

The impact of sound-field amplification in mainstream cross-cultural classrooms: Part 2 Teacher and child opinions

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This article presents teachers' and children's views of the effectiveness of sound-field amplification intervention. The rating scale, Teacher Opinions re Performance in Classrooms (TOPIC) provided information on teacher perceptions regarding changes in student performance in unamplified 'OFF' and amplified 'ON' listening conditions. The teachers observed improvement in attention, communication strategies and classroom behaviour when the amplification systems were operating. The answers from questionnaires indicated a high level of satisfaction from both teachers and students following use of the systems. Less vocal strain was identified by the teachers to be a major benefit. The children reported that they could hear better, clearer or louder.

The classroom is an environment for listening and learning, and, as such, should be free of acoustical barriers (Nelson & Soli, 2000). Unfortunately, poor classroom acoustics as a result of excessive noise and reverberation represent a barrier for both students and teachers (Crandell, Smaldino, & Flexer, 1999). Research has shown that individuals for whom English is a second language experience greater speech perception difficulties in poor listening environments than native English listeners (Crandell & Smaldino, 1994). The implication this has for non-native English-speaking children who are learning in classrooms with adverse listening conditions is a concern for both educationalists and audiologists (Picard & Bradley, 2001).

On average, teachers talk for 6.3 hours per school day (Siebert, 1999). Gotaas and Starr (1993) showed that 80 per cent of teachers reported vocal fatigue compared to 5 per cent of the general population. These problems are associated with the extended amount of time teachers spend talking per day and the loudness levels required to be heard over classroom noise (Crandell & Smaldino, 1995). It has also been found that teachers are at high risk for vocal abuse and pathological voice conditions compared with non-teaching professions (Smith, Gray, Dove, Kirchner & Heras, 1997; Titze, Lemke & Montequin, 1996).

A number of other factors influence the natural occurrence of communication in cross-cultural classrooms. Teachers and students bring different perspectives, expectations, understandings and interpretations to the classroom. Such differences

can lead to sources of misunderstandings, as highlighted by Eriks Brophy & Crago (1994) and Kearins (1985). In a study with Inuit school children, Eriks Brophy and Crago (1994) found that teachers identified the facilitation of peer exchanges as one of their most important roles in the classroom, reporting that students need to learn from others. As noted by Nienhuys and Burnip (1988), the Australian Aboriginal child is faced with similar communication and cultural differences when they enter the westernised school system. Interestingly, the literature also refers to the peer group having a crucial effect on Aboriginal children's learning strategies and behaviour (Howard, 1994).

Sound-field amplification

According to Rosenberg et al. (1999), sound-field amplification is an intervention strategy which enhances listening and learning in the classroom by increasing the overall level of the teacher's speech, substantially improving the signal-to-noise ratio (SN ratio) by approximately 10 dB, and producing a uniform speech level throughout the classroom. Several populations of children seem to be especially in need of signal-to-noise-enhancing technology. These include children with fluctuating middle-ear related hearing loss, children for whom English is a second language (ESL), children with auditory processing problems, learning disabilities, attention problems, articulation disorders, and behaviour problems (Crandell, Smaldino & Flexer, 1995).

The efficacy of sound-field amplification is supported by 20 years of research studies, some of which have relied on the quantitative measurement of classroom performance (Arnold & Canning, 1999; Darai, 2000; Flexer, Kemp Biley, Hinkley, Harkema & Holcomb, 2002). With regard to the effects of sound-field amplification intervention in cross-cultural classrooms, Eriks Brophy and Ayukawa (1999) reported Inuit children showed significant improvements in speech intelligibility and attending behaviours with amplification. In a study with Aboriginal and Torres Strait Islander children, Massie (2000) found that short and intermittent exposure to sound-field amplification facilitated the children's learning interaction with peers (which was their cultural learning preference), demonstrated increased verbal communication between teachers and children, caused the children to respond more to teacher instruction directed to the entire class, and enabled the children to play a more proactive role in classroom discussion. These effects were more evident in classrooms with non-Indigenous teachers (Massie, Theodoros, Byrne, McPherson & Smaldino, 2002).

Self-report techniques are also widely used in the qualitative assessment of human performance, and include interviews, rating scales and questionnaires (Robson, 1993).

The most widely used protocol to measure the efficacy of sound-field amplification is a rating scale named the Screening Identification For Targeting Educational Risk (SIFTER). Developed by Anderson (1989) as a screening tool to help identify children with educationally significant hearing loss, the SIFTER has been used for pre-test and post-test comparisons of sound-field amplification outcomes (Flexer, Buie & Brandy, 1994; Massie, 2000).

Teacher response to sound-field amplification in the classroom has been positive (Rosenberg & Blake-Rahter, 1995). Allen (1993) found that teachers valued the equipment over eight other types of instructional delivery equipment, including overhead projectors and computers. Nelson and Schmidt (1993) surveyed teachers following the introduction of sound-field amplification to the Rochester Public Schools in the United States. The teachers indicated enthusiastic support for continued use and expanded use of the systems. In their follow-up survey, Nelson and Nelson (1997) found that teachers ranked the following as the greatest benefits: students hear other students better, room acoustics are better and students attend/listen better.

