Changing the listening environment in classrooms at Mornington Island State School

Executive Summary

Classrooms in remote settings can be very noisy spaces to listen and learn. For Aboriginal and Torres Strait Islander children, with potentially differing language backgrounds and a history of fluctuating hearing loss, listening and learning in these environments can be challenging. Ultimately, this can limit their ability to participate effectively in the curriculum.

Aim

In response to this issue, the Deadly Ears team has undertaken a project in partnership with the staff at Mornington Island State School to explore if the implementation of low cost acoustic modifications can a) enhance the acoustic parameters within classrooms, and b) build teacher’s understanding and capacity to make modifications to improve their classroom listening environment.

Method

Teachers from seven classes, ranging from prep to year 10 participated in the study. Both qualitative (semi-structured interviews) and quantitative measures (sound-level meter readings of background noise levels, reverberation time and the level of the teacher’s voice compared to the background noise) were recorded, prior to and following the implementation of low cost acoustic modifications.

Results

Background noise levels of all of the classrooms, with air-conditioners on, exceeded the levels recommended by the Australian and New Zealand Standard (AS/NZ 2107:2000). The acoustic modifications made a slight positive change to the background noise levels in five of the seven classrooms. Reverberation times reduced in all classrooms following the modifications. One classroom, which was within the standard prior to modifications stayed within the standard while two classrooms (one primary classroom and one secondary classroom) fell within the standard. Reverberation times increased (prior to acoustic modifications) in the three classrooms that had their carpet removed, highlighting the acoustic properties of having carpet in classrooms. When using sound-field amplification, there was generally an increase in the signal-to-noise ratio for all teachers following the implementation of the modifications, however no teachers achieved the recommended minimum signal-to-noise ratio of 15dB. The project processes led to teacher’s having an increased understanding of listening environments and the awareness that improving the listening environment could lead to better learning for the children in their class.

Conclusion

The project has shown that low cost acoustic modifications, developed in collaboration with classroom teachers, can make a positive change to the acoustic parameters within classrooms. It has highlighted the acoustic benefits of various resources as well as the challenges associated with the disruptive nature of noise originating from both inside and outside classrooms. The project has been a valuable collaboration between the Deadly Ears Program and Mornington Island State School which will hopefully enable students to participate more effectively in the curriculum.
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Glossary of Terms

**Background noise (BGN)** refers to any undesired auditory stimuli that interfere with what a child wants, or needs, to hear and understand (Crandell et al., 1995a). Background noise in classrooms can originate either internally (eg: air conditioners, students) or externally (eg: traffic, lawn mowing).

**Conductive Hearing Loss (CHL)** is a hearing loss (greater than 20dB) where the loss is in the outer and/or middle ear system. The most common cause of CHL in Aboriginal and Torres Strait Islander populations is otitis media.

**dB** stands for ‘decibel’ and is the standard unit measurement for sound intensity. The higher the decibel, the louder the perceived sound. **dB(A)** is an expression of the relative loudness of sounds as perceived by the human ear. **dB(A)Leq** is a sound that is equivalent to this level of sound in dB(A) as experienced over an eight hour period.

**Otitis Media (OM)** refers to all forms of inflammation and infection of the middle ear. Active inflammation or infection is nearly always associated with a middle ear effusion (fluid in the middle ear space).

**Reverberation Time (RT)** is the time it takes sound to decrease by 60dB after the generation of the sound has stopped. Reverberation is generally a good measure of how much sound is ‘bouncing’ around in a space. Compare having a conversation in a reverberant space with lots of hard surfaces (like a squash court) with a sound-treated space with lots of soft surfaces (like a movie cinema).

**Signal-to-Noise Ratio (SNR).** In most learning environments, the most important consideration for accurate speech perception is the relationship between the intensity of the signal (the teacher’s voice) and the intensity of the background noise at the child’s ear (for example, if the teacher’s voice was at 70dB and the BGN was 60dB, the SNR would be +10dB). This is referred to as the signal-to-noise ratio and for a primary school student, the signal at a student’s ear should exceed a minimum of +15dB greater than background noise.¹

**Sound-field Amplification System (SAS)** Sound-field amplification is an educational tool that allows control of the acoustic environment in a classroom. The teacher wears a small microphone that transmits sound to a receiver system attached to loudspeakers around the classroom. The goal of sound-field amplification is to amplify the teacher’s voice to provide uniform amplification throughout the classroom without making speech too loud for normal hearing children.

**Sound-Level Meter (SLM)** is an instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.

### Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAAC</td>
<td>The Association of Australian Acoustical Consultants</td>
</tr>
<tr>
<td>AH</td>
<td>Australian Hearing</td>
</tr>
<tr>
<td>BGN</td>
<td>Background Noise</td>
</tr>
<tr>
<td>CHL</td>
<td>Conductive Hearing Loss</td>
</tr>
<tr>
<td>dB</td>
<td>Decibel</td>
</tr>
<tr>
<td>DE</td>
<td>Deadly Ears</td>
</tr>
<tr>
<td>ENT</td>
<td>Ear, Nose and Throat Specialist</td>
</tr>
<tr>
<td>OM</td>
<td>Otitis Media</td>
</tr>
<tr>
<td>RT</td>
<td>Reverberation Time</td>
</tr>
<tr>
<td>SAS</td>
<td>Sound-field Amplification System</td>
</tr>
<tr>
<td>SLM</td>
<td>Sound-level Meter</td>
</tr>
<tr>
<td>SNR</td>
<td>Signal-to-noise Ratio</td>
</tr>
</tbody>
</table>
Background

It is clear from the research that poor acoustic environments in classrooms can significantly affect listening comprehension, identification and higher order cognitive functions such as memory and mental processing. Studies have also shown that children are more effected by unfavourable acoustic conditions than adults. This is due in part to their neurological immaturity and lack of experience in predicting a message from context.

Good classroom acoustics are vital for children from various stages of language development, for students where their home language different from the language of learning and students with hearing loss. This is particularly pertinent in Australian classrooms with a high number of Aboriginal and Torres Strait Islander children who are frequently from diverse linguistic and cultural backgrounds and who have a high prevalence of hearing loss due to otitis media. It is estimated that between 30-80% of Aboriginal and Torres Strait Islander school children suffer from significant conductive hearing loss caused by otitis media.

In Australia, The Recommended Design Sound Levels and Reverberation Times for Building Interiors recommends design criteria for conditions affecting the acoustic environment within occupied spaces. For primary and secondary classrooms, a background noise level between 35 – 45dB(A) in unoccupied classrooms and a reverberation time no greater than 0.4s for primary and 0.5s for secondary school classrooms is recommended. The Association of Australian Acoustical Consultants, in their Guidelines for Educational Facilities Acoustics, recommends background noise levels in unoccupied classrooms to be within 30 – 40dB(A).

Noise and reverberation degrade the acoustic signal of wanted sound and adversely affects the comprehension of the spoken word. The most important consideration for accurate speech perception is the relationship between the intensity of the signal (e.g. the teacher’s voice) compared to the intensity of the background noise at the child’s ear. The recommended signal-to-noise ratio for a normal hearing primary school student should exceed a minimum of +15dB. This will allow clarity of sound or speech and allow an optimum chance of perception and understanding. Classroom signal-to-noise ratios have typically been in the range of -7dB to +5dB, and are often close to 0dB. A study conducted in 2004 in two Queensland Aboriginal communities found extremely poor signal-to-noise ratios resulting in considerable reduction in speech recognition in the children.

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8. The Standard also states that teaching spaces, including those for students with English as a second language, should have reverberation times at the lower end of the specified range (AS/NZ 2107:2000).
While these are recommended standards and levels, they are currently not mandatory in schools in Queensland. In fact, there are no Australia-wide regulations or standards that encompass all aspects of the acoustical qualities of educational and training facilities, including primary and secondary schools.

**Project Goal**

In response to this issue, the Deadly Ears team has undertaken a project in partnership with the teaching staff at Mornington Island State School. The project aimed to explore if the implementation of low cost acoustic modifications could a) enhance the acoustic parameters within classrooms, and b) build teacher’s understanding and capacity to make modifications to improve their classroom listening environment.

**Mornington Island**

**Location**

Mornington Island is located in the Gulf of Carpentaria and is the northernmost, and largest, of 22 islands that form the Wellesley Islands group. The island is approximately 700km² and permission needs to be sought from the Mornington Shire Council to visit.

![Figure 1a. Mornington Island is located in the Gulf of Carpentaria](image)

![Figure 1b. Mornington Island is 700km²](image)

![Figure 1c. The township of Gununa](image)

**History**

The local Indigenous groups who inhabit the main island consist of Lardil, Yangkaal from the southern islands and Kaiadilt who are originally from the neighbouring Bentinck Island. The Presbyterian Church established a mission on Mornington Island in 1914 which continued until 1978, at which stage the Local Government Act came into place.¹⁴

The Lardil, Yangkaal, Kaiadilt and Gangalidda people have successfully won a Native Title Sea claim determination, and have also been awarded their Native Title rights to their land. The community is initiating programs to get their people back on country and reconnect with their heritage.¹⁵

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¹⁴ Mornington Island Culture – an Introduction; Mirndiyan Gununa Aboriginal Corporation.
¹⁵ Mornington Island Culture – an Introduction; Mirndiyan Gununa Aboriginal Corporation.
Population

The population of Mornington Island is approximately 1,250 and the majority of the citizens live in the township of Gununa. 30% of the population are under the age of 15 years and less than 5% are aged 65 year and over. The majority of the islanders are Aboriginal. 16

Climate

The Wellesley group of islands experience a wet season between December and March each year. Access to the community is cut off for extended periods of time when the barge from Karumba (on the Western cape of Queensland) is unable to deliver basic supplies and goods.

