# Helping Children Hear: Teachers' Experiences of Using Soundfield Amplification Systems

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## ABSTRACT

*The purpose of the evaluation was to assess the quality and success of the implementation of Soundfield Amplification Systems (SAS) in primary schools in Hawke's Bay, where audiometry failure rates at school entry are generally higher than overall national rates and are particularly high for Māori and Pacific children who are at greater risk for otitis media. Process evaluation findings indicated the project was evidence-based and well-implemented. Early successes were: increase in ability of teachers to get and maintain students' attention; decrease in teacher vocal fatigue; increase in student ability to follow oral instructions; and, decrease in teacher repetition of instructions.*

## INTRODUCTION

Children spend a considerable proportion of each school day in activities that involve listening. Until children are able to read, classrooms are typically auditory-verbal environments, requiring them to listen to instructions of teachers until they develop reading skills (Matkin, 1996). Being able to hear is essential for classroom learning (Crandell, Smaldino, & Flexer, 1995). The underlying assumption is that if children 'cannot hear consistently and clearly, their acquisition of language and the development of literacy is compromised' (Heeney, 2007, pp. 44-45).

Children do not perceive speech in challenging listening conditions the same as adults due to their auditory neurological network not being fully developed until about the age of 15 years. Younger children perform more poorly than older children and require better conditions for listening (Anderson, 2004; Boothroyd, 2004). Unlike adults, children have not accumulated a history of listening and life experience to bring to their learning that enables them to fill in the blanks of missed information (Flexer & Long, 2003). A classroom where the sounds are acceptable to an adult may be unsuitable for children given that they require a quieter environment and a sharper auditory signal than adults (Anderson, 2001).

This paper provides a literature based context for the Soundfield Amplification Systems (SAS) project implemented in Decile One and Two primary schools in the Hawke's Bay region and presents the findings from the process and outcome evaluation. The SAS project was implemented as a universal intervention in Year One and Two classrooms to improve listening conditions for all children and particularly for those with audiometry failure rates.

## RATIONALE FOR THE SAS PROJECT

Over the past nine years, audiometry failure rates at school entry in the Hawke's Bay region (the focus of this paper) have been generally higher than overall national rates (10.8% locally compared to 4.7% nationally) (Ministry of Social Development, 2008). Audiometry failure rates are particularly high for Māori (16.6%) and Pacific children (18.6%) at school entry. In 2006/07, over 30% of primary schools in Hawkes Bay had new entrant hearing failure rates of 10% or greater. Of these schools, 61% had a decile rating of one or two. There are also schools in the area where 25-50% of new entrants fail the hearing test which indicates hearing loss of a level that can interfere with speech perception in the classroom (Ministry of Social Development, 2008). These statistics provided the impetus for the SAS project.

The vast majority of hearing failures among children result from conductive hearing loss due to chronic otitis media with effusion (glue ear) which is often associated with episodes of upper respiratory tract infection, as well as attendance at child care centres, exposure to environmental tobacco smoke, and low rates of breastfeeding.

Given that most early classroom learning occurs through the auditory channel, school age children experiencing hearing loss often perform poorly in language based subjects, class tests, class participation and verbal interaction with peers and teachers (Matkin & Wilcox, 1999). While children with acute or chronic otitis media may not show significant loss in an audiogram where listening conditions are favourable, in a classroom with high levels of background noise and other unfavourable acoustic conditions they may not be able to hear speech sound accurately (Allcock, 1997). The success of these children at school is largely dependent on the quality of audiological and academic support they receive.

### Classroom acoustics

Typical classroom environments are full of sounds in the midst of which children are expected to distinguish speech from background noise (Rubin, Flagg-Williams, & Aquino-Russell, 2007). The main difficulty of trying to learn in a poor acoustic environment is that children cannot distinguish specific speech sounds. While speech may be audible it may not be consistently intelligible, with children hearing words such as walked, walking, walker all as '-ah' (Flexer & Long, 2003). While the quality of the listening environment in classrooms affects all children, those experiencing fluctuating or permanent hearing loss, English as second language and those who have difficulty paying attention to and remembering and processing auditory information have been found to be most affected (Allcock, 1997).