The first benefit reflects the importance of using a second microphone which can be passed around the students. According to Flexer (2002), the demonstration of microphone techniques and strategies to use the equipment more effectively should be an integral component of teacher in-service training. Grauf (1994), in a survey of teachers on Aboriginal and Torres Strait Islander communities who had used sound-field amplification in excess of six months, reported increased attentiveness, greater participation in oral language sessions, more accurate reception of instructions, and increased student confidence.

As sound-field amplification minimises the extent to which teachers have to raise their voices to be heard over background noise, reduced vocal strain has been the most common report from teachers (Allen, 1995; Anderson, 2001; Grauf, 1994; Massie, 2000). Sapienza, Crandell and Curtis (1999) found that sound-field amplification reduced the vocal output of the teachers by a significant 2 dB. Teachers with diagnosed vocal pathology have been successful in obtaining sound-field amplification systems as an accommodation required by the *Americans with Disabilities Act* (Anderson, 2001). In a three-year project conducted in 33 elementary schools in Florida, Rosenberg et al. (1999) found that teachers were unanimous in their agreement that decreased vocal strain was their greatest perceived benefit from sound-field amplification. In the same project, teachers used the systems an average four hours use per day.

Sound-field amplification is a relatively new amplification option in Australia. The present study was designed to provide predominantly qualitative information on teacher and student perceptions on the effects of sound-field amplification intervention in cross-cultural classrooms.

Method

Participants

Twelve teachers and 12 classes of Year 2 children participated in this study. Of the 242 children, 60 per cent came from non-English speaking backgrounds, including Vietnamese, Samoan, Spanish and Aboriginal and Torres Strait Islander. The teachers, one male and 11 female, had an average of 13 years experience as educators.

Design

For classes 1 to 8, the two experimental conditions were unamplified 'OFF' and amplified 'ON'. Four of these eight classes began the school academic year in the

amplified 'ON' listening condition, two classes having one microphone and two classes having two microphones. The other four classes remained in the unamplified 'OFF' listening condition. Midway through the academic school year (at the end of Semester 1), the eight classes were crossed over from 'OFF' to 'ON' or from 'ON' to 'OFF'. Classes 9 to 12 were alternated between the single-channel and dual-channel transmission options, each condition being for two terms (i.e. one semester) of the four-term school year.

In view of the study design, only teachers from classes 1 to 8 completed the questionnaire comparing the children's performance with and without the system. These eight teachers, one male and seven female, had a very broad range of teaching experience ranging from two years to 39 years.

All of the 242 children were given the opportunity to respond to questions. The original intention was for the investigator to interview each child. However, as many children were shy or withdrawn in their answers to an unfamiliar person, teachers suggested that more reliable responses would be obtained if they asked the questions to the class as a whole. This procedure was followed.

Instrumentation

Sound-field amplification

NAL Twin FM Sound-field Amplification Systems (Type 3032) were installed in each classroom. Each system features two lapel microphone/transmitters, a twin channel receiver/amplifier unit and four loudspeakers. Teachers were provided with auxiliary input cords and adaptors to use with external sound sources such as tapes recorders and televisions.

TOPIC rating scale

The TOPIC rating scale (Appendix A) comprised eight questions focusing on the teachers' observations of classroom performance in the areas of attention, communication, and classroom behaviour. The format of the rating scale was derived from the SIFTER rating scale. However, in the present study, the teachers were asked to directly rate the effect of the amplification system for each child following use of the amplification system, rather than complete separate pre-trial and post-trial questionnaires.

Teacher questionnaire

The teacher questionnaire was designed to include key issues discussed in the literature. The questions ascertained the teachers' opinions and attitudes towards the amplification technology, as well as their perceived benefits or otherwise of the sound-field systems (Berg, 1993). Two questions related to the use of the dual-transmission option. In view of the study design, four of the 12 teachers did not respond to these questions.

Child questionnaire

The child questionnaire concentrated on the children's reactions and opinions in the following key areas: their attitudes towards the device, and their opinions on the

advantages and disadvantages of the systems. In attempting to elicit the most information from the children, and in view of the teacher-interview procedure adopted, all questions were in open-set format.

Procedure

An information booklet was developed for the teachers outlining the rationale behind sound-field amplification and summarising the aims and requirements of the study.

In-service training was provided to each teacher, and included demonstration of the systems. However, due to the teachers' time constraints this was conducted on an individual basis.

The TOPIC rating scale and teacher questionnaire were given to participants following the field trial of sound-field amplification. Generally the teachers completed the questionnaires in their own time. Child interviews were conducted in the classrooms during a quiet period of the school day. The teachers asked the interview questions within the context of an informal discussion.

Data analysis

For the TOPIC rating scale, statistical analysis of the data was performed using a repeated-measures ANOVA. The questionnaire data were categorised into broad response themes that could be generated from interview material.