Mornington Island Ear and Hearing Health

Hearing Screening

Hearing screenings were performed in February and June 2013 on Mornington Island by Senior Health Workers. The hearing screening was conducted at the school and at the child care centre, and included children 0 – 14 years. Only those children whose parents/guardians had signed a consent form were assessed. During the initial screen in February, 195 children were screened, with 54 children (28%) passing. Of those children, 111 children were reviewed in June, with only 10 children (9%) passing. Refer to Appendix A for further details.

ENT

In 2013, the Deadly Ears Hospital Walkin’ Country ENT Team visited Mornington Island in February and August. There were a total of 143 consultations at these clinics, with 108 diagnostic audiological assessments conducted. Thirty-eight children underwent surgery during these visits. Refer to Appendix A for further details.

16 http://www.abs.gov.au/ausstats/abs@.nsf/2f762f958454 17aeca25706c010834efa/65f1ae55ef773f18ca2575eo011117a4!OpenDocument
Australian Hearing

Australian Hearing, the agency responsible for providing hearing rehabilitation services to children, young adults and eligible older adults with permanent or persistent hearing loss, visited Mornington Island in July and October 2013.

Mornington Island State School

Mornington Island State School is located in the township of Gununa. The school’s emblem, the turtle, represents the need for courage, making choices and to learn from each challenge, but to never forget where one comes from and how to return to homeland. The school’s vision of *Thaldi Bana Merri* (Come and Learn) along with the concepts of *Courage, Choice, Challenge and Respect* is alive and functional within the school community.19

During 2013 Mornington Island State School had an overall enrolment of 309 students (including seven non-Indigenous students). Classes ranged from Prep through to year 10 with a total of 26 teachers and four non-teaching staff employed at the school.20

The students at Mornington Island State School retain a strong link to their Aboriginal culture and heritage. The school proudly supports the community in this regard and traditional Aboriginal language and culture are an important part of the curriculum. The school’s traditional student dancers are in high demand to perform at a variety of community events and school functions.21

Mornington Island State School students are ‘English as a Second Language’ (ESL) learners and as such require specific support to effectively access the curriculum. The school is a ‘Language Leaders’ school which provides a framework to support ESL students.22,23
Process

Participants

In January 2013, Deadly Ears team members provided an ear and hearing health information session to the staff of Mornington Island State School. At this time, interested teachers completed expressions of interest to participate in the project. Teachers from seven classes, ranging from prep to year 10 participated in the project. All the classrooms assessed were primary school classes, with the exception of classroom three, which was a combined year seven/eight class. Participants were e-mailed information about the project, including the project schedule, requirements and intended measures. Teachers completed a Queensland Health consent form at their first interview which explained that their interviews would be recorded in order to inform the project direction and the project outcome.

Classrooms

All the classrooms in the project were demountable structures with similar dimensions. The exception to this was classroom 4, which had a slightly different design consisting of a considerably larger area, a higher roof, corrugated walls, and a mixture of both carpet and lino flooring. As a result, this classroom was a considerably better acoustic environment than the other six classrooms. Four of the classrooms contained carpet while three had lino flooring. Five of the classrooms had two large under-ceiling air-conditioner units installed, with classrooms five and six having three units installed.

Classroom Modifications

There are many challenges and barriers to retro-fit classrooms with appropriate acoustic adaptations. For this project, the acoustic modifications were limited to $1,000 per classroom, which were funded by the Deadly Ears Program. The modifications were items that were able to be acquired from suppliers and retailers in and around Brisbane. The aim of acoustic modifications was to reduce the internal and external noises in the classroom, as well as decreasing the reverberation. The specific modifications and their location were primarily decided by the teachers, in consultation with the project team, to best meet the needs of the classroom teacher and their students. Prior to any modifications being ordered or installed, the project team consulted with the Principal to ensure the modifications would be appropriate from an administrative perspective. For a list of the acoustic modifications and the cost breakdown see Appendix C.
Change of Flooring

Following the March pre-modification data collection visit, the carpet was removed from classrooms 5, 6 and 7 and replaced with lino flooring. The Principal stated that the carpet was removed due to health and hygiene reasons. This presented an opportunity to compare the acoustic qualities of these classrooms with and without carpet, and before and after the modifications.

Project Schedule

<table>
<thead>
<tr>
<th>Month</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>Introductory information session; expressions of interest obtained</td>
</tr>
<tr>
<td>March</td>
<td>Pre-modification data collection</td>
</tr>
<tr>
<td>May</td>
<td>Additional pre-modification data collection (following carpet removal)</td>
</tr>
<tr>
<td>August</td>
<td>Implementation support visit to assist in resource application</td>
</tr>
<tr>
<td>November</td>
<td>Post-modification data collection</td>
</tr>
</tbody>
</table>

Table 1. Data Collection Schedule

<table>
<thead>
<tr>
<th>Teacher/Classroom</th>
<th>Grade</th>
<th>Trip One (March)</th>
<th>Trip Two (May)</th>
<th>Trip Three (November)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>7/8</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>4*</td>
<td>Prep</td>
<td>✓ Carpet</td>
<td></td>
<td>✓ Carpet</td>
</tr>
<tr>
<td>5*</td>
<td>2</td>
<td>✓ Carpet</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6*</td>
<td>3</td>
<td>✓ Carpet</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7*</td>
<td>2</td>
<td>✓ Carpet</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓ Quantitative and Qualitative data gathered  
* carpet remained in classroom 4  
* carpet was removed from classrooms 5, 6 and 7 following trip one  
* qualitative data not obtained due to teacher absence

Challenges

Asbestos was present within the classrooms. This meant that Q-Build (QLD Government’s Department of Housing and Public Works) were required to install items in the classrooms (eg. nailing hooks to the walls for netting or installing the brackets for the curtains). This extended timeframes and was an additional expense to the school.

There were resources for two classrooms that were not installed for the final data collection trip in November. The curtains, netting and egg cartons, and not all of the acoustic tiling were installed in classroom 6. A post-modification interview was also not obtained from this teacher. The curtains were not set up and the cushion covers were not made for classroom 3. The teacher originally planned a sewing

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25 It should also be noted that the flooring in classroom 3 was also replaced following the initial trip in March. However, as the flooring was replaced with the identical material (lino), it was decided not to re-assess this classroom.
project for the students to make the curtains and cushion covers, but unfortunately this did not eventuate.

Acquiring and transporting the resources to Mornington Island often proved challenging. Some suppliers had short timeframes on the quoted prices, which impacts on procuring via government processes. The team had to be aware of allowing sufficient time for resources to arrive at the island as well as sourcing a suitable place to store the resources securely at the school once they arrived.

## Methodology

### Sound-Level Meter Measurements

Sound level meter measures were obtained within the classroom of the background noise, reverberation time and the signal-to-noise ratio of the teachers’ reading voice compared to the background noise prior to, and following the application of the low cost acoustic modifications. Sound-level meter measurements of these parameters were also obtained prior to and following the removal of the carpet in classrooms 5, 6 and 7. Project team members recorded measurements directly onto data recording sheets. The height of the sound-level meters for the background noise and reverberation measures was 1.2m, and their placement for all the measurements were as follows:

![Figure 5a. Location of SLM for BGN measurement.](image)

![Figure 5b. Location of SLM for reverberation measurement.](image)

![Figure 5c. Location of SLM for teacher's voice measurement.](image)

For the purpose of this report, the background noise measurements and reverberation times will be compared to the recommended standards that are outlined in the *Recommended Design Sound Levels and Reverberation Times for Building Interiors*.

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Background Noise

Four 15 minute sound-level meter measurements were made in the classrooms. Two measurements were made with the air-conditioner on and two with the air-conditioner off. The sound-level meter was positioned in the centre of the classroom at a height of 1.2 metres. The two corresponding measurements were compared and averaged (to ensure validity and reliability).

Reverberation

Sound-level meter recordings were made of balloons being popped in nine discrete locations within the unoccupied classroom and then averaged. The balloons were popped approximately one meter away from the side walls and room corners, and one in the centre of the classroom. The sound-level meter was held approximately 30 cm from the balloons at chest height. Measurements were made with the air-conditioners off.

Signal-to-noise Ratio

The signal-to-noise ratio measurements were obtained by comparing the teacher's voice (with and without their sound-field amplification systems), with the unoccupied ambient noise levels in the classrooms with the air-conditioners on. For this analysis, the unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement. This conversion is roughly equal to the known difference in noise level between average occupied and average unoccupied classrooms. Teachers were asked to read a story (of their own choosing) for five minutes at a time, in their normal reading voice, from their usual story-reading location, under the following conditions:

1. with children not present and their SAS off
2. with children not present and their SAS on
3. with children present and their SAS off
4. with children present and their SAS on

For the purpose of this report, condition 1 and 2 were analysed. All seven teachers used FrontRow® Pro Digital sound-field amplification systems, consisting of a microphone, a receiver, two sensors and four speakers. The specific settings of the systems were set to the individual teacher's preferred level and were fully functional, except where noted (see Appendix D). The sound-level meters were positioned one metre from the wall on either side of the room in the centre, at a height of 1.2 meters. The results from the two sound-level meters were averaged to determine the final result for the teacher.

Teacher Interviews

Teachers undertook a questionnaire and semi-structured interview process pre and post classroom modifications. The questionnaire was based on the Modification Teacher Questionnaire which was developed and used in a previous study in New Zealand. 28 Five discrete sections were addressed: room characteristics, noise sources inside the classroom, noise sources outside the classroom, vocal effort and teaching style. (see Appendix E and F). Additional open-ended questions were added to enable teachers to discuss their current knowledge and awareness of listening environments, and their preferences in establishing their classroom environment. The interviews were recorded to enable verbatim transcription.