### Soundfield Amplification Systems

Soundfield amplification increases the sound of the teacher's voice and in effect brings the signal closer to the student's ear (DiSarno, Schowalter, & Grassa, 2002). The teacher's voice is amplified to create a more favourable signal-to-noise ratio (SNR) which means that the sound is more intense than the competing background noise in the classroom (Larsen & Blair, 2008). Soundfield Amplification Systems (SAS) are similar to small, high-fidelity, wireless public address systems and the teacher wears a wireless microphone

so that mobility is not restricted (Flexer, 2002). The teacher's speech is evenly transmitted throughout the classroom via an amplifier connected to one or more loudspeakers. The transmitter can also be connected to a tape recorder or video recorder which can also improve the sound of these recordings (DiSarno, *et al*., 2002). The technology provides a clear and consistent signal to all children in the classroom, no matter where the teacher is located. Ideally, every child hears as if seated in a front-row centre seat (Flexer & Long, 2003).

**Benefits and classroom implications**

Since the Mainstream Amplification Resource Room Study (MARRS) began over 30 years ago, the effectiveness and benefits of SAS have been well-documented (Allcock, 1997; DiSarno, *et al*., 2002; Flexer, 2002; Massie, Theodoros, McPherson, & Smaldino, 2004; McSporran, 1997; Rosenberg & Blake-Rahter, 1995; Rosenberg *et al*., 1999). The MAARS project found students in classrooms with amplification had significantly higher scores, particularly in reading and language arts (Crandell, 1998). Other benefits for children identified in the literature included: improved academic achievement, particularly for younger children (5-9 years); improved speech recognition; increased seating options for children with hearing loss; increased self-esteem; increased understanding of the teacher; increased understanding of other students; and, less stigma in that students with hearing loss do not have to wear something different from their peers. Teacher benefits included: decreased teacher vocal strain and fatigue; increased teacher ability to get and maintain children's attention; increased ease of teaching; and, increased teacher mobility (DiSarno, *et al*., 2002; Heeney, 2007; McSporran, 1997).

New Zealand research conducted by Heeney (2007) produced similar results to international research. The study involved a total of 626 students in their first to sixth year of schooling. The students represented five Rotorua primary schools and were divided into an intervention (438 students in 30 classrooms) and control group (188 students in 12 classrooms). The Progressive Achievement Tests (PATs) noted statistically significant improvements in the intervention group's scores for listening and reading comprehension and reading vocabulary ($p>0.0001$). Findings also indicated SAS improved learning and literacy outcomes, created enhanced classroom harmony and improved student behaviour as well as reducing voice strain among teachers. Soundfield amplification achieves this by overcoming problems associated with noise and distance. Heeney (2007) recommends that: all classrooms should be fitted with SAS to support good teaching practice; teachers should use the systems consistently to maximise benefits; and, Soundfield amplification should be used for all students regardless of school decile, ethnicity, or whether or not they have hearing difficulties. He also states that Soundfield amplification is one of the most cost effective investments a school can make to increase literacy outcomes.

To ensure SAS are well-implemented, Rosenberg and colleagues (1999) suggested the need for adequate teacher training, ongoing technical support, monitoring or troubleshooting assistance and teachers' willingness to use the system.

### Project description

The Soundfield Systems in Schools Project (S/SP) was initiated by the Hawke's Bay District Health Board (HBDHB) to address audiometry failure rates in the Hawke's Bay region. While the project was universal, recognising that all children benefit from SAS, the intent was to ensure Māori and Pacific children with ear disease were not disadvantaged at school entry. Children with compromised hearing require much better acoustic conditions than are currently available in many Aotearoa New Zealand school classrooms and the installation of SAS is one way to address this issue. Given that the first two years at school are pivotal to long term positive educational outcomes, children who experience otitis media can be severely disadvantaged. Research has also shown that children with weak language skills are at risk of serious academic, social and emotional disadvantages (Vail, 1999).

## EVALUATION DESIGN AND APPROACH

The evaluation approach was programme theory-driven (Donaldson, 2007) and utilisation-focused (Patton, 1997). The programme theory, that is the explanation of the way in which the programme is expected to achieve the desired outcomes, is depicted in a logic model developed in consultation with the project collaborators (see Figure 1 on the next page). Programme or intervention logic is a way of clarifying the rationale or thinking behind a programme or project or intervention and sets out the intended effects or outcomes. An outcome refers to a change in the lives of the people participating in the project and/or changes in the wider environment.

