

# The Impact of Sound-field Amplification in Mainstream Cross-cultural Classrooms

**Investigators: Robyn Massie and Harvey Dillon**

**National Acoustic Laboratories, Sydney, Australia**

## Executive Summary

**Sound-Field amplification systems were installed in twelve classrooms for half a school year within each classroom in a balanced cross-over design. Children acquired reading, writing and numeracy skills at a much faster rate during the half year in which the sound-field systems were installed than during the half year in which they were not installed. Questionnaire responses from the teachers and students also supported general use of these systems.**

**Background:** Poor classroom acoustics as a result of excessive noise and reverberation represent communication barriers for both students and teachers (Crandell, Smaldino, & Flexer, 2005). Research has shown that individuals for whom English is a second language experience greater speech perception difficulties in poor classroom listening conditions than native English listeners (Crandell & Smaldino, 1994). A study conducted by the National Acoustic Laboratories (Australia) on the effects of sound-field amplification intervention in classrooms of Aboriginal and Torres Strait Islander children indicated that short and intermittent exposure to this technology had positive effects on the communicative interactions naturally occurring in the classroom (Massie, Theodorus, McPherson, & Smaldino, 2004). 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). 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.

**Objectives:** The aim of this study was to examine the effects sound-field amplification had on the acquisition of specific educational goals, as routinely assessed by teachers. Investigation centred around two areas:

- the evaluation of measures relating to the development of literacy and numeracy skills in children, and used by the Education Department in Queensland as a basis for resource allocation.
- the collation of questionnaire data from teachers and children on perceived changes in classroom performance in the “ON” listening condition compared with the “OFF” listening condition.

**Procedure:** Twelve classes of Grade-2 children participated in the project. Of the 242 subjects, 61% came from varying ethnic backgrounds including Vietnamese, Samoan, Spanish and Aboriginal and Torres Strait Islander.

Hearing screenings were performed on the subjects at the beginning of the school year. The Year 2 Diagnostic Net, used in Queensland to identify children who may need additional support, was used to evaluate educational outcomes. A teacher questionnaire provided subjective data regarding key performance areas. Named the T.O.P.I.C (Teacher Opinions re Performance in Classrooms), this rating scale consisted of eight questions relating to the areas of attention, communication and classroom behaviour.

## Findings:

### *Hearing status:*

The mean hearing level for this population of children was 15 dB HL. This level was at the upper limits of normal hearing.

### *Classroom acoustic measurements:*

Table 1 outlines the reverberation time measurements recorded for each classroom and the impact of the sound-field systems on the teacher voice levels received by the children. Ambient noise levels, and reverberation times were extremely high, and confirmed there has been little change in classroom acoustic conditions from those reported in the literature over the past 20 years.

Table 1: Acoustic measurements for each classroom

Class	Mean RT	Teacher voice dB SPL system "OFF"	Teacher voice dB SPL system "ON"	Voice level dB increase
1	1.8	63	71	8
2	1.0	65	71	6
3	1.9	68	72	4
4	1.6	69	74	5
5	1.7	69	74	5
6	1.9	67	73	6
7	1.5	67	73	6
8	1.3	63	73	10
9	1.2	67	72	5
10	1.2	66	70	4
11	1.5	62	70	8
12	1.4	62	69	7
<b>Mean</b>	<b>1.5</b>	<b>66</b>	<b>72</b>	<b>6</b>

*Educational outcomes:* Beneficial effects of amplification were obtained in all three skill areas of reading, writing and numeracy (Figure 1). Averaged across the three areas, the number of skills acquired per semester increased from 4.1 without amplification to 5.8 with amplification.