Classroom Acoustic Audit

The aim of the classroom acoustic audit was for teachers to identify positive aspects of their classrooms as well as potential areas for improvement. The pre-modification audits were undertaken by the teachers in March (and May for classrooms with carpet removed) and the post-modification audits were completed in November. (See Appendix G).

Pre and Post Modification Classroom Photographs

The aim of the photographs was to demonstrate the integration of the acoustic modifications into the existing teaching environment.

Classroom Maps

The aim of the classroom maps was to identify potential spaces where the acoustic modifications would have best benefit, and to also record where the modifications were placed. This assisted the team to identify and confirm the location and measurements of the different acoustic modifications.

Results

Classroom Summary

Background Noise (Classrooms 1 – 4)

The area in yellow are the levels recommended in the Design Sound Levels and Reverberation Times for Building Interiors (AS/NZ 2107:2000)

Figure 6a. Classroom 1 – No Carpet

Figure 6b. Classroom 1 – No Carpet

Figure 7a. Classroom 2 – No Carpet

Figure 7b. Classroom 2 – No Carpet

Figure 8a. Classroom 3 – No Carpet

Figure 8b. Classroom 3 – No Carpet

Figure 9a. Classroom 4 – With Carpet

Figure 9b. Classroom 4 – With Carpet
Classroom Summary

Background Noise (Classrooms 5 – 7)

Figure 10a. Classroom 5 - With Carpet  
Figure 10b. Classroom 5 – Without Carpet  
Figure 10c. Classroom 5 – Without Carpet

Figure 11a. Classroom 6 - With Carpet  
Figure 11b. Classroom 6 – Without Carpet  
Figure 11c. Classroom 6 – Without Carpet

Figure 12a. Classroom 7 - With Carpet  
Figure 12b. Classroom 7 – Without Carpet  
Figure 12c. Classroom 7 – Without Carpet
Reverberation

Figure 13. Reverberation Times for Classrooms 1, 2 and 4 (Primary School Classrooms)

Figure 14. Reverberation Times for Classrooms 3 (Secondary School Classroom)

Figure 15. Reverberation Times for Classrooms 5, 6 and 7 (Primary School Classrooms)

Recommended RT for high school classrooms is 0.5 – 0.6s, in Australian New Zealand Standard: “AS/NZS 2107:2000, Acoustics—Recommended design sound levels and reverberation times for building interiors.” Standards New Zealand, December 2000.
Table 2. Signal-to-Noise Ratio Summary

<table>
<thead>
<tr>
<th>Teacher</th>
<th>PRE-MODIFICATION</th>
<th>POST- MODIFICATION</th>
<th>DIFFERENCE PRE V POST INTERVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO SAS (dB)</td>
<td>SAS (dB)</td>
<td>DIFFERENCE (dB)</td>
</tr>
<tr>
<td></td>
<td>NO SAS (dB)</td>
<td>SAS (dB)</td>
<td>DIFFERENCE (dB)</td>
</tr>
<tr>
<td>1</td>
<td>+7</td>
<td>+4</td>
<td>-3</td>
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<td>+2</td>
</tr>
<tr>
<td>7</td>
<td>-5</td>
<td>-1</td>
<td>+4</td>
</tr>
</tbody>
</table>

Other

Classroom Audits

Figure 16. Classroom audit for all classrooms pre-modification

Figure 17. Classroom audit for all classrooms post-modification
Teacher/Classroom 1

Teachers description of listening environment (Pre-modification)

- The classroom is confusing, loud and irritating (especially for group work when the children don’t have an adult with them);
- The air-conditioner and fans create background noise;
- There is too much echo in the room;
- Noise level produced by students is too high;
- (There is a need to) reduce the movement of the tables and chairs;
- Noise inside the classroom is more intrusive than noise outside the classroom.

Classroom modifications and rationale

- **Curtains** were chosen due to their acoustic qualities. They were placed on the windows opposite the air-conditioning systems. It would be difficult to put curtain rods on the windows with the air-conditioning systems above.
- **Acoustic tiles** installed above the whiteboard and in the reading corner. As well as reducing the reverberation in the room, the tiles will also enable this space to display curriculum content.
- **Yacker Tracker** was suggested as this teacher had identified that the student’s noise was a key contributor to background noise levels.
- **Chair bags** to replace tidy trays at the students’ desk in an attempt to decrease the movement of desks and chairs throughout the day.

![Figure 18. Classroom map (with modifications) for classroom 1.](image)
Teachers description of listening environment (Post-modification)

- Comfortable

Table 3. Rating of overall listening environment by (Teacher 1)

<table>
<thead>
<tr>
<th>PRE - MODIFICATION</th>
<th>POST - MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
<tr>
<td>Poor / Acceptable</td>
<td>n/a</td>
</tr>
<tr>
<td>Why?</td>
<td></td>
</tr>
<tr>
<td>• When more than one person is talking, the noise escalates</td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

![Figure 19a. Classroom 1 pre-modification photographs.](image)

![Figure 19b. Classroom 1 post-modification photographs.](image)
Background Noise

4.2 Reverberation

4.3 Signal-to-Noise Ratio\(^\text{30}\)

\(^30\)The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher/Classroom 2

Teachers description of listening environment (Pre-modification)

• It is difficult to hear all the students
• The SAS doesn’t always work properly when walking around the classroom
• Air-conditioning contributes to the background noise

Classroom modifications and rationale

• **Curtains** to be placed on the windows opposite the air-conditioning systems, as it would be difficult to put curtain rods on the windows with air-conditioning systems above.
• **Acoustic Tiles** to be attached in the front corner adjacent to the whiteboard in an attempt to absorb some of the noise generated by the air-conditioner. It is also the largest piece of flat space in the classroom.

![Figure 23. Classroom map (with modifications) for classroom 2.](Diagram by Robin Harris)
Teachers description of the listening environment (Post Modification)

- Comfortable; clear; relaxing

Table 4. Rating of overall listening environment by (Teacher 2)

<table>
<thead>
<tr>
<th>PRE-MODIFICATION</th>
<th>POST-MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
<tr>
<td>Acceptable</td>
<td>n/a</td>
</tr>
<tr>
<td>Why?</td>
<td>Why?</td>
</tr>
<tr>
<td>● SAS is not always working properly when walking around the classroom</td>
<td>● because of the scaffolded reward system in place</td>
</tr>
<tr>
<td>● Not getting as much information re: specific kids with hearing loss</td>
<td>● the SAS makes it very clear</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Background Noise

Figure 25a. Classroom 2 – No Carpet

Figure 25b. Classroom 2 – No Carpet

Reverberation Time

Figure 26. RT for Classroom 2 pre-modification and post-modification

Signal-to-Noise Ratio\textsuperscript{31}

Figure 27a. Teacher 2 pre-modification SNR

Figure 27b. Teacher 2 post-modification SNR

\textsuperscript{31} The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher/Classroom 3

Teachers description of listening environment (Pre-Modification)

- The classroom is comfortable and relaxing
- The classroom also tends to echo

Classroom modifications and rationale

- **Carpet Matting.** As this classroom has a small number of students of high school age, the teacher was happy to take responsibility for maintaining the carpet matting (as per the Principal's request).
- **Cushions.** The teacher was keen for the students to undertake a project to make the cushion covers
- **Curtains,** like the cushion covers, the teacher was keen for the students to undertake a project to sew together the curtain material
- **Acoustic Tiles** were to be placed underneath the air-conditioning units on the back wall to help absorb some of the noise as well as decreasing the reverberation in the room.

Figure 28. Classroom map (with modifications) for classroom 3. Diagram by Robin Harris
Teachers description of listening environment (Post-Modification)

- Comfortable

Table 5. Rating of overall listening environment by (Teacher 3)

<table>
<thead>
<tr>
<th>PRE-MODIFICATION</th>
<th>POST-MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
<tr>
<td>Good</td>
<td>n/a</td>
</tr>
<tr>
<td>Why?</td>
<td></td>
</tr>
<tr>
<td>● because of the SAS</td>
<td></td>
</tr>
<tr>
<td>● I have only 12 kids</td>
<td></td>
</tr>
<tr>
<td>● There is plenty of space to do different activities</td>
<td></td>
</tr>
<tr>
<td>● Never a lot of noise during (classroom) rotations</td>
<td></td>
</tr>
</tbody>
</table>

Figure 29a. Classroom 3 pre-modification photographs.

Figure 29b. Classroom 3 post-modification photographs.
Background Noise

Figure 30a. Classroom 3 – No Carpet

Figure 30b. Classroom 3 – No Carpet

Reverberation Time

Figure 31. RT for Classroom 3 pre-modification and post-modification

Signal-to-Noise Ratio

Figure 32a. Teacher 3 pre-modification SNR

Figure 32b. Teacher 3 post-modification SNR

The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher/Classroom 4

Teachers description of listening environment (Pre-modification)

- air-conditioning and air-freshener contribute to background noise
- lawn mowing and leaf blowing (outside) contribute to background noise
- if children are not listening, they are distracting other children from learning.
- Generally, the listening environment is comfortable and clear

Classroom modifications and rationale

- **Curtains** were requested on the window next to interactive whiteboard as a lot of teaching time is spent in this part of the classroom. The teacher also finds the glare challenging in this space.
- **Acoustic Tiles** on small discreet wall panels around the classroom. As well as reducing reverberation, the teacher saw this as an opportunity to display visual information linked to the curriculum.
- **Yacker Tracker** to help reduce some of the internal noise within the classroom.
- **Cushions** to be placed in the reading corner.
- **Splitters and headphones** were chosen to enable several children to use the computers at once while reducing the internal classroom noise.

