators identified positive benefits from the use of FM soundfield amplification. The project also provided for publication of the ICA Inservice Training Manual and the accompanying ICA Inservice Training Transparency Master Manual for use during inservice training and as a project implementation reference.

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Improving Classroom Acoustics Advisory Committee
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Comments or requests for further information about the IMPROVING CLASSROOM ACOUSTICS (ICA) project should be directed to the project manager.

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