Results

TOPIC rating scale

The TOPIC data were analysed with a two-way ANOVA with class as a grouping factor and question as a repeated-measures factor. Question, class and the interaction of question by class were all significant. The effect of question was highly significant ($p < 0.000001$), as was the effect of class ($p < 0.000001$). There was also a highly significant interaction between question and class ($p < 0.000001$).

Figure 1 indicates the score for each question averaged across classes. For all questions, the 95 per cent confidence interval lay completely above the value 3.0, which corresponded to 'no change' as a result of installing the sound-field amplification system. Consequently the teachers reported significant improvement for all questions. The improvement was, however, very slight and of no practical significance for question 6 (non-verbal communication strategies). Highest scores were obtained for the first three questions relating to attention.

Figure 2 outlines the average scores for the TOPIC questionnaire for each of the eight classes. The 95 per cent confidence interval lay above the value 3.0 for all classes except class 4. Compared with the other classes, the improvement for class 3 was slight. Classes 5 and 7 scored the highest improvement.

Teacher questionnaire

Seven teachers had suspicions that some of their students had hearing difficulties. The remaining five teachers responded in the negative. The majority of teachers (10) considered their children had benefited from sound-field amplification. One

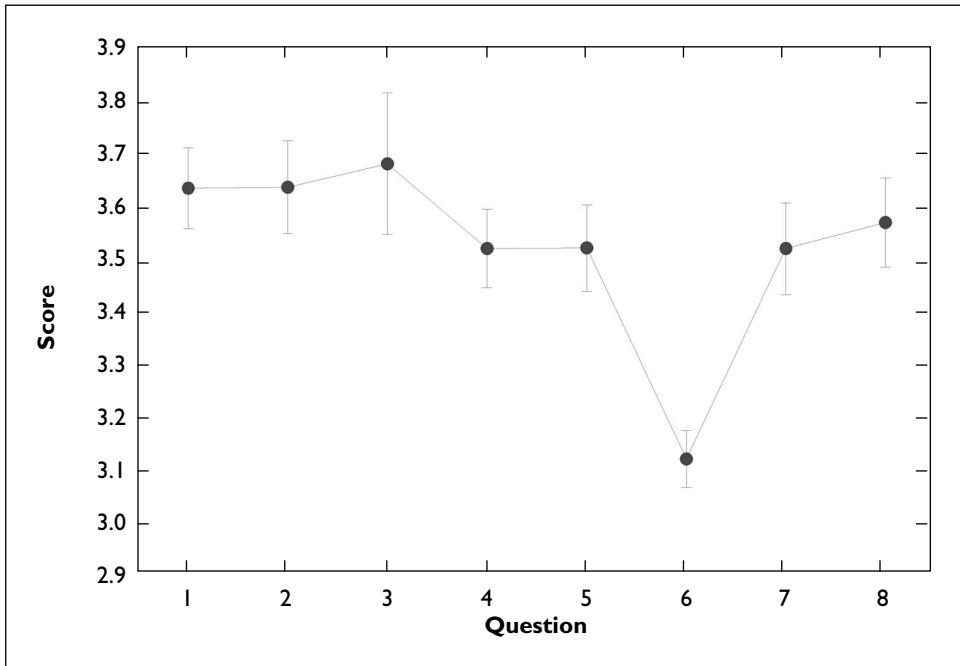


Figure 1 Scores for each TOPIC question averaged across classes. Error bars show 95 per cent confidence levels.