Figure 33. Classroom map (with modifications) for classroom 4. Diagram by Robin Harris
Teachers description of the listening environment (Post-Modification)

- Comfortable and loud
- Clear (because of the SAS)

Table 6. Rating of overall listening environment by (Teacher 4)

<table>
<thead>
<tr>
<th>PRE-MODIFICATION</th>
<th>POST-MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
<tr>
<td>Good</td>
<td>n/a</td>
</tr>
<tr>
<td>Why?</td>
<td>Why?</td>
</tr>
<tr>
<td>● Sound travels well thanks to my SAS</td>
<td>● The air-conditioner is not too bad (noise-wise)</td>
</tr>
<tr>
<td>● Kids like it when the SAS is being used</td>
<td>● I can tell by the children’s body language and their progress with work</td>
</tr>
</tbody>
</table>

Figure 34a. Classroom 4 pre-modification photographs.  
Figure 34b. Classroom 4 post-modification photographs.
Background Noise

Figure 35a. Classroom 4 – With Carpet

Figure 35b. Classroom 4 – With Carpet

Reverberation Time

Figure 36. RT for Classroom 4 pre-modification and post-modification

Signal-to-Noise Ratio

Figure 37a. Teacher 4 pre-modification SNR

Figure 37b. Teacher 4 post-modification SNR

The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher/Classroom 5

Teachers description of listening environment prior to carpet removal (Pre-modification - March)

- The classroom is clear and comfortable
- The buzz / crackle from the SAS is sometimes irritating;
- Computer and air-conditioner contribute to background noise;
- External noise sources, such as leaf blowing, noise from other classrooms, corridors, and student traffic on decks contributes to background noise.

Teachers description of listening environment following carpet removal (Pre-modification - May)

- The classroom is loud and echoes
- The children notice the lawn mowing and leaf blower
- The student noise level is too high – they are all talking over the top of one other.
- The air-conditioner is the most obtrusive noise

Classroom modifications and rationale

- **Netting and egg cartons** Once the carpet was removed, echo was more of an issue. Netting and egg cartons was decided upon to help reduce the echo.
- **Acoustic tiles** were decided upon for the back wall to decrease reverberation and reduce noise transference from adjoining classroom
- **Chair and table stoppers** noise generated by furniture movement now evident
- **Splitters and Headsets** for the computers as they were often used during rotations and interrupt the other groups

![Diagram of Classroom](image)

*Figure 38. Classroom map (with modifications) for classroom 5.*
Teachers description of the listening environment (Post-Modification)

- It does echo, but it is comfortable at the same time.

Table 7. Rating of overall listening environment by (Teacher 5)

<table>
<thead>
<tr>
<th>PRE-MODIFICATION</th>
<th>POST-MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acceptable</th>
<th>Poor</th>
<th>Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why?</td>
<td>Why?</td>
<td>Why?</td>
</tr>
<tr>
<td>• can’t change what is happening outside</td>
<td>• too much echo in the room</td>
<td>• Despite the air-conditioner being still too loud and no sound-proofing between walls, it is better than it was before</td>
</tr>
<tr>
<td>• older kids running on the verandah and knocking on the windows</td>
<td>• gardener doing maintenance during class time</td>
<td></td>
</tr>
<tr>
<td>• air-conditioning</td>
<td>• students constantly talking over each other</td>
<td></td>
</tr>
</tbody>
</table>

Figure 39a. Classroom 5 pre-modification photographs.  
Figure 39b. Classroom 5 post-modification photographs.
Background Noise

**Figure 40a.** Classroom 5 - With Carpet

**Figure 40b.** Classroom 5 – Without Carpet

**Figure 40c.** Classroom 5 – Without Carpet

Pre Modification  |  Post Modification

Reverberation Time

**Figure 41.** RT for Classroom 5 pre-modification (carpet and no carpet) and post-modification (no carpet)

Signal-to-Noise Ratio

**Figure 42a.** Teacher 5 pre-modification SNR (without carpet)

**Figure 42b.** Teacher 5 post-modification SNR

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The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher/Classroom 6

Teachers description of listening environment prior to carpet removal (Pre-Modification - March)

- The classroom is a confusing, harsh and loud listening environment.
- The air-conditioning prevents it from being a better listening environment.
- Computers contribute to the background noise.
- External noise sources such as lawn mowing, noise from other classrooms and student traffic on the decks contributes to background noise.

Teachers description of listening environment following carpet removal (Pre-Modification - May)

- The classroom listening environment is loud, harsh, irritating and it echoes.
- The change in the flooring meant that the noises that are not wanted (eg. air-conditioning) are amplified.

Classroom modifications and rationale

- **Curtains** to reduce the reverberation in the room. To be placed on the far wall as it was not possible to install curtain rods under the air-conditioning units
- **Acoustic tiles** above the whiteboard to reduce echo and reduce noise transference from the classroom next door
- **Rubber matting** in spaces with high foot traffic to reduce the background noise
- **Egg Cartons** and **Netting** to decrease echo

![Diagram by Robin Harris](image)

Figure 43. Classroom map (with modifications) for classroom 6. (the
Teachers description of the listening environment

• Did not complete interview

Table 8. Rating of overall listening environment by (Teacher 6)

<table>
<thead>
<tr>
<th>PRE-MODIFICATION</th>
<th>POST-MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
<tr>
<td>Acceptable</td>
<td>Very Poor / Poor</td>
</tr>
<tr>
<td>Why?</td>
<td>Why?</td>
</tr>
<tr>
<td>• have SAS</td>
<td>• because of the changes in the flooring, noises you don’t want (to hear) are amplified</td>
</tr>
<tr>
<td>• small number of children</td>
<td></td>
</tr>
<tr>
<td>• the air-conditioner stops it from being better</td>
<td></td>
</tr>
<tr>
<td>Trip 03 (November)</td>
<td>Did not complete interview</td>
</tr>
</tbody>
</table>

Figure 44a. Classroom 6 pre-modification photographs.  
Figure 44b. Classroom 6 post-modification photographs.
Background Noise

Figure 45a. Classroom 6 - With Carpet

Figure 45b. Classroom 6 – Without Carpet

Figure 45c. Classroom 6 – Without Carpet

Pre Modification

Post Modification

Reverberation Time

Figure 46. RT for Classroom 6 pre-modification (carpet and no carpet) and post-modification (no carpet)

Signal-to-Noise Ratio

Figure 47a. Teacher 6 pre-modification SNR (without carpet)

Figure 47b. Teacher 6 post-modification SNR

The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher/Classroom 7

Teachers description of listening environment prior to carpet removal (Pre-modification - March)

- The classroom is comfortable but echoes
- Background noise created from: verandahs, adjoining classroom, fans, and AC

Teachers description of listening environment following carpet removal (Pre-modification - May)

- The classroom is confusing (harder to hear children when they speak), loud, echoes, and is harsh. It is clear when the SAS is used.
- Background noise is created from outside with other children on the verandah. The adjoining classroom can be heard more now.
- The noise level produced by the students in the classroom is too high.

Classroom modifications and rationale

- Curtains to reduce the amount of echo in the room and to reduce kids tapping on the windows as they walk by.
- Acoustic Tiles to be placed beside and under the whiteboard to reduce the amount of reverberation as this was the largest flat space available.
- Yacker Tracker to reduce student-generated noise in the classroom.
- Cushions in the reading area to absorb some reverberation.
- Egg Cartons and Netting to decrease echo

Figure 48. Classroom map (with modifications) for classroom 7. Diagram by Robin Harris
Teachers description of the listening environment (Post-modification)

- Comfortable; loud; clear

Table 9. Rating of overall listening environment by (Teacher 7)

<table>
<thead>
<tr>
<th>PRE-MODIFICATION</th>
<th>POST-MODIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
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</table>

**Poor**

**Why?**
- the neighbouring classroom – can hear every step, every word
- fans and air-conditioner

**Poor**

**Why?**
- too much noise from the students - I find it hard to hear (them)
- more echoey – the carpet muffled the sound, but with the lino you hear it
- too much noise outside

**Good**

**Why?**
- the vast majority of the kids listen really well

Figure 49a. Classroom 7 pre-modification photographs.

Figure 49b. Classroom 7 pre-modification photographs.
Background Noise

![Figure 50a. Classroom 7 - With Carpet](image1)

![Figure 50b. Classroom 7 – Without Carpet](image2)

![Figure 50c. Classroom 7 – Without Carpet](image3)

Pre Modification

Post Modification

Reverberation Time

![Figure 51. RT for Classroom 7 pre-modification (carpet and no carpet) and post-modification (no carpet)](image4)

Signal-to-Noise Ratio\(^{36}\)

![Figure 52a. Teacher 7 pre-modification SNR (without carpet)](image5)

![Figure 52b. Teacher 7 post-modification SNR](image6)

\(^{36}\) The unoccupied noise levels were converted to occupied levels by adding 10dB to each unoccupied measurement (Crandell and Smaldino 1995b).
Teacher Questionnaires

The results from the semi-structured interviews were examined under three key project questions:

1. Do the participants have an increased understanding of listening environments?
2. Do the participants have an increased understanding to the barriers to listening environments?
3. Do participants have increased awareness of how to improve the listening environment?

The key themes from the participants will be reported below, with specific quotes from participants used to highlight examples of how their understanding and awareness has changed.

Do the participants have an increased understanding of listening environments?

Two key themes emerged from the participants in regards to increased understanding of listening environments.

1. Good hearing and listening environments support better learning;
2. Teaching practice contributes to the listening environment.

Participants discussed examples of how they had increased their understanding of listening environments:

Good hearing and listening environments support better learning

- “I think it’s very important that they’d (the children) be able to hear and clearly (too) to make sure that they’re getting the best out of the learning environment as well.”

- “Acoustics in your classroom can have a direct effect on the students’ learning ability – if they can clearly hear me even with their impairment, they’ll be able to understand how to do things and they’ll have the confidence to do them.”