Programme logic is usually represented as a diagram with arrows showing the linkages and relationships between components. The logic model shows that if a particular activity is implemented, this will lead to the achievement of short-term outcomes and if these are achieved then medium-term outcomes should follow and so on. The lines and arrows are important because they represent the assumptions and theories of change that underpin the project.

### Evaluation aim

The broad aim of the evaluation was to determine the quality of the intervention (process evaluation) and the extent to which the SAS contributed to the achievement of the short and intermediate outcomes (outcome evaluation) outlined on the logic model (see Figure 1 on the next page).

### Evaluation questions

- Is the SAS project evidence-based?
- How well implemented is the project?
- To what extent have the short and intermediate outcomes of the project been achieved?

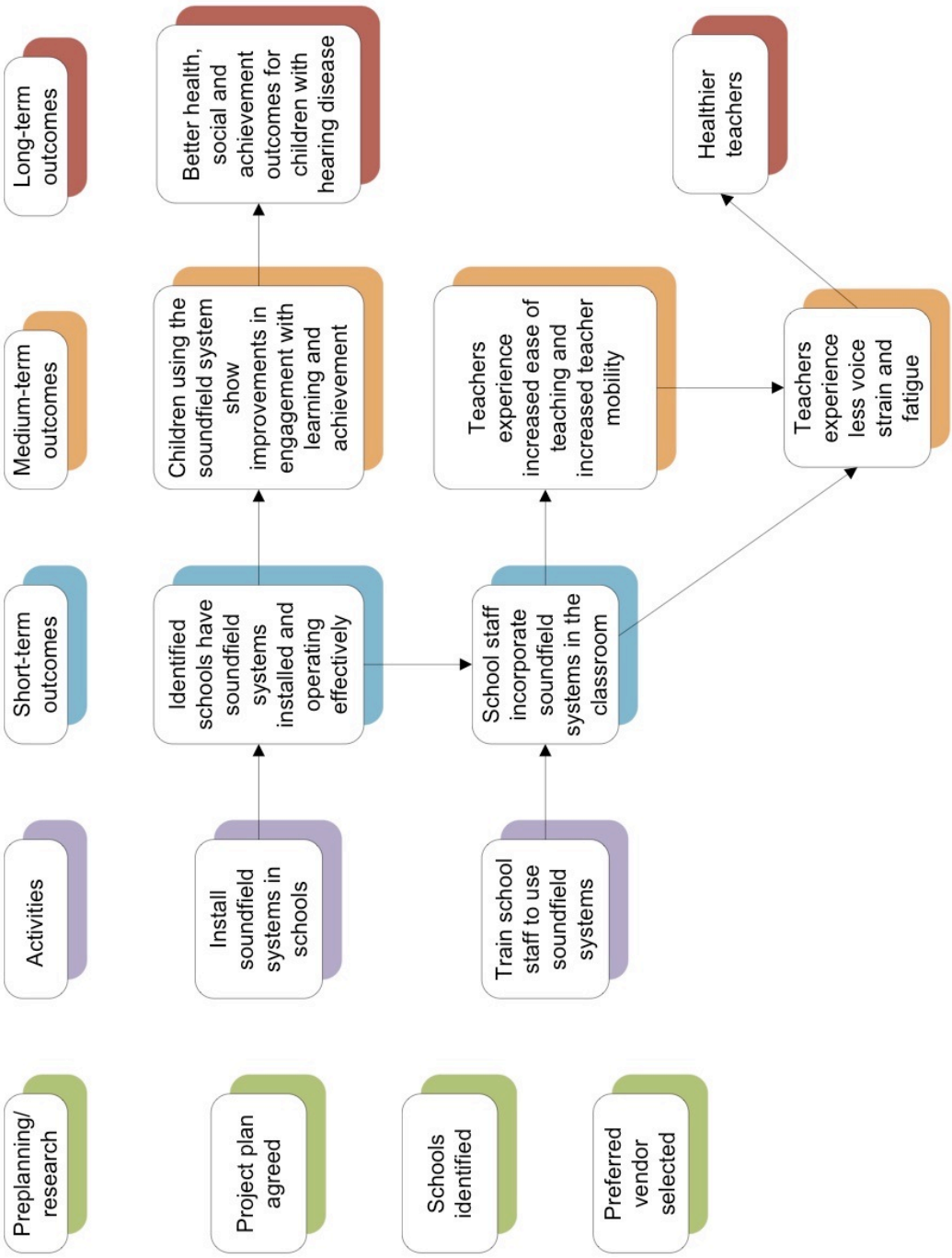


**Figure 1.** The Soundfield Amplification System Project Logic Model

## EVALUATION METHODS

This evaluation was considered to be of low ethical risk by the Health and Disability Ethics Committee. Information sheets were provided and consent forms were completed by evaluation participants. The project was implemented over 12 months (January – December, 2009). All Decile 1 and 2 primary schools in the region were contacted by telephone in early December, 2008. Those that were interested in being involved in the project were sent a letter outlining the project and its aims and benefits. The 16 schools willing to be involved signed a letter of agreement to work collaboratively with the HBDHB to implement the project. The HBDHB's role was to: raise awareness about SAS; organise training and take part in this; establish an infrastructure to support the implementation of the SAS; disseminate information on the SAS as it became available; and, provide further relevant support when required. The schools were asked to commit to: working within a whole school approach; school staff incorporating the SAS as daily practice in the classroom; support ongoing maintenance costs such as batteries for the systems; create a shared vision with school community representatives by identifying strengths and needs; evaluate and review the SAS activity at a whole school community level and participate in the external evaluation of SAS; and, work towards identifying and implementing strategies that support the sustainability of SAS (i.e., so that it continues to operate after installation).

The HBDHB reviewed tenders from three SAS providers. The preferred provider was contracted by the HBDHB to provide and install the SAS and provide training for teachers. The model selected for installation included a pass around microphone. The reason for selecting this component was that students, when talking to the class, could use the microphone to enable them to be heard clearly. The system consisted of a receiver, a pendant microphone and two infra-red speaker units. The process evaluation methods included:

- A brief overview of relevant local and international literature,
- Observation of training sessions,
- Post-training feedback from participants (N=17),
- A follow-up survey of teachers using SAS (N=23),
- A joint interview with the project coordinator and manager (N=2).

The outcome evaluation activities included:

- A follow-up survey with teachers using SAS (N=23),
- A joint interview with the project coordinator and manager employed by the Hawke's Bay District Health Board (N=2).

### Evaluation participants

Sixteen schools involving 23 teachers participated in the evaluation. The schools were selected on the basis of their decile rating and their willingness to be involved in the project. Interviews were also conducted with the project facilitator and the project manager.

## EVALUATION FINDINGS

The findings presented provide answers to the evaluation questions.

### Is the SAS project evidence based?

An important indicator of a well-designed project is that it is informed by available research evidence and local knowledge. This means projects incorporate approaches that are likely to achieve the intended outcomes and are appropriate to the local context. The literature review identified the following factors as contributing to the quality of implementation of SAS in schools: providing teachers with evidence that SAS are effective in improving listening conditions for all children and reducing voice strain for teachers; appropriate SAS equipment; training in the use of SAS; and, appropriate on-going technical support. These factors were used as evaluation criteria.

The HBDHB identified a need for the SAS project to be implemented in Decile 1 and 2 schools in the Hawke's Bay region. The need was based on recent research evidence relating to audiometry failure rates in the region as described earlier. The evidence review identified the following benefits of implementing SAS, which include: a more positive learning environment; children are better focused and attend better; learning outcomes improve for all students; and, teachers' voice strain is reduced. Audiometry failure rates in the Hawke's Bay region along with evidence review findings highlighting the advantages of SAS provided a sound evidence-based rationale for the SAS project.

As stated earlier, the HBDHB reviewed tenders from three SAS providers. The SAS system provided was the preferred option based on assessment of quality, pricing (not simply the least expensive) and the option of the student pass around microphone to enable students to be heard when sharing with the class. This suggests that appropriate equipment was selected for the project.

Training in the rationale for and use of SAS was offered to all participating schools and schools were assured that ongoing support, monitoring, troubleshooting and technical support would be provided for the duration of the project, as recommended in the literature reviewed.