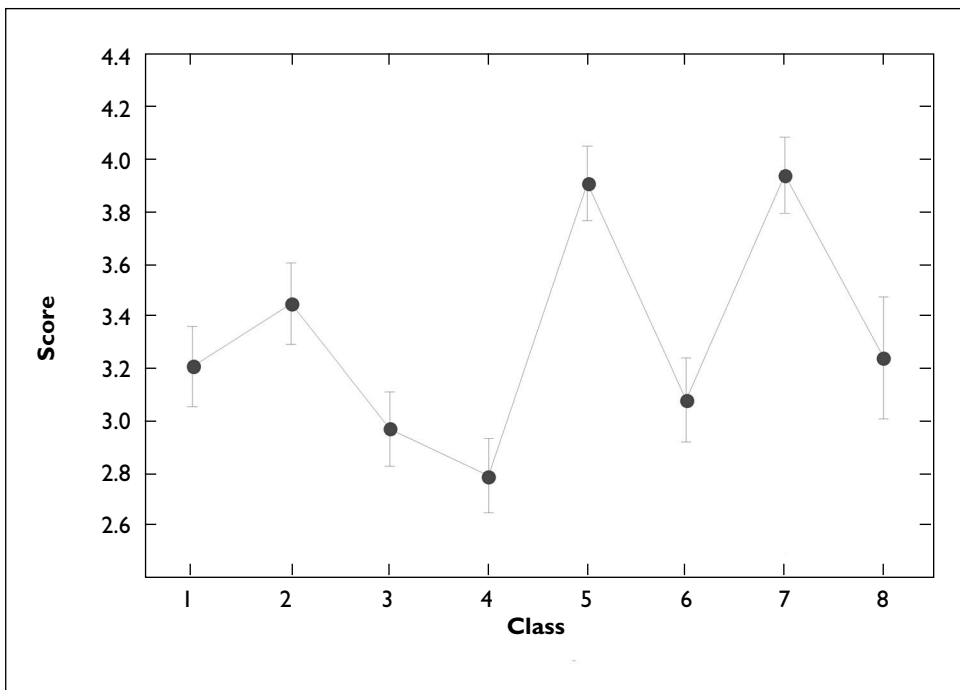


Figure 2 Average TOPIC scores for each class. Error bars show 95 per cent confidence levels.

teacher (class 4) indicated the children had not benefited, and one teacher (class 1) was undecided.

Teacher responses to questions regarding whether the amplification systems had changed the way they conducted classroom teaching gave useful information. Seven teachers (classes 1, 5, 6, 7, 9, 10, 12) considered they had, while five teachers (classes 2, 3, 4, 8, 11) indicated they had not altered their teaching style.

Of the former group, the following responses were recorded: 'I became conscious that children listened to me rather than other children, questioning became more organised' (class 1); Three teachers (classes 5, 6, 9) referred to the fact that 'I could use normal speaking voice rather than straining'; 'I could see students grow in confidence when reading into microphone. This affected my teaching' (class 7); 'I was not so conscious of always facing the students when talking. I never raised my voice' (class 10); 'I didn't have to have children in small groups when sharing stories as they could speak to the whole class' (class 12).

Eleven teachers indicated they would keep the amplification systems permanently if given the choice. Table 1 shows the reasons given by these teachers for wanting to keep the systems. The teacher in class 4 responded in the negative.

The teachers were asked to rate a number of statements regarding their impressions on various subject areas following use of sound-field amplification. Table 2 details the responses as to whether they agreed with the statement, were uncertain, or disagreed with the statement. When examining which teachers disagreed with the statements, it was found that teachers in classes 3 and 4 did not agree with the first four statements, the teacher in class 2 did not agree with statement (iii), and the class 4 teacher also did not agree with statement (v).

When asked how often they used the amplification systems, 11 of the 12 teachers responded that they used the systems every day. The one other teacher (class 4) clarified her answer by responding that she initially used the system every

Table 1 Responses for teachers wanting to keep amplification systems

<i>Class</i>	<i>Teacher responses</i>
1	It would be good to have the second microphone built into each desk.
2	Our room is particularly noisy. All classrooms would benefit.
3	Assists the children with hearing difficulties.
4	No response.
5	My voice clarity. Children can hear more clearly and evenly.
6	Allows more children to share ideas when microphone passed around.
7	I was able to be heard by the whole class.
8	The system was an asset. I feel it assisted in the children's learning.
9	My class was more attentive.
10	Less strain on my voice. You can distinguish more between children not hearing and not listening.
11	Less strain on my voice.
12	I could hear the difference in my voice. It carried more effectively to all parts of the room.

Table 2 Teacher responses to statements

Statement	Agree %	Uncertain %	Disagree %
(i) The children participated more in class	58	25	17
(ii) The children interacted more with peers	58	25	17
(iii) It was easier to maintain discipline	58	17	25
(iv) I felt less fatigued at the end of the day	66	17	17
(v) I had less vocal strain	92	0	8
(vi) The children liked using the systems	100	0	0
(vii) Sound-field systems were easy to use	83	17	0

day. However, during the trial her use of the teacher's transmitter reduced to once a week, then not at all. She did note, however, that she used the second transmitter for passing around the children on a regular basis. When asked, on average, how long the systems were in use each time, four teachers reported they used the systems during all classes. Five teachers used the amplification systems for more than one hour but less than two hours each time, and three of teachers used the amplification systems for more than two hours at a time.

Teachers were asked to state which activities they preferred to use with the amplification systems. Table 3 outlines the responses. Whole-class activities, presentations to the class, and teacher-directed lessons featured in the responses.

When asked their opinions regarding the benefits and disadvantages of the amplification systems, teachers' responses were varied. Tables 4 and 5 (overleaf) provide an outline of the responses. Some teachers gave more than one response to these questions. One teacher (class 4) did not provide an answer to the question pertaining to benefits, but did to the question concerning disadvantages.

With regard to the dual-transmission option, five of the eight teachers used the second microphone every day, with the remaining three teachers using it every two days. The same five teachers utilised the second microphone for up to one hour

Table 3 Question: During which activities did you prefer to use the amplification systems?

Class	Teacher responses
1	Morning talks, oral reading sessions, teacher-directed lessons
2	Class presentations, e.g. child doing oral language activity with class
3	'Show and tell'; art and science lessons which tend to be noisier
4	I had no preference when I used it
5	Whole class activities
6	Group work
7	In classes I wanted children's attention all the time
8	Teacher-directed lessons
9	Whole-class activities; most of the time
10	Whole class activities
11	Counting, reading, phonics instruction, 'show and tell', class discussion
12	Children's news sessions; whole-class instruction

Table 4 Question: What benefits did the amplification system provide?