- “Obviously (the acoustics) have a direct effect on their learning ability because if the acoustics in the class aren’t good, then they won’t be able to hear, especially since we have such a high number of children that have hearing difficulties, acoustics are even more important in the classroom.”
Teaching practice contributes to the listening environment

• “Having it in the kids’ minds that it’s an absolute quiet space I think is essential. When you get started then you really have to have absolute quiet in the environment so we can build from there.”

• “It’s vitally important (to have a good listening environment) so it comes down to the rules and it comes down to the set out of the classroom and the adjustments as well.”

Do the participants have an increased understanding to the barriers to listening environments?

Five key themes emerged in regards to the participants understanding of the barriers to the listening environment:

1. Noise from school maintenance;
2. Children’s behaviour;
3. Noise from adjoining spaces;
4. Noise from air-conditioning;
5. Echo in the room.

Participants discussed examples of how these barriers impacted on the listening environment:

Noise from school maintenance

• “With outdoor noise impacting… so if people were constantly cutting the grass all the time… that would impact as well.”

• “…because the kids want to know who’s out on the verandah, they want to know and before we got our new groundskeeper they’d all be talking about it. So external noises actually made internal noise because we’d all be talking about what’s going on outside or someone’s peeping in there and “oh, this person’s out there Miss, you’ve got to go and get them!” and so external noises caused internal noise.”

Children’s behaviour

• “Kids all want to have their say and they all want to be able to say it there and then, and it does matter if someone else is speaking they want to say it and if you ask them to wait for their turn, they’ll get cranky about it.”

• “Poor listening environment.. if you have the children uncontrollable it’s yelling across the room, talking quite loudly, not using their hand to answer questions, it becomes chaos… it’s that chaotic yelling, yelling out answers.”
Noise from adjoining spaces

- “Classrooms being so close together, and not having those sort of sound-proof sort of walls… it tends to effect the environment in here…. You can hear them running around and it kind of creates that atmosphere in here…”
- “Corridors is a big one, and then that’s just that, I’ve told you before about that boom, boom, boom noise you can hear.”
- “Video or music (from next door) Kids always complain because we will be sitting here and they’ll say “Miss, why can’t we watch movies?” But yeah, that’s the big thing, that we can always hear (next door).”

Noise from air-conditioning

- “Whereas now (we have a) ‘good’ (listening environment) because we’ve got, it’s not ‘very good’ because of the air-conditioning is still very loud and we can’t not have it on because it’s too hot with just the fans.”

Echo in the room

- “Her room is just like hard floors…. lots and lots of kids…. and it was loud… I guess when you have obviously too many kids talking at the same time… you could just tell that, you know, none of that noise was going anywhere it was all just going round and round the room…”

Do participants have increased awareness of how to improve the listening environment?

Five key themes emerged in regards to the participant’s awareness of how to improve listening environments:

1. Scheduling of school maintenance;
2. Acoustic adjustments (inside the classroom);
3. Behaviour management (school-wide positive behaviour support);
4. Sound-field Amplification Systems;
5. Reduce noise from adjoining spaces.

Participants discussed examples of their awareness of improving the listening environment:

Scheduling of school maintenance

- “Even when he (the groundskeeper) was still here he tended to do more (mowing / leaf blowing) before school – that changed dramatically, there was no cutting grass or blowing (leaves) during school time around my classroom.”
• “Lawn mowing – used to be noise from the other classrooms but now it’s been good.”

Acoustic adjustments (inside the classroom)

• “The boards (acoustic tiles) being put in place has made a huge difference… with hearing as well I think not just those kids (with hearing loss) but for all of them. I’m not hearing as many “What? What Miss?” like they’re and I can’t hear (Teacher) as much now… I mean, she is sometimes is still a bit loud still but it’s made a huge difference in that way.”

• “And I got headphones for the computers… and we love them and they’re attachable so they can all listen to the same thing. It’s just made my life and their life I think so much better because they, I can have you know, three or four people on a computer and they’re not all fighting cause they can all hear their own individual thing.”

• “If I could get more of those kind of chairs (the ones with rubber on the bottom). ‘Cause those ones work fine and we’ve stopped that loud screeching and the slamming of chairs and what not so that’s been really helpful as well”

• “To reduce the amount of background noise – I’ve put curtains up on that side, you guys have given me curtain on the other side running across the room. I’ve put up lots of things that will soak it (the noise) up like the flags, you guys have put the … acoustic tiles on the corner of the room and I really had it (the acoustics) in mind when I’ve designed this time around like a lot of these things to soak up the sound and hopefully it’s made a bit of a difference…”

• “…..with that whole window covered, they used to always look out there if they saw kids walking around, or whatever…they’d go out and call out. So with the whole wall covered they just don’t even worry about anything. It’s like we’re not part of the outside world anymore because it’s so dark and they like that. They say “Miss, shut the door” and they don’t want anyone else around.”

• “Obviously improved (the) environment, like as soon as those curtains came… like when they were so excited for it and they would keep saying, “Keep it like this Miss, keep those things on the walls” It felt nicer in here with the stuff on there (the walls and windows).”

Behaviour management (school-wide positive behaviour support)

• “I say my main rule is that we do not speak unless I’ve asked you to and they have put their hand up, the way I’ve got them to do that is through a tick system we have in our class and being really heavy especially during term one with rewarding those children who are sitting quiet and working and not talking.”
• “The kids know they have to be very quiet throughout the whole day to use their hand and use their manners... the way the classroom is set up. I’m always walking around the room and that the kids can always hear me.”

• “I have a small class size and the relationship with my students is better so they know to stay quiet.”

• “When it comes to student noise, obviously I try to engage those students more, I try to make those students who aren’t engaged my little helpers and make them feel more empowered so I’m trying to eliminate that classroom noise. Sitting them in close proximity to the teacher.... Certain things like that.”

Sound-field Amplification Systems

• “Also just wearing the sound-field, the system and having the speakers around the room, has obviously helped as well.”

• “I have noticed a difference obviously with the SAS when I use the SAS. It has improved listening.”

Reduce noise from adjoining spaces

• “I don’t have any of that outside noise from people walking past as much so it does, it blocks out that noise, but also because kids can’t see through it makes a difference as well, they don’t bother trying to yell in”

Table 10. Teacher perception of overall listening environment

<table>
<thead>
<tr>
<th></th>
<th>PRE-INTERVENTION</th>
<th>POST-INTERVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trip 01 (March)</td>
<td>Trip 02 (May)</td>
</tr>
<tr>
<td>Teacher 1</td>
<td>Poor / Acceptable</td>
<td>Good</td>
</tr>
<tr>
<td>Teacher 2</td>
<td>Acceptable</td>
<td>Very Good</td>
</tr>
<tr>
<td>Teacher 3</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Teacher 4</td>
<td>Good</td>
<td>Good / Very Good</td>
</tr>
<tr>
<td>Teacher 5</td>
<td>Acceptable</td>
<td>Poor (No Carpet)</td>
</tr>
<tr>
<td>Teacher 6</td>
<td>Acceptable</td>
<td>Very Poor/Poor</td>
</tr>
<tr>
<td>Teacher 7</td>
<td>Poor (Carpet)</td>
<td>Poor (No Carpet)</td>
</tr>
</tbody>
</table>

* A post-modification interview was not obtained from Teacher 6
Discussion

The project aimed to explore if the implementation of low cost acoustic modifications can a) enhance the acoustic parameters within classrooms, and b) build teacher’s understanding and capacity to make modifications to improve their classroom listening environment. These two questions will be explored separately in the discussion and results section as the acoustic parameter changes relate to the quantitative results and the teachers’ understanding and capacity to make modifications was explored through the qualitative process.

a) Did the project modifications enhance the acoustic parameters within classrooms?

The sound-level meter measurements indicated that the background noise levels of the all the classrooms, without air-conditioning, were within the levels recommended in the Australian and New Zealand Standard. However, those levels were exceeded in all seven classrooms when the air-conditioning was turned on. The background noise levels decreased slightly in five of the seven classrooms following the implementation of the acoustic modifications. Reverberation times reduced in all classrooms following the acoustic intervention. One classroom (classroom 4), remained within the recommended standard pre and post modification, and two classrooms (one primary and one secondary) fell to be within the recommended standard following the modifications. Reverberation times increased in all classrooms that had their carpet removed and decreased following the implementation of the acoustic modifications. One of these classrooms (classroom 5) fell outside the recommended standard following the removal of the carpet. Similar results were found when teachers both used or didn’t use their sound-field amplification systems, with an increase in the signal-to-noise ratio in six out of the seven teachers following the implementation of the acoustic modifications. However, the minimum signal-to-noise ratio of 15dB, which was recommended in the literature, was unable to be achieved by any of the teachers.

b) Did the project (process) build teacher’s understanding and capacity to make modifications to improve their classroom listening environment?

The project processes led to teacher’s having an increased understanding of listening environments. Teachers became aware that improving the listening environment could lead to better learning for the children in their class. Furthermore, that their own teaching practice was pivotal in obtaining a positive listening environment. Teachers identified an increased awareness of the barriers to a positive listening environment in five key areas: noise from school maintenance, children’s behaviour, noise from adjoining spaces, noise from air-conditioning, and echo in the room.

 Teachers’ awareness of how to improve the listening environment increased through their participation in the project. These included scheduling of school maintenance, acoustic adjustments (inside the classroom), behaviour management, sound-field amplification systems and reducing noise from adjoining

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spaces. Whilst all teachers had modifications fitted in their classrooms, the modifications were not the only ways teachers’ understood they could improve their listening environments. One teacher, for example identified a link between the implementation of the School-wide Positive Behaviour Support (behaviour management) processes and controlling the listening environment in their classroom.

A pleasing aspect of the project was the teachers taking ownership over the modifications in their classroom. This was evidenced through teachers assisting with the placement and installation of their own acoustic tiles and advocating for their curtains to be installed. One teacher even made additional acoustic modifications with resources he found throughout the school and community (eg. additional curtains, flags). Another teacher involved her students by painting and decorating the egg cartons which were then placed in netting. It was an excellent example of talking to her students about noise and how to improve their listening environment.