The preparation phase was informed by evidence of what was likely to work: evaluation findings indicate the SAS project was based on the need for the project to be implemented in Decile 1 and 2 primary schools in the Hawke's Bay region; the choice of SAS equipment was carefully considered and an appropriate provider selected; and, participating schools were offered training and technical support.

### How well implemented was the project?

The information below is drawn from evaluator observations, teacher survey data (N=23), feedback from training participants (N=17), a joint interview with the SAS project coordinator and the HBDHB manager, and email and telephone communication with the SAS provider. A key assumption of the SAS project was that the installation of SAS in schools would contribute to improved social and learning outcomes for students and improved wellbeing for teachers. Therefore, process evaluation questions addressed how well the SAS project was implemented. It was anticipated that this information would be useful for the

HBDHB and other groups who wish to implement similar projects in the future. The literature review identified a number of processes supporting project implementation, which included: training; ongoing support and monitoring; and, troubleshooting assistance.

*Training*

Four after-school training sessions were conducted involving 35 teachers and two management staff. The training sessions were held in classrooms with a SAS installed and were approximately one hour in duration. The SAS provider delivered this model of training to ensure teachers were available and had time to attend. The evaluators attended two training sessions and the SAS project coordinator attended all four sessions. The facilitator conducted the training using the necklace microphone to demonstrate voice projection and sound. The presentation was mainly didactic and relied on a PowerPoint presentation to provide research evidence supporting the use of SAS in classrooms. There were no opportunities for participants to have any hands on experience with the equipment.

The programme coordinator sent surveys to teachers after they attended the training session. Completed evaluations were provided by 17 of the 35 teachers. Teachers were asked to rate the usefulness of the training from excellent (5) to very poor (1). Ratings ranged from average to excellent (see Table 1).

| Very Poor | Poor | Average | Very Good | Excellent |
|---|---|---|---|---|
| 0 | 0 | 6 | 7 | 4 |

**Table 1:** Teachers ratings of usefulness of training (N=17)

Most of the teachers considered the training was useful, particularly in relation to good information, and demonstration of the equipment 'was informative and answered the questions that I had about the sound system'.

A few comments related to one of the sessions being disorganised due to the equipment not being 'up and running at the start' and 'the facilitator gave the impression that she was new to the job and relied on ICT for presentation'.

Several participants offered suggestions for improvement which included needing to have the training before the systems were installed, having a hands on component and more interactive training, and the facilitator being better organised at the start of the training session.

While feedback collected immediately after the training was positive, when the teachers were surveyed several months later they identified as challenges: not knowing how to charge the batteries; the voice pack not charging while plugged in; adjusting volume; and, learning how to use the TV/ DVD and computer functions. Some teachers who were not able to attend the training were unsure how to use the equipment correctly:

> The voice pack is no longer charging while plugged in. Manually recycling batteries but still not able to use the voice pack. Maybe I'm not plugging or switching something on correctly. No professional development.
> (Teacher)

Hands-on training may have reduced these problems given the needs of adult learners commonly identified in the literature, which include: acknowledging them and their use of experiences and prior knowledge; their different learning styles; and, their desire to be actively involved in the learning process versus being a passive audience (Merriam, 1993; Silberman, 2006).

*Project coordination*

One of the strengths of the project was that the HBDHB appointed a project coordinator to establish relationships with each of the schools involved in the SAS project and with the SAS provider. All teachers rated the coordinator as either excellent or very good in providing them with background information on the SAS project and ongoing support and monitoring: 'She always comes across as passionate in what she does. Information/ background of project very enlightening'.

The project coordinator also facilitated access to technical support when teachers had difficulties communicating their support needs to the SAS provider. One school experienced a substandard installation job where the staples used to secure speakers had gone through the wiring:

> I did visit the school this afternoon and viewed what I would consider a substandard installation job. I was walked through the remaining classrooms and other areas of concern were pointed out. I have been assured by [name] of [SAS provider] that these concerns will be addressed. In the meantime I will visit all schools involved in the project to date and feedback any further concerns.
> (Coordinator)

At the training sessions teachers were assured that if there were any problems with the SAS equipment they could contact the technician. However, several schools experienced problems with the systems and had difficulty accessing technical support. This resulted in their either not being able to use the SAS at all, or only intermittently:

> Used the system on a daily basis until it stopped working. Was sent away and lasted one week on return. The caretaker has spent considerable time trying to rectify the problem. I believe a new neck machine is needed.
> (Teacher)

Several teachers reported attempting to problem solve some of the technical issues experienced by testing equipment in other classrooms and found that the equipment worked in some rooms but not others. One teacher spent a considerable amount of time trying to solve problems with 'crackling'

that occurred after seven weeks of experiencing no faults. This teacher experienced problems accessing technical support:

> This system was installed in my class last holidays and I attended the training. The system worked well for 7 weeks but the last few weeks it became very crackly and we were unable to use it. We tried both microphones in other rooms and they work well. We tried another microphone in this room and it crackles. So we have eliminated the microphones as being faulty. We have phoned [SAS provider] twice and they have been no help at all. What we need is someone to come and look at the system and check it. We have been unable to progress any further on this issue so the resource is not being used. As we found it invaluable to start with, this is very disappointing.
> (Teacher)

Another teacher had a similar experience and expressed concerns about support:

> I have tried to explain to you and the people at [SAS provider], it is not the microphones, so see no point in sending them back. They work fine in other rooms. Do you want me to take the whole box off the wall fitting? I don't feel qualified to do this!
> (Teacher)

In summary, training teachers to use SAS is essential. While training was provided and teachers were presented with a strong rationale for the use of SAS there were limitations relating to effectiveness. Teachers were not provided with any opportunity for hands-on experience with the equipment and there was little time available for learning basic troubleshooting strategies. Participating schools were assured that they could access technical support as required and part of the provider's contract with the HBDHB was to provide appropriate support. Unfortunately, several schools experienced problems that they were unable to fix themselves and had difficulty accessing timely support from the provider. Given the SAS project was a pilot, this is a key issue that needs to be resolved for the future to ensure continued use of SAS by schools.

**To what extent have the short and intermediate outcomes of the project been achieved?**

The short-term outcomes were: identified schools have SAS installed and operating effectively; and, school staff incorporate SAS in the classroom. The medium-term outcomes were: children using the SAS show improvements in engagement with learning and achievement; teachers experience less voice strain and fatigue; and, teachers experience increased ease of teaching and increased teacher mobility. Teachers were surveyed at least one school term after SAS installation and data were collected from 23 teachers representing ten schools.

*Soundfield systems installed and operating effectively*

A total of 50 SAS were installed in 15 of the 16 schools. Over half the teachers reported experiencing some technical problems particularly relating to interference, such as echoing, feedback, breaking up, static, volume adjustment and crackling:

> When using the hand piece, sometimes you have too much static feedback from the receiver. Children tend to focus on pointing it/ finding the right place to point the microphone at the receiver to get a clear sound.
> (Teacher)

> The main challenge was getting the system right with no interference.
> (Teacher)

> I really enjoy it although I am having a bit of 'feedback' and 'breaking up' which I must follow up.
> (Teacher)

*School staff incorporate SAS in classrooms*

At the start of the project teachers expressed their enthusiasm regarding their use of SAS. The systems were installed in the Phase One schools prior to the training being facilitated. This meant that some of the teachers had already started using the systems and reported that the children were also appreciating the SAS:

> The kids love sharing their work with the microphone and this is awesome, as, at this stage, voice projection is a real teaching point and many of the kids just aren't able to speak loud enough for all their peers to hear.
> (Teacher)

Teachers were asked to indicate how consistently they were using the SAS in their classrooms on a scale ranging from: consistently for all or most teaching sessions (1), to not used at all (4). Table 2 shows teachers' ratings of consistency of use.

| Consistently for all or most teaching sessions | Consistently for selected teaching sessions | Inconsistently | Not used at all |
|---|---|---|---|
| 16 | 3 | 3 | 1 |

**Table 2:** Teachers' ratings of consistency of use of SAS (N=23)

Those using the SAS consistently for all or most teaching sessions reported they were able to get children's attention through wearing the necklace and using the hand-held microphone and that children were asking for the system to be switched on:

> Excellent. Wide range around the classroom. Able to get children's attention.
> (Teacher)

> I wear it all day. I notice that the children are not so attentive at the start of the day if I don't put it on.
> (Teacher)

> We use the hand-held microphone too when children present news or share ideas with the class. Both make a huge difference to children's listening and focusing.
> (Teacher)

> Kids complain if it's around my neck but not on – they know straight away!
> (Teacher)

Only one teacher rated their use of SAS as 1 stating, 'the system did not suit my teaching style so it was rarely used'.