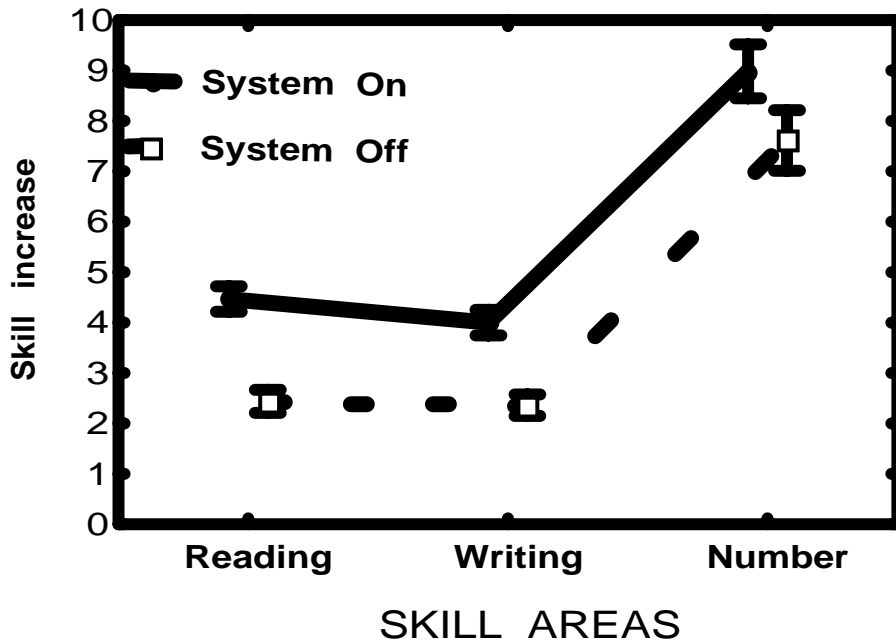


Figure 1. Changes in educational outcomes in the “ON” and “OFF” listening conditions. Error bars show the 95% confidence intervals.

As shown in Table 2, the amplification system produced broadly similar effects in each semester, especially when averaged across the three skill areas. The system effect per skill area per semester (1.7 skills for Semester 1 and 1.6 skills for Semester 2) was one third of the total number of skills acquired in each semester. As skills are acquired with each passing semester, **these results indicated that sound-field amplification intervention had a similar effect to increasing the length of each semester by an extra one third.**

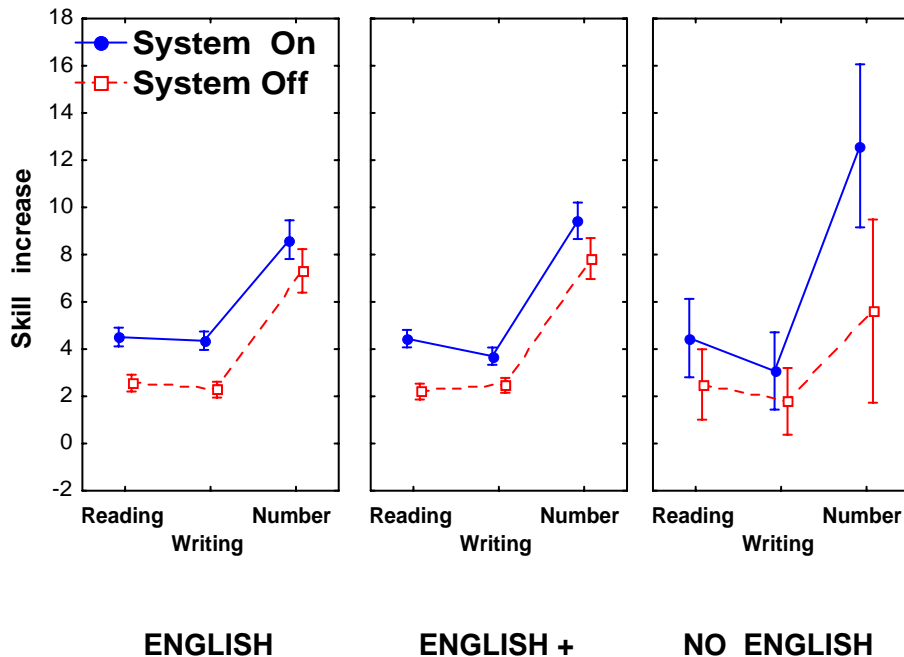
Table 2: *The first four rows show the skill increases observed, averaged across the four classrooms that experienced each of the conditions shown. The final two rows show the inferred effect of amplification in each semester.*

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	<b>Reading</b>	<b>Writing</b>	<b>Number</b>	<b>Average</b>
System OFF, Semester 1	3.25	3.19	7.44	4.63
System ON, Semester 1	5.53	4.49	9.02	6.35
System OFF, Semester 2	1.63	1.53	7.78	3.65
System ON, Semester 2	3.40	3.51	8.94	5.29
Amplification effect, Semester 1	2.28	1.29	1.58	1.72
Amplification effect, Semester 2	1.77	1.98	1.16	1.64

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The data was further examined to ascertain the effect of family language on the benefit afforded by the amplification systems. The subjects were divided into three subgroups according to the language spoken at home. Group 1 (44%) spoke only English at home. Group 2 (47%) spoke another language plus English at home. Group 3 (9%) spoke no English at home. Improved outcomes for reading, writing and number were demonstrated for each group of children during the two terms the amplification systems were operating (Figure 2).