<i>Teacher responses</i>	<i>No. of teachers</i>
Children were more attentive in class.	4
I had less voice strain.	4
Children showed improved listening skills.	3
Children stayed on task longer and understood more.	2
Equal volume and clarity in room.	2
Children could hear clearer.	2
Less confusion of soft speech sounds.	1
Many of these children are peer listeners. Helpful to hear them clearer.	1
Children showed increased confidence to speak in front of peers.	1
I did not have to raise my voice.	1

Table 5 Question: Were there disadvantages in using the amplification system?

<i>Teacher responses</i>	<i>No. of teachers</i>
Technical interference at times.	6
No disadvantages.	2
Children listened to my voice and less to the children's quiet responses.	1
Unsuitable for individual activities.	1
A headworn microphone would be better.	1
Distracted other children when working in groups.	1
Children wanted to use microphone so they could hear themselves better.	1
A distraction at times. The children kept looking at the speakers.	1

each time, with the same remaining three teachers using it for less than half an hour each time. In response to a question regarding the preferred activities for using the second microphone, all eight teachers stated morning talks (e.g. 'show and tell' and news sessions) and one-on-one presentations to the class (e.g. reading books out loud). Two teachers (classes 11, 12) also used the second microphone for class discussion and small group sharing work. For class 4, where the majority of children were Vietnamese, the teacher noted: 'As Vietnamese children are very shy and use tiny voices, the second microphone allowed the child to be heard when presenting to the class'.

Six of the eight teachers considered increased confidence of the children to be the main benefit of the second microphone. This included when children presented to the class, as well as when they asked questions of their peers as the second microphone was passed around. An example of a comment exemplifying this was: 'There was a greater desire for the children to "have a go", especially for those usually reluctant to speak' (class 3). Additionally, a teacher (class 2) noted that she found it useful to be able to discipline the class with her microphone while a child was presenting to the class using the second microphone. Another teacher (class 4) found the major benefit to be that she did not have to ask the children to speak up because of the children's naturally soft voices.

The teachers were asked to record any disadvantages in using the second microphone. Three answers were given from six teachers. These were: the second microphone did not encourage the children to project their voices (when speaking without microphone) (class 4); extra discipline, i.e. new rules had to be set, for ease of use of the second microphone (classes 1, 3, 11); technical interference at times (classes 2, 9). Two teachers did not respond (classes 10, 12).

The sound-field systems had an audio input facility for use with other equipment such as televisions and video machines. The 12 teachers were asked how regularly they used this facility. The majority did not use this facility at all. One teacher (class 2) used the audio input once a week, and another teacher (class 10), once a month.

The final questions in the teacher questionnaire related to repair requirements during the trials. Ten teachers reported they had not had major repair difficulties, and two teachers reported they had experienced faulty transmitters.

One teacher (class 10) expressed a major concern during the trials. She stated: 'I have a concern that we may be training the children not to listen when they haven't got the system. They may grow accustomed to not having to look at the speaker because they will hear him/her anyway. The children will not see the need to stop what they are doing to listen. Normally we are constantly reminding the children to stop, look and listen, and the system does not reinforce the need to do so'.

Child questionnaire

The children were asked to describe how they felt when their teacher was using the microphone. The response from 10 of the 12 classes was they felt 'happier' when the microphone was in use; one class (class 11) responded they felt 'the same', and one class (class 4) was 'undecided'.

Each class of children was asked to say what they liked, and disliked, when their teacher was using the microphone. The responses are contained in Tables 6 and 7. Some classes had more than one response. The majority of answers in Table 6 relate to the fact that many children identified that they could hear better, clearer or louder. All class responses made reference to technical interference ('buzzing, funny noises, squeaks') being an intermittent negative factor (Table 7).

Table 6 Question: Tell me what you liked when I (teacher) was wearing the microphone.

<i>Children's responses</i>	<i>No. of classes</i>
We liked it louder and clearer.	5
We could hear you better.	3
We could hear you everywhere.	2
We could hear you when you walked around the room.	2
We listened better; good in news.	1
It was cool; your voice was pretty.	1
It was fun; we all laughed.	1
We stop because we can hear the teacher say 'Stop'.	1

Table 7 Question: Tell me what you didn't like when I (teacher) was wearing the microphone.

<i>Children's responses</i>	<i>No. of classes</i>
It made funny noises at times (crackles/squeaks).	12
We could hear teacher talking to another group.	1
Your voice was scary at first.	1
I was jealous because I wanted to wear the microphone.	1

Table 8 Question: Why do you like using the microphone yourself?