While a few teachers found getting used to wearing the necklace microphone, interference from clothing and accessories, and their and students positioning in relation to the speakers as initially challenging, these challenges were managed:

> I had to get used to wearing something around my neck and stepping outside my comfort zone.
> (Teacher)

> When using the hand held microphone children have to move to certain places in the room away from the speakers.
> (Teacher)

> You are unable to wear scarves and jewellery and have zips close to the proximity of the machine.
> (Teacher)

The rubric below (see Table 3 on the next page) rates teachers' use of SAS as *very good* based on the available feedback.

| Rating | Explanation<br>(How you decide merit) |
|---|---|
| Excellent | All teachers have the SAS on throughout each school day and are wearing their microphones. All teachers are confident in using the SAS. |
| *Very Good* | *Most of the teachers have the SAS on throughout each school day and are wearing their microphones. Most teachers are confident in using the SAS.* |
| Good | Most of the teachers have the SAS on most school days and are wearing their microphones. A few teachers lack confidence in using the SAS. |
| Just Adequate | At least half of the teachers have the SAS on throughout most school days and are wearing their microphones. Some lack confidence in using the SAS. |
| Inadequate | Most teachers are not using the SAS and/or are not confident in using the SAS. |

**Table 3:** Teachers' use of SAS

**Children using the SAS show improvements in engagement with learning and achievement**

Teachers were asked to provide feedback on noise levels, on task/ off task behaviour, understanding instructions, student cooperation and student learning outcomes.

*Noise levels*

Most teachers observed a reduction in noise levels:

> The children are quieter. They listen more to instructions which can be delivered effectively to the class and they can all hear.
> (Teacher)

> The working atmosphere is much quieter. Groups reporting back to the class are quieter and even quiet children can be heard and the audience is focused.
> (Teacher)

A few teachers reported that they had not noticed a reduction in noise levels but considered that using the SAS enabled the children to hear well: 'The level of noise is much the same but children are able to hear me more clearly'.

*On task/ off task behaviour*

Most teachers reported that children were more focused on learning, were back on task quicker, remained on task and completed tasks faster and were working more quietly:

> There is a noticeable reduction in off task behaviours.
> (Teacher)

> They are more focused on learning, all children can clearly hear the same message and there is less off task behaviour.
> (Teacher)

Only a few teachers observed no differences in on/off task behaviour: 'Once the novelty wore off, there's no real difference. Students who are usually off task are still off task and vice versa'.

*Understanding teacher instructions*

Most teachers noted improvements in children's ability to understand instructions. Indicators of better understanding of instructions included less repetition of instructions by the teacher, children getting started on work more quickly, and better focus and listening:

> Much clearer. I trust that children have heard my instructions now. I never realised how much they didn't hear until now.
> (Teacher)

> Instructions are easier to deliver and appear to be clearer for those children who have difficulty hearing and staying on task.
> (Teacher)

Only one teacher noted no marked difference in children's understanding of instructions.

*Student cooperation*

Most teachers noted positive changes in student cooperation. Changes related to students being able to hear messages with greater clarity, students hearing positive praise through the system which resulted in them working more consistently, and better cooperation at mat time:

> All are cooperative and easy to pull back into line those who are not.
> (Teacher)

> They are listening better, are more on task as they are able to hear and understand more effectively.
> (Teacher)

*Student learning outcomes*

Several teachers noted improvements in children's learning particularly in relation to the achievement of learning tasks relating to oral language, group discussion and reading and writing:

> There is a huge growth in children's attitude to learning and this is evident in reading and writing lifting close to national norms. All children hear the learning messages explicitly.
> (Teacher)

> Oral language, discussions in groups and class have improved for all children.
> (Teacher)

However, most teachers considered that it was too soon to observe any noticeable improvements in student learning outcomes. For example, several teachers in one school considered that the system would need to be used for a more extended period of time for changes to be noted: 'Too soon to say. General consensus was that it will be interesting to revisit after the children have had a full year of it'.