Background noise generated from external sources may be conveyed through ducts, through small cracks and openings, through windows and doors, walls and roofs, and through the building structure itself. Several teachers identified noise originating from adjoining classrooms as having an impact on their classroom listening environment. Of particular note were the classrooms separated by concertina doors (classrooms 1, 2, and 7) where the doors were not acoustically treated and in some cases were not able to close properly. Several teachers also identified noise originating from student foot traffic on the verandahs outside their classrooms. The verandahs, which were made of wooden floorboards, made considerable noise when groups of students walked by. Attempts have been made by the school to improve both these issues. Several teachers identified noise originating from garden and lawn maintenance during school hours. Whilst this maintenance is necessary, the teachers felt that it frequently occurred during key learning times (usually in the morning). During the final data gathering trip in November, teacher’s reported that these tasks no longer impacted on their teaching and listening environment.

All seven teachers commented on the intrusive noise of the air conditioners whilst teaching. It is important to acknowledge that given the high temperature and humidity levels on Mornington Island, air-conditioning is used throughout most of the year. A recent study in South Australia found that when 17 classrooms with conventional air-conditioners changed to newer split-level systems, noise levels reduced by an average of 13dB. Two teachers identified student noise around computers as being disruptive to the class, citing an increase in noise levels when more than one student was using the computers at any one time. The teachers reported that installing splitters and additional headphones to computer stations decreased the noise when having students working at the computers.

38 Mornington Island State School made arrangements to purchase and install three acoustically treated concertina doors (separating individual classrooms). However, following a long and exhaustive exercise in fell through because the suppliers were unwilling to travel to Mornington Island to install the doors. Another example of how schools in remote areas of Australia face enormous obstacles in trying to improve the classroom acoustics.

39 In an attempt to reduce this, the school purchased rubber matting to run along the length of the verandahs. While this was outside the timing of the project, it was another example of how the school leadership was proactive in attempting to reduce external noise sources. Deadly Ears is hoping to follow up with teaching staff to determine the effectiveness of this measure.

Acoustic tiles are designed to reduce the reverberation time in enclosed spaces. They can also provide a convenient place for the display of curriculum items and student artwork. Whilst this decreases the acoustic effectiveness of the tiles, the project team was conscious that it is a requirement for curriculum material to be displayed.

The addition of ‘soft and absorbent’ material such as the curtains contributed in reducing the reverberation in the classrooms. Similar to the acoustic tiles, some teachers used the curtain space to display curriculum material and artwork, potentially reducing the acoustic benefits of the curtains. The curtains also provided two unanticipated yet positive outcomes: a) students from other classes paid less attention to disrupting the classroom as they were unable to see the students’ inside and b) one teacher felt that the curtains made the classroom ‘less bright’, providing a somewhat calming effect for the children.

Carpet quietens footfall and furniture noise, absorbs sounds, and makes classrooms less reverberant. A significant factor in terms of reverberation time was whether the classroom had carpet or not. The results indicated that the removal of the carpet increased the reverberation time significantly and the teacher’s perceptions of noise within the classroom also changed. The results indicated that the removal of the carpet made it a more difficult listening environment, as evidenced by both the qualitative and quantitative measures. The three teachers who had the carpet removed in their classrooms commented that there was more echo in their classrooms, making teaching and communicating more challenging. However, following the implementation of the acoustic modifications, two of these three teachers rated their overall listening environments more positively. The project demonstrated that carpet makes a significant contribution to decreasing the reverberation within the classroom. However, it would appear that this is not a practical solution in the current context for Mornington Island State School. Studies have shown that normal hearing children’s auditory processing capabilities are adversely affected by long reverberation times. Long reverberation times also can have a significant impact on teachers with a Finnish study finding that reverberation times greater than 0.5s lead to greater working stress (as measured by heart rate).

The benefit of teachers using sound-field amplification systems are well documented, both for students and teachers. It was evident that the teachers were proficient in the use and knowledge of their sound-field amplification systems. The expectation of sound-field amplification system use is clearly documented within the school’s Standard of Practice ‘Classroom Expectations - Intentionally Inviting and Engaging Classrooms’. All of the teachers were able to identify the benefits of using sound-field amplification for both their class and their teaching practice.

41 Unfortunately a post-modification interview was not obtained from teacher 6.
45 Heeney, M. F. (2007) found that students in the SFA classrooms showed significantly greater improvement in listening comprehension, reading comprehension and reading vocabulary as well as improvements in mathematics.
An explanation as to why higher signal-to-noise ratios were not achieved by any of the teachers may be due to the possible adverse effect of teachers using their sound-field amplification systems in loud, reverberant classrooms. The signal-to-noise levels were negative for teacher three and seven (i.e., the background noise was louder than the teacher’s voice) which suggests that these teachers would be very difficult for the students to understand. A positive result was that there was an improvement in the signal-to-noise ratio in almost all classes when teachers both used their SASs and when they did not following the acoustic intervention. Nonetheless, the fact that none of the teachers were able to achieve the recommended levels is concerning as research has indicated that this may adversely affect speech intelligibility for normal hearing children, let alone children with a conductive hearing loss.\(^46\)\(^47\) In research conducted on normal hearing children, as the signal-to-noise ratio became more negative, their speech recognition performance deteriorated.\(^48\) A further study found that the more reverberant the environment, the better the signal-to-noise ratio required, and the younger the child, the better signal-to-noise ratio was required.\(^49\) Young children need a higher signal-to-noise ratio because they have a more limited working memory capacity and poorer speech recognition-in-noise than young adults.\(^50\)

If children are spending additional effort in listening, they have limited resources available to dedicate to additional tasks, which ultimately compromises their overall learning.\(^51\) This has proven increasingly problematic when combined with factors such as having a hearing impairment\(^52\) and being taught in a language that is not your first language.\(^53\)

While the project has demonstrated that low cost acoustic modifications can make a difference to the acoustic parameters within classrooms, it is clear that there is much to do to ensure that all classrooms fall within the recommended levels suggested in the Australian and New Zealand Standard and outlined in the current research. It has highlighted the acoustic benefits of various low-cost resources as well as the challenges associated with reverberation and the disruptive nature of noise originating from both inside and outside classrooms. The process undertaken in the project has successfully increased teacher’s understanding and capacity to make modifications to improve their classroom listening environment. This was demonstrated by the enthusiasm displayed with the entire process as well as the ownership they took over the resources in their classrooms. The project has been a valuable collaboration between the Deadly Ears Program and Mornington Island State School which will hopefully enable those children, who so often experience fluctuating hearing loss due to otitis media, to participate more effectively in the curriculum.

Recommendations

1. Improving the Listening Environment – Acoustic Modifications

The following recommendations are made with primary consideration to the acoustic qualities in the classrooms. The project team acknowledge that there are logistic and financial implications for many of these recommendations.

Room Characteristics

Acoustic Tiles
- Classrooms with reverberation times outside the recommended standards have strategically placed acoustic tiles installed.

Curtains
- Classrooms with reverberation time outside the recommended standards have curtains installed.

Furniture
- That chair stoppers and sliders for furniture in rooms with hard surfaces.
- That chair bags be considered to replace tidy trays.
- When new furniture is due to be purchased, consider the material of the chair and table legs to minimise noise production on the lino flooring.

Noise Sources – Inside the Classroom

Air Conditioning
- Replace existing air-conditioners units with quieter split system units.
- Regular servicing and maintenance is completed with the existing air-conditioning units to ensure are operating as efficiently and quietly as possible.

Computers / iPads
- Continue to use the headphones and splitters to ensure noise is confined to those using the computers / iPads;
- Ensure computers are turned off when they are not being used.

Noise Sources – Outside the Classroom

Outdoor Maintenance
- That outdoor maintenance continue to be completed outside of key learning times.

Verandas (foot traffic)
- Rubber matting be installed on veranda floorboards outside of the classrooms.

Adjoining classrooms
- Acoustically treated concertina doors be installed to replace the current concertina doors separating classrooms.

Vocal Effort
Sound-field Amplification
- That all teachers continue to use their sound-field amplification systems in accordance with the schools’ Standards of Practice;
- That there be funding prioritised to support the regular maintenance of the sound-field amplification systems;
- That teaching staff receive regular in-servicing and trouble-shooting advice from the Special Education Teacher and/or FrontRow® consultant and/or Deadly Ears staff member and/or Australian Hearing Audiologist (especially for new teaching staff);
- That an easy-to-understand laminated ‘How To’ and ‘Troubleshooting’ guide be placed on the wall above every sound-field amplification system unit.

2. Improving the Listening Environment – Processes

- For the teachers that were not involved in the Classroom Acoustics Project, follow a similar process in utilising the questionnaire to identify the key listening challenges in their classrooms, and support those staff to identify some of the potential solutions to improve their listening environment. Where possible, utilise Sound Level Meter apps (available on smart phones) to measure background noise levels in their classrooms, to enable a rough comparison to the recommended standards (AS/NZ 2107:2000).
- Discuss the findings from the Classroom Acoustics project with the Principal to encourage continuity of these processes for classrooms that have not been involved thus far.