<i>Children's responses</i>	<i>No. of classes</i>
It's fun.	8
My voice is louder.	6
Everyone can hear me.	2
I can hear my voice all over.	1
You don't have to yell out.	1
Everyone looks at me.	1
I feel like a teacher.	1
It makes you nervous.	1
We got to read with it.	1

Table 9 Question: Why do you like your friends using the microphone?

<i>Children's responses</i>	<i>No. of classes</i>
We can hear them better/louder.	10
Their voices were too soft before.	1
We can hear people with little voices.	1
They feel special.	1
They get nervous.	1
If they speak softly you can still hear them.	1
You can listen better.	1
It's fair; we can share it.	1
I could hear them read.	1

The children were asked whether they liked using the microphone themselves. Each of the 12 classes responded 'Yes'. When asked 'Why?', the majority of class answers related to the fact that they could hear their own voice louder, hear others better, and it was fun. Some classes gave more than one response. Table 8 outlines the responses.

Each of the 12 classes responded 'Yes' to the final question 'Do you like your friends to use the microphone?' The majority of reasons, detailed in Table 9, alluded to hearing better. Some classes gave more than one response.

Discussion

The results of the TOPIC rating scale confirmed that teachers observed significant improvement in attention, communication and classroom behaviour when the amplification systems were operating. These were positive findings in view of the complex interaction of cultural influences, language differences and poor listening conditions operating in each classroom. The 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. These results give further support to the findings of Eriks Brophy and Ayukawa (1999); Grauf (1994) and Massie (2000). As the facilitation of peer exchanges has been found to play an integral role in learning in cross-cultural classrooms (Eriks Brophy & Crago, 1994; Howard, 1994), the fact that teachers considered there was increased communication between children and their peers when the amplification systems were operating was an important finding.

The range of class scores demonstrated in Figure 2 indicated that some teachers had quite different opinions than others. An interesting result was that the teachers in classes 5 and 7 with the highest scores, and with one rather than two microphones, had particularly positive attitudes towards trialling the systems. They also initiated ways to maximise use of their one microphone with all the children. The lowest scores were recorded for classes 3 and 4, the latter reporting no change. Compared with the other 10 classes of children, classes 3 and 4 had by far the highest proportion of ESL children.

When examining the teacher and child questionnaire responses in relation to sound-field amplification, a number of themes emerged. Both teachers and children gave overwhelmingly positive responses to the use of sound-field amplification. Generally speaking, the respondents identified ease of hearing and improved listening to be major benefits. The teachers agreed the children liked the systems and they were easy to use. These results support the high levels of teacher and student satisfaction noted by other researchers (Crandell, Sapienza, & Curtis, 1996; Eriks Brophy & Ayukawa, 1999; Flexer et al., 1994; Nelson & Nelson, 1997; Rosenberg et al. 1999).

Given the choice, 11 of the 12 teachers indicated they would like to keep the amplification systems. The one teacher who was reticent to use the teacher's microphone as the trial progressed (class 4) was also the most experienced. This teacher gave the following reason for her preference not to use her microphone over time: 'Because of the way I organise my room and the expectations I have of my class (e.g. one voice at a time, eyes on the person speaking), the system initially amused the children. However, it became more of a distraction because the children kept looking at the speakers'. The same teacher reported she regularly used the second microphone for morning talks because 'the children had soft voices'.

When examining the answers to questions relating to positive aspects of sound-field amplification, the teachers repeatedly made reference to voice-related issues. Ninety-two per cent of the teachers indicated they had less vocal strain and the majority felt less fatigued at the end of the day after using the systems. In view

of the extremely poor classroom acoustic conditions under which the teachers taught (Massie & Dillon, 2003), this was not surprising, and is congruent with other teacher surveys on sound-field amplification (Anderson, 2001; Nelson & Nelson, 1997).

Due to constraints on their time, teachers received individual in-service training prior to using the systems. There was no opportunity provided for the teachers as a group to discuss their experiences or develop strategies to assist their use of the equipment. It is thought this limitation influenced a number of responses from the teacher questionnaire. Eleven out of 12 teachers used the systems every day. However, only four teachers used the systems during all classes. Five teachers utilised the systems for more than one hour but less than two hours per day. Three teachers used the system for more than two hours per day. These figures do not compare favourably with the Rosenberg et al. study (1999), where the teachers used the systems an average of four hours per day.

Flexer (2002) commented that teachers may need to utilise different teaching strategies in order to use the equipment effectively. Although over half the teachers indicated they had altered their teaching style, these were not in ways pertaining to microphone use or taking advantage of 'incidental learning strategies'. When examining the answers to questions relating to the use of dual-channel transmission, it was disappointing that in this study five of the 12 teachers used the second microphone for only up to an hour each time, and three teachers for half an hour each time. As noted by Flexer (2002), a greater emphasis on the demonstration of microphone techniques may have affected the outcomes. In the Nelson and Nelson study (1997), hearing other children better was identified as one of the main advantages.

There is agreement in the literature regarding the important role that peer group culture plays in the natural learning style of children in cross-cultural classrooms, and teachers in this study agreed the main advantage of the second microphone was increased confidence in the children. Future research, therefore, could focus on the outcomes achieved if the second microphone was utilised for longer periods of time.