**Voice strain and fatigue**

Teachers were asked whether they had noticed any changes regarding their health and wellbeing since using the SAS. All but one teacher experienced less voice strain as the most significant positive influence on their wellbeing. Their comments related to not experiencing sore throat syndrome, being able to speak at a normal level rather than having to raise their voices, not feeling tired at the end of a day's teaching and no loss of voice since using the system:

> It is less strain on your voice and also less tiring as one does not need to raise one's voice.
> (Teacher)

> Less voice strain. I can talk more quietly as children can all hear with sound amplified.
> (Teacher)

> Excellent health. There is no need to strain or raise my voice, the system definitely helped here.
> (Teacher)

**Ease of teaching and increased teacher mobility**

Nearly all teachers reported that using the SAS contributed to increased mobility in the classroom and consequently ease of teaching. Examples provided included being able to work with individuals or groups and have the rest of the class hearing the teaching, being able to focus on good points that students are achieving while roaming around the room, having all students hear instructions regardless of where the teacher is in the classroom and being able to manage the class better:

> When I am working with an individual group of children I leave the system on and the children all still hear the same learning focused language which is excellent strategy reinforcement.
> (Teacher)
>
> Students are learning from listening to points from other groups.
> (Teacher)

## DISCUSSION

The process evaluation findings indicate the SAS project is evidence based, key project components were implemented and the project was well coordinated. With regard to judging the success of the SAS project it is important to reiterate that the available evidence is not representative of all the teachers using SAS. Nevertheless, the early successes achieved are encouraging. There are indications, based on teacher self-report, that the SAS project resulted in positive changes for teachers and students. Evaluation findings are consistent with previous research (DiSarno, *et al*., 2002; Heeney, 2007; McSporran, 1997) indicating the use of SAS in classrooms increases teachers' ability to get and maintain students' attention, decreases teacher vocal strain and fatigue, improves students' ability to follow oral instruction with less need for teachers to repeat instructions, and teachers and students enjoying using the system.

As expected there are some areas where improvements can be made which mainly relate to training and technical support. Given that these two aspects have been identified in the literature (Rosenberg *et al*., 1999) as key components of successful SAS implementation and use, the following action points have been identified: the provision of more in-depth, hands-on training for teachers which includes basic troubleshooting skills; and, readily accessible technical support to avoid disruption in continuity of use of SAS equipment.

It is important to note that the evaluation was limited to accessing self-report data from teachers in relation to the implementation of SAS in classrooms. A more comprehensive evaluation could explore different perspectives including those of students and families. It was also not within the project's timeframe to determine actual learning and achievement outcomes for students. As several teachers commented, this would require a longer timeframe and the collection of pre and post data to determine whether students' learning outcomes improved. However, previous studies have found an association between SAS use and improved learning outcomes.

## CONCLUSION

Clearly, the better children can hear, the more they are able to learn. The benefits of SAS for both children and their teachers appear to far exceed any challenges to implementation. SAS provides a means for children to hear the teacher's voice clearly over background noise. Teachers are able to communicate in normal, effective voices without straining themselves to be heard. Children can hear the teacher as if the teacher is communicating with them individually. It is therefore likely that Māori and Pacific children with audiometry failure rates at school entry would benefit from learning in classrooms with SAS.

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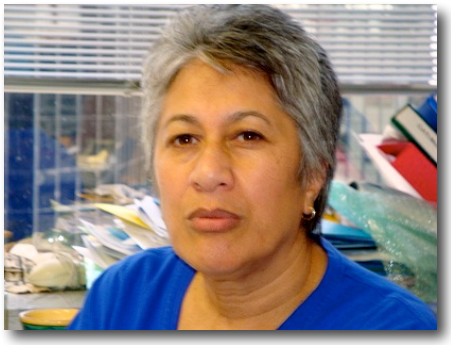

Dr Lanuola Asiasiga's research interest is Pacific people's well being and most of her research projects have touched on some aspect of this. Since being at SHORE she has been involved in survey work and evaluation. Lanuola's evaluation work includes a range of public health projects such as community renewal, breastfeeding, Soundfield systems in schools, and families with complex needs.

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