3. Improving the Listening Environment – Sharing Beyond the School

- The Classroom Acoustics report is shared with the Deadly Ears, Deadly Kids, Deadly Communities steering committee representatives from the Department of Education, Training and Employment (DETE). This group may be able to provide advice on dissemination of the information, state and regional priorities, and linkages with the Facilities Department within DETE.
- The approaches utilised within the Classroom Acoustics project is documented within the Deadly Kids Can Listen and Learn online course – for sharing with those enrolled in the course with an interest in improving listening environments in the school/s they work with.
- The results from the Classroom Acoustics Project be shared through forums such as otitis media and conductive hearing loss conferences, health professional and education conferences, and through other channels identified as relevant by the Steering Committee and Deadly Ears Director.
- The processes of supporting schools’ with their listening environments are shared with the broader Deadly Ears program to enable more schools to engage in collaborative processes to improve their classroom acoustics. Deadly Ears team members will need to identify their gaps in knowledge and skill and partner with members from the Classroom Acoustics team for support.
Acknowledgements

The Deadly Ears team would like to thank the extraordinary staff at Mornington Island State School for assisting us with every aspect of the project. Specifically, John Bosward (Principal), Prue Ruler (Deputy Principal), Rachel Haley (Advisory Visiting Teacher for Hearing Impairment) and Prudence Marler (Learning Support Teacher) as well as the amazing staff and students at Mornington Island State School.

We would especially like to thank the teachers who were kind enough to give of their valuable time to participate in the project: Claire Allen, Teneale Briggs, Sandy Lewis, Tara O’Brien, James Da Silva, Aron Smith, and Melissa Sparrow.

Back Row: James Da Silva, Aron Smith, Claire Allen, Melissa Sparrow, Teneale Briggs, Sandy Lewis, Rachael Haley, Josephine Ferguson, Karyn Taylor
Front Row: Jodie Booth, Prudence Marler, Tara O’Brien, Simon McCormack

Project Team

Emily Bishop
Jodie Booth
Josephine Ferguson
Bonny Marsh
Simon McCormack
Jillian Scholes
Karyn Taylor

With thanks to:

- Matthew Brown - Director, Deadly Ears
- Dr Wayne Wilson - University of Queensland
- Dr Jenny Ziviani - University of Queensland/Queensland Health
- Rebecca Bull - Renwick Centre for Research and Professional Education
References


Heeney, M. F. (2007). *Classroom sound field amplification, listening and learning.* University of Newcastle, NSW, Australia, Newcastle.


Appendix A

Mornington Island – Hearing Screening

The hearing screening consisted of assessments in otoscopy, tympanometry and pure tone audiometry (if the child was old enough and able to be conditioned). A child did not pass the screening assessment if they failed one or more of these assessments in one or both ears. Those children who did not pass the initial hearing screen in February had a review hearing screen in June. Those children who failed two consecutive screens, or who required immediate medical intervention, were referred for appropriate intervention. The results of these assessments are as follows:

**Results from the Initial Hearing Screening (February)**

- Number of children assessed: 195
- Number of children passed: 54 (28%)

**Results from the Review Hearing Screening (June)**

- Number of children assessed: 111
- Number of children passed: 10 (9%)

An interesting observation is the relatively large percentage of children with middle ear pathology (Type B tympanograms) at the review screen. This resulted in the low number of ‘pass’ results. Despite this there was little change in the audiometry results between the two screens indicating that this did not significantly influence the overall relative hearing levels. It can be speculated that due to the time of year, these results may have been the result of winter colds and associated ailments.

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44 A failed otoscopy test consisted of a wet or dry perforation, discharge in the ear canal, a red/bulging ear drum and/or a foreign body in the ear canal. A failed tympanometry test consisted of a Type B tympanogram (consistent with middle ear pathology) or a Type C tympanogram (consistent with a blocked Eustachian tube). A failed audiometry test consisted of air conduction levels greater than 25dBHL at 1kHz and/or 4kHz.
45 Referral for further medical management were made as per the Recommendations for Clinical Care Guidelines for the Management of Otitis Media.
46 This data cannot be considered as prevalence data but rather those children who attended the school and childcare during the dates of screening.
Appendix B
Mornington Island – ENT Clinic and Surgery

Results from ENT Clinic and Surgery (February)

![Clinic Findings (n=110 ears)]

- Acute Otitis Media (aOM): 16%
- Chronic Suppurative Otitis Media (CSOM): 16%
- Otitis Externa (OE): 8%
- Perforation: 14%
- Retraction: 19%
- No Abnormality Detected (NAD): 24%
- Wax: 7%
- Pneumonic Otitis Externa: 2%
- Otitis Media with Effusion (OME): 18%
- Other: 2%

![Procedures]

- Adenoidectomy: 19%
- Myringotomy: 30%
- Myringoplasty: 5%
- Removal of Foreign Body: 11%
- Minor nose surgery: 4%
- EUA: 35%

Results from ENT Clinic and Surgery (August)

![Diagnosis (n=119 ears)]

- Acute Otitis Media (aOM): 24%
- Chronic Suppurative Otitis Media (CSOM): 11%
- Otitis Externa (OE): 8%
- Perforation: 13%
- Retraction: 13%
- No Abnormality Detected (NAD): 99%
- Wax: 7%

![Procedures (n=19)]

- Adenoidectomy: 19%
- Myringotomy: 55%
- Myringoplasty: 10%
- Removal of Foreign Body: 5%
- EUA: 18%

Diagnosis

- **Acute Otitis Media (aOM)** is the presence of fluid behind the ear drum plus at least one of the following: bulging ear drum; red ear drum; recent discharge of pus; fever; ear pain

- **Chronic Suppurative Otitis Media (CSOM)** is characterised by persistent ear discharge through a perforation (hole) in the ear drum (from 2 weeks to 12 weeks)

- **No Abnormality Detected (NAD)** in the outer ear or ear drum

- **Otitis Media with Effusion (OME)** is the presence of fluid behind the ear drum without any acute symptoms.

- **Otitis Externa (OE)** is an infection of the ear canal associated with pain, swelling and sometimes discharge

- **A Perforation** is a hole in the ear drum

- **A Retracted ear drum** is caused by a blocked Eustachian tube (usually associated with a mild hearing loss)

- **Wax** is a sticky substance in the ear canal that traps dirt and occasionally blocks the sound reaching the ear drum

Procedure

- **Adenoidectomy** is a surgical operation to remove the adenoid tissue at the back of the nose

- **Examination Under Anaesthetic** involves a closer inspection of the ear while the child is under an anaesthetic

- **A grommet** is a small tube surgically placed across the ear drum to re-establish ventilation to the middle ear

- **A Myringoplasty** is a surgical operation to repair a damaged ear drum

- **A Myringotomy** A surgical incision in the ear drum to drain fluid

- **Removal of a Foreign Body** is a surgical procedure to remove an object from the ear canal
# Appendix C

## Classroom Acoustic Modifications

*Prices as at March – May 2013*

### Curtains*

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtain material:</td>
<td>190.00</td>
<td>/unit</td>
</tr>
<tr>
<td>• available in a variety of colours and designs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Block out material (including the printed edge)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Curtains were sewn with rod pockets:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• prevented curtain from falling or being pulled down</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block out material (including the printed edge)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Curtain Accessories

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Towel rack (cut to specific curtain width)</td>
<td>13.00</td>
<td>each</td>
</tr>
<tr>
<td>• Towel railing brackets</td>
<td>8.64</td>
<td>each</td>
</tr>
<tr>
<td>• Middle bracket to support longer sections</td>
<td>1.50</td>
<td>each</td>
</tr>
<tr>
<td>• no hooks were required</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Stick-on Acoustic Tiles

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• size of each tile: 600mm X 600mm (thickness: 10-12mm)</td>
<td>41.00</td>
<td>tile</td>
</tr>
<tr>
<td>• velcro, pin and staple compatible (for student artwork)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• available in 12 different colours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• fade, stain, moisture and fire resistant (AS1530.3.1999)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• DIY install (instructions supplied); able to cut to size</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Chair Bags

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Made from: Poly Cotton Drill</td>
<td>7.50</td>
<td>chair bag</td>
</tr>
<tr>
<td>• Reinforced double hemmed side seams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• heavy duty thread that is washable and durable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• size: 460mm x 440mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• available in a variety of sizes and colours</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Computer Headsets

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brand: Deluxe Stereo Headphones</td>
<td>12.90</td>
<td>headset</td>
</tr>
<tr>
<td>• Colours: black and silver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Adjustable for a child’s head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• volume control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Headphone Splitters

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brand: Belkin Rockstar Multi-headphone Splitter</td>
<td>19.98</td>
<td>splitter</td>
</tr>
<tr>
<td>• 5 headphones able to connect to each splitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Can also be used with any device with a 1/8 (3.5mm) stereo mini-jack (eg: laptop; MP3 player; iPad)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Netting

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brand: EDEX Classroom Fish Net</td>
<td>20.00</td>
<td>Net</td>
</tr>
<tr>
<td>• netting size: 8900mm X 7000mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• available in blue only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• attached with zip ties to established classroom landmarks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Egg Cartons

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• donated by MI State School and DE staff</td>
<td>free</td>
<td>Carton</td>
</tr>
<tr>
<td>• children individualised by painting and decorating them</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Cushions

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost ($)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>European square pillows</td>
<td>12.00</td>
<td>cushion</td>
</tr>
<tr>
<td>• 100% polyester filling (in white only)</td>
<td></td>
<td>insert</td>
</tr>
<tr>
<td>• Size: 650mm x 650mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Washable and durable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Cost ($)</td>
<td>/unit</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Cushion Covers</strong></td>
<td>9.76</td>
<td>9.76</td>
</tr>
<tr>
<td>- Poly cotton European square pillow cases</td>
<td>650mm X 650mm</td>
<td>machine washable</td>
</tr>
<tr>
<td><strong>Rubber Floor Matting</strong></td>
<td>27.00</td>
<td>27.00</td>
</tr>
<tr>
<td>- Brand: Ring O Slope Mat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Size: 900mm x 1500mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Tampered edge prevents accidents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Suitable for both indoors and outdoors</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carpet Matting</strong></td>
<td>52.00</td>
<td>52.00</td>
</tr>
<tr>
<td>- Baylis Tough Clean commercial Mat</td>
<td>900mm X 1500mm</td>
<td>vacuum or hose down</td>
</tr>
<tr>
<td><strong>Classroom Noise Monitor</strong></td>
<td>125.00</td>
<td>125.00</td>
</tr>
<tr>
<td>- Brand: Yacker Tracker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Features:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- built-in sound level meter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- alarm sounds if set noise level is exceeded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- self-standing or wall-mountable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- an extension cord may be required for optimal placement</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chair Stoppers</strong></td>
<td>11.00</td>
<td>11.00</td>
</tr>
<tr>
<td>- 2 types:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 1. snap glides (pictured)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 2. Chair stoppers</td>
<td>8.22</td>
<td>8.22</td>
</tr>
<tr>
<td><strong>Incidentals</strong></td>
<td>1.98</td>
<td>1.98</td>
</tr>
<tr>
<td>- Cable ties (packet x25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 150mm x 3.6mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Australian plug converter (for Yacker Tracker)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*to lower costs, the curtains were sewn together by the mother of one of the Deadly Ears team members*
### Appendix D