The versatility of the amplification system for use with other equipment such as video equipment was not considered by the majority of teachers. Again, this outcome may reflect the disadvantage of having individual in-service training. Without input from others, teachers may have adopted a less proactive approach to exploring alternative teaching strategies.

The mechanical repair maintenance requirements during this study were minimal. However, both teachers and children identified intermittent technical interference as a disadvantage. Such interference can be the result of poor classroom acoustic environments or less than optimal speaker placement (Flexer, Crandell & Smaldino, 1995). In Australia, the effective management of sound-field amplification devices has been a concern for service providers since systems were first introduced to classrooms of Aboriginal and Torres Strait Islander children living on remote communities in the early 1990s (Grauf, 1994; Massie, Theodoros, Byrne, McPherson, & Smaldino, 1999). As with all technology, teachers require ongoing

support to meet any technical challenges. It is recommended in the literature that teachers require a technology/support person to handle troubleshooting for effective system operation (Flexer, 2002; Grauf, 1994; Nelson & Nelson, 1997). At present, as the amplification programs are school-based, success relies largely on the availability of expertise from liaison teachers, audiologists or teachers for the hearing-impaired.

Conclusion

There is a convincing amount of evidence to indicate that sound-field amplification enhances listening and learning in the classroom. As demonstrated in this study, teachers play a vital role in the effective use of this technology. The provision of adequate infrastructure needs to be addressed to provide teachers with the knowledge of the rationale and benefits of sound-field amplification. Additionally, teachers need ongoing support from audiologists to promote the effective use of this technology.

Keywords

cross cultural studies
student assessment

teacher evaluation
voice disorders

teaching methods
cultural education

References

- Allen, L. (1993). Promoting the usefulness of classroom amplification equipment. *Educational Audiology Monograph*, 3, 32–34.
- Allen, L. (1995, June). *The effect sound-field amplification has on teacher vocal abuse problems*. Paper presented at the Educational Audiology Association Biannual Convention, Lake Lure, NC.
- Anderson, K. L. (1989). *Screening instrument for targeting educational risk (SIFTER)*. Austin, TX: PRO-ED.
- Anderson, K. (2001). Voicing concern about noisy classrooms. *Educational Leadership*, April, 77–9.
- Arnold, P., & Canning, D. (1999). Does classroom amplification aid comprehension? *British Journal of Audiology*, 33, 171–78.
- Berg, S. F. (1993). *Acoustics and sound systems in schools*. San Diego, CA: Singular Publishing Group.
- Crandell, C., Sapienza, C., & Curtis, B. (1996). *Effects of sound-field amplification on vocal pathology*. Paper presented at the American Academy of Audiology annual meeting, Salt Lake City, UT.
- Crandell, C., & Smaldino, J. (1994). An update of classroom acoustics for children with hearing impairment. *The Volta Review*, 96, 291–306.
- Crandell, C., & Smaldino, J. (1995). Speech perception in the classroom. *Sound-field FM amplification: Theory and practical applications*. San Diego, CA: Singular Publishing Group.
- Crandell, C., Smaldino, J., & Flexer, C. (Eds.) (1995). *Sound-field FM amplification: Theory and practical applications*. San Diego, CA: Singular Publishing Group.
- Crandell, C., Smaldino, J., & Flexer, C. (1999). An overview of sound-field FM amplification. *The Hearing Review*, 6(6), 40–2.