**Figure 2. Classes 1 to 8: Changes in skill area for each subgroup of children differing in the language/s spoken at home. Error bars show the 95% confidence intervals.**

### *Teacher and child opinions*

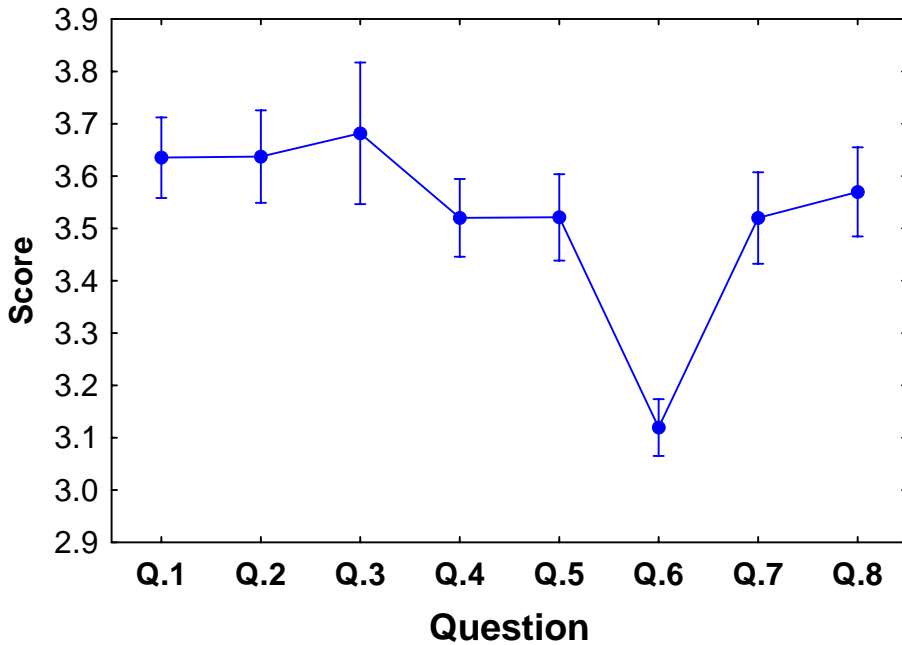
Both teachers and children gave positive responses to the use of sound-field amplification. The teachers repeatedly made reference to voice-related issues. Ninety-two percent of the teachers indicated they had less vocal strain and the majority felt less fatigued at the end of the day after using the systems.

### **T.O.P.I.C rating scale**

The results of the T.O.P.I.C. rating scale confirmed that teachers observed significant improvement in attention, communication and classroom behaviour when the amplification systems were operating (Figure 3). 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. The improvement was very slight and of no practical significance for question 6 on non-verbal communication strategies. Highest scores were obtained for the first three questions relating to attention.

The twelve teachers were asked to rate a number of statements regarding their impressions on various subject areas following use of sound-field amplification. Table 3 details the responses as to whether they agreed with the statement, were uncertain, or disagreed with the statement.

**Figure 3. Scores for each T.O.P.I.C. question averaged across classes.**



**Error bars show 95% confidence levels.**

Table 3: 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

Each of the 12 classes of children were asked to say what they liked about their teacher using the microphone. The responses are contained in Table 4. Some classes had more than one response. The majority of answers relate to the fact that many children identified they could hear better, clearer or louder

Table 4

*Question: Tell me what you liked when I (teacher) was wearing the microphones*

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<b>Children's responses</b>	<b>No. of classes</b>
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

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***Significance:***

The Australian House of Representatives Standing Committee on Education and Training published the findings of an inquiry into the education of boys (October, 2002). In this report the importance of developing strong foundation literacy and numeracy skills in the early years of schooling was emphasised. Given that the acquisition of educational outcomes for all school children is of national priority, the findings from this study have important ramifications.

This study supports the use of sound-field amplification to advance the acquisition of literacy and numeracy skills for children in mainstream classrooms, and not only for those children with identified hearing loss or with ESL backgrounds. At present in Australia, there are no enforceable standards for classroom acoustics. However, sound-field amplification may be viewed as a cost-effective part of the solution to improving classroom listening environments for all children.

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More details of this study can be found in:

- Massie R, Dillon H (2006). The impact of sound-field amplification in cross-cultural classrooms. Part 1 Educational outcomes. *Australian J of Education*, 50(1):62-77.
- Massie R, Dillon H (2006). The impact of sound-field amplification in cross-cultural classrooms. Part 2 Teacher and child opinions. *Australian J of Education*, 50(1):78-94.