#### Sound-field Amplification Issues

<table>
<thead>
<tr>
<th>Trip</th>
<th>Classroom</th>
<th>Identified Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 (March)</td>
<td>Classroom 1</td>
<td>Teacher was frustrated of the placement of the receiver. It is located near the reading area and at a level where the children were able to play with the dials.</td>
</tr>
<tr>
<td></td>
<td>Classroom 2</td>
<td>Teacher feels that the SAS is not always working properly when walking around the classroom</td>
</tr>
<tr>
<td></td>
<td>Classroom 4</td>
<td>Two speakers (of four) working</td>
</tr>
<tr>
<td></td>
<td>Classroom 5</td>
<td>One of the back speakers not working (this teacher identified that there was sometimes crackling, buzzing and feedback from the SAS)</td>
</tr>
<tr>
<td></td>
<td>Classroom 6</td>
<td>Some static observed</td>
</tr>
<tr>
<td>03 (November)</td>
<td>Classroom 5</td>
<td>SAS cracking slightly One of the back speakers not working</td>
</tr>
</tbody>
</table>
Appendix E - Pre-Modification Teacher Questionnaire

Classroom Acoustics Pre-Modification Teacher Questionnaire

Teacher’s Name: ________________________________
e-mail: ____________________________________________________________________________
Years of Teaching Experience: __________________________
School: Mornington Island State School
Year: ________________________________
Nº of children in your class: ________________________________
Nº of children with a known hearing loss: ________________________________

Thank you for taking the time to complete this questionnaire. We are investigating classroom modifications to improve the acoustic listening environment for children to assist them with listening and learning.

Listening Environments

1. What does a good listening environment look (and sound) like?

2. What does a poor listening environment look (and sound) like?

3. How do you know when listening is easy for children in your class?

4. How do you know when listening is difficult for children in your class?

5. When organising your classroom at the beginning of the year, what were the most important aspects you considered in the set-up?

6. By engaging in this project we hope to work alongside you to develop your capacity to improve the listening environment in your classroom on a daily basis. What do you think will enable or facilitate you to sustain changes in your classroom?
Room Characteristics

1. In your opinion what aspects of your classroom are the most important? Rank those categories below with 1 being the most important and 5 the least important.

☐ Lighting (state example if known) ________________________________
☐ Ventilation (state example if known) _____________________________
☐ Acoustics (listening environment) (state example if known) ______
☐ Equipment (state example if known) _____________________________
☐ Sufficient room space (state example if known) _________________

2. How would you describe the listening environment in the classroom?  
*Please choose all the words that best describe your present classroom*

☐ Comfortable  ☐ Confusing  ☐ Echoes  ☐ Harsh  ☐ Loud  ☐ Clear  ☐ Irritating  ☐ Relaxing  ☐ Other *(please specify):* ________________

3. How do you rate your overall classroom listening environment?

<table>
<thead>
<tr>
<th>Very poor</th>
<th>Poor</th>
<th>Acceptable</th>
<th>Good</th>
<th>Very good</th>
</tr>
</thead>
</table>

Why? *(please specify):* __________________________________________

4. If you answered ‘poor’ or ‘very poor’, why do you think that it is hard for students to hear well in your classroom?

☐ Open plan style room  ☐ Too much echo in the room  ☐ Too much noise from outside the room  ☐ Noise level produced by the students is too high  ☐ Other *(please specify):* __________________________________________

Noise Sources – Inside the Classroom

1. Do you have any problems with the noise created inside the classroom (this includes the noise students themselves make)?

☐ Yes (continue to Q2)  ☐ No (Go to the next section ‘Noises Outside the Classroom’)

2. What proportion of noise generated inside the classroom is student generated?
3. Please identify all other sources of noise inside the classroom:

- Equipment (eg: computer, fish tanks, clocks….)
- Air conditioning
- Heaters
- Lights
- Fans
- Other (please specify): ________________________________

4. Which is the most intrusive noise from the list in Q3 above? ______________

5. What do you think could be done to eliminate noises from inside the classroom?

---

**Noise Sources – Outside the Classroom**

1. Do you have any problems with outside noise entering your classroom (this includes noise from adjacent rooms)?

- Yes (continue to Q2)
- No (go tho the next section – ‘Vocal Effort’)

2. Identify the sources of outside noise

- Traffic noise
- Lawn mowing
- Noise from other classrooms
- Noise from sports fields
- Corridors
- Student traffic on decks
- Other (please specify):

3. Which is the most intrusive noise from Q2?: ________________________________

4. How important do you think it is to eliminate or reduce these external noises for the students?

- Critical
- Important
- Not very important
- Unimportant

5. What could be done to eliminate these noises from outside your classroom?
6. Which is the worst source of noise problems for you?

- [ ] Noise made inside the classroom
- [ ] Noise coming into the classroom from outside

**Vocal Effort**

1. When teaching would you consider yourself to have?

- [ ] A soft speaking voice
- [ ] A normal level speaking voice
- [ ] A loud speaking voice

2. How often is it necessary for you to elevate your voice to be heard clearly?

- [ ] Always
- [ ] Often
- [ ] Sometimes
- [ ] Never

3. Does the level at which you need to speak seem to strain your voice?

- [ ] Yes
- [ ] No

4. From where in the classroom do students appear to be able to hear your instructions best?

- [ ] Easy everywhere
- [ ] Near the teacher
- [ ] Far from the teacher
- [ ] In the centre of the room
- [ ] Near the back
- [ ] At the sides
- [ ] Have not considered this

Comments: ____________________________________________

5. From where in the classroom do students seem to have the most difficulty hearing?

- [ ] Difficulty everywhere
- [ ] Near the teacher
- [ ] Far from the teacher
- [ ] In the centre of the room
- [ ] Near the back
- [ ] At the sides
- [ ] Have not considered this

Comments: ____________________________________________

6. How often do you use your Sound-field Amplification System?

- [ ] Never
Teaching Style

1. Approximately what percentage of time do you spend in the classroom teaching in each of these styles?

☐ Mat work  %
☐ Group work  %
☐ Blackboard/didactic  %
☐ Other (please specify): %

Total: 100%

2. In what situations do you find it necessary to elevate your voice to be heard clearly?

☐ Mat work
☐ Group work
☐ Blackboard
☐ Other (please specify):

3. Where is your usual position in the class?

☐ At the centre
☐ In the front
☐ Walking around
☐ Other (please specify):

4. Do you think acoustics in your classroom have a direct effect on the student’s learning ability?

☐ Yes
☐ No
☐ Don’t know?

5. Please explain why you think the acoustics in your classroom have a direct effect on the student’s learning ability.

☐ Sometimes
☐ Frequently
☐ All the time
Comments: 

7. What are the positives about using the SAS?

8. What are the negatives about using the SAS?
Appendix F – Post-Modification Teacher Questionnaire
(The first section only is included as all subsequent pages are a repeat of the pre-modification questionnaire)

Classroom Acoustics Post-Modification Teacher Questionnaire

Teacher’s Name: ____________________________ Date: ______________

e-mail: ______________________________________

Years of Teaching Experience: __________________________

School: Mornington Island State School

Year: ______________________________________

Nº of children in your class: __________________________

Nº of children with a known hearing loss: __________________________

Thank you for taking the time to complete this questionnaire. We are investigating classroom modifications to improve the acoustic listening environment for children to assist them with listening and learning.

Listening Environments

1. What has been happening for Ears and with Hearing in your class?

2. What has been happening with your classroom listening environment?

3. What acoustic adjustments have been made in your classroom?

4. What difference if any did the acoustics adjustments make?

5. What does a good listening environment look (and sound) like?

6. What does a poor listening environment look (and sound) like?

7. How do you know when listening is easy for children in your class?

8. How do you know when listening is difficult for children in your class?

9. Throughout the year, have there been any changes to the way you set up your classroom?

10. How do you think you have managed the changed to your classroom environment?

11. What do you think will enable the classroom changes to be sustained for future teachers in your classroom?
### Mornington Island Classroom Acoustic Audit

<table>
<thead>
<tr>
<th>Description</th>
<th>YES</th>
<th>NO</th>
<th>If no, what are the barriers to change?</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are there curtains on the windows?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is the floor surface soft and sound absorbing?</td>
<td></td>
<td></td>
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<tr>
<td>Are there rubber stoppers on chair and table legs?</td>
<td></td>
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<tr>
<td>Are these wall hangings or cork display boards on walls?</td>
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<td></td>
</tr>
<tr>
<td>Do the lights work without humming?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do the fans work without an electrical buzz sound?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does your air-conditioning work without thumping or humming?</td>
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<tr>
<td>Is the ceiling made out of acoustic material?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are most surfaces soft, bumpy or absorbent eg. floors, walls, dividers?</td>
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<tr>
<td>Is there a Soundfield Amplification System(s) used for a majority of the teaching day?</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>