- Darai, B. (2000). Using sound-field FM systems to improve literacy skills. *Advance Speech-Language Pathology and Audiology*, 10(27), 5–7.
- Eriks Brophy, A., & Ayukawa, H. (1999). Alternatives in amplification: Use of sound-field FM systems in classrooms of Nunavik. *Frequencies*, 11(1), 26–8.
- Eriks Brophy, A., & Crago, M.B. (1994). Transforming classroom discourse: An Inuit example. *Language and Education*, 8(3), 105–22.
- Flexer, C. (2002). Rationale and use of sound field systems: An update. *The Hearing Journal*, 55(8), 10–18.
- Flexer, C., Buie, C., & Brandy, W. (1994). Making the grade with amplification in classrooms. *Hearing Instruments*, 45(10), 24–6.
- Flexer, C., Crandell, C., & Smaldino, J. (1995). Considerations and strategies for amplifying the classroom. In J. L. Danhauer (Ed.), *Soundfield FM amplification—Theory and practical applications*. San Diego, CA: Singular Publishing Group.
- Flexer, C., Kemp Biley, 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.
- Gotaas, C., & Starr, C. (1993). Vocal fatigue among teachers. *Folia Phoniatr (Basel)* 45, 120–9.
- Grauf, N. (1994). *Report on whole class amplification systems installed in Cape and Gulf schools*. Cairns, Qld: Torres Strait, Cape and Gulf School Support Centre.
- Howard, D. (1994). Culturally responsive classrooms: A way to assist Aboriginal students with hearing loss in urban schools. In S. Harris & M. Malin (Eds.), *Aboriginal kids in urban classrooms* (pp. 37–51). Darwin: Social Science Press.
- Kearins, J. (1985). Cross-cultural misunderstandings in education. In J. B. Pride (Ed.), *Cross-cultural encounters: Communication and mis-communication* (pp. 65–79). Melbourne: River Seine Publications.
- Massie, R. (2000). *The effects of sound-field FM amplification on the communicative interactions of Aboriginal and Torres Strait Islander children*. Unpublished doctoral dissertation, The University of Queensland, Queensland, Australia.
- Massie, R. & Dillon, H. (2003). *The educational impact of sound-field amplification in cross-cultural classrooms*. Manuscript submitted for publication.
- Massie, R., Theodoros, D., Byrne, D., McPherson, B., & Smaldino, J. (1999). The effects of sound-field amplification on the communicative interactions of Aboriginal and Torres Strait Islander children. *The Australian and New Zealand Journal of Audiology*, 21(2), 93–109.
- Massie, R., Theodoros, D., Byrne, D., McPherson, B., & Smaldino, J. (2002, May). *Differences in communication outcomes when utilising sound-field FM amplification in the classrooms of Aboriginal and Torres Strait Islander children*. Paper presented at the 26th International Congress of Audiology, Melbourne, Australia.
- Nelson, D. G., & Nelson, D. K. (1997). Teacher and student satisfaction with freefield FM amplification systems. *The Volta Review*, 99(3), 133–70.
- Nelson, D. G., & Schmidt, M. (1993). Take anything else, but leave my classroom FM system. *Perspectives in Education and Deafness*, 12, 8–11.
- Nelson, P. B., & Soli, S. (2000). Acoustical barriers to learning: Children at risk in every classroom. *Language, Speech, Hearing Services in Schools*, 31, 356–61.
- Nienhuys, T. G., & Burnip, L. (1988). Conductive hearing loss and the Aboriginal child at school. *Australian Teacher of the Deaf*, 28, 5–17.
- Picard, M., & Bradley, J. S. (2001). Revisiting speech interference in classrooms. *Audiology*, 40, 221–44.

- Robson, C. (1993). *Real world research—A resource for social scientists and practitioners—researchers*. Oxford, UK: Blackwell.
- Rosenberg, G. & Blake-Rahter, P. (1995). Sound-field amplification: A review of the literature. In C. Crandell, J. Smaldino & C. Flexor (Eds.), *Sound-field FM amplification: Theory and practical applications* (pp. 107–23). San Diego, CA: Singular Publishing Group.
- Rosenberg, G., Blake-Rahter, P., Heavner, J., Allen, L., Redmond, B., Phillips, J., & Stigers, K. (1999). Improving classroom acoustics (ICA): A three-year FM sound-field classroom amplification study. *Journal of Educational Audiology*, 7, 8–28.
- Sapienza, C., Crandell, 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), 375–81.
- Siebert, M. (1999, February 7). Educators often struck by voice ailments. *The Des Moines Register*, p. 4.
- Smith, E., Gray, S., Dove, H., Kirchner, L., & Heras, H. (1997). Frequency and effects of teachers' voice problems. *Journal of Voice*, 11(1), 81–7.
- Titze, I. R., Lemke, J., & Montequin, D. (1996). Populations in the US workforce who rely on voice as a primary tool of trade. *NCVS Status and Progress Report*, 10, 127–32.

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APPENDIX A

**T.O.P.I.C.
TEACHER OPINIONS re PERFORMANCE IN CLASSROOMS**

CHILD'S NAME _____ TEACHER _____ DATE: _____

ATTENTION:

1. How distractible was the child when the amplification system was working compared with the unamplified condition?

NOT VERY		AVERAGE		LESS
5	4	3	2	1

For the following, please circle the number best representing the child's behaviour according to the following legend:

MORE		NO CHANGE		LESS
5	4	3	2	1

2. Have you observed a change in the child's response to your verbal instructions to the class in the 'ON' compared with the 'OFF' listening condition?

5	4	3	2	1
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3. Did the child respond more to what his/her classmates were saying when the amplification system was operating compared with the unamplified condition?

5	4	3	2	1
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COMMUNICATION:

4. Have you observed a change in verbal communication between yourself and the child when in the 'ON' compared with the 'OFF' listening condition?

5	4	3	2	1
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5. Have you observed a change in verbal communication between the child and his/her classmates when using the amplification system compared with the unamplified condition?

5	4	3	2	1
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6. Have you observed a change in the use of non verbal communication strategies between the child and his/her classmates in the 'ON' compared with the 'OFF' listening condition?

5	4	3	2	1
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CLASSROOM BEHAVIOUR:

7. Did the child volunteer more communication without being directly prompted in the 'ON' compared with the 'OFF' listening condition?

5	4	3	2	1
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8. How confident was the child when the amplification system was working compared with the unamplified condition?

5	4	3	2	1
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