ACOUSTICAL EVALUATION OF BERWICK PRESCHOOL

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1. INTRODUCTION

Speech intelligibility is the major concern in classroom acoustics, since speaking and hearing are the most important modes of communication in teaching and learning.

Findings [1,2] indicate that academic achievement - in particular reading skills - are vulnerable to the effects of chronic noise exposure. The general pattern of adverse psychological stress reactions is associated with chronic exposure to noise among children [3].

The teachers in many preschool and child care - as well as, in the Berwick Preschool studied here - frequently commented on how noisy the classrooms were. For many who work in preschool classrooms, there is a tendency to simply accept the fact that young children can be noisy. Regardless of the many reasons, it is clear that there is a fair amount of noise in preschool classrooms. Individuals working in early childhood classrooms tend to tolerate the noise as the "price of doing business".

2. EVALUATION

All of the classrooms were architecturally identical and had same classroom equipment. The floor area was 73 m^2, and the volume was 269 m^3 in the classroom.

2.1 Objective measurement

As shown in Figure 3.3, all of the classrooms had RT$_{mid}$'s that exceed the 0.6 seconds limit of ANSI S12.60-2002 for core learning spaces with enclosed volumes less than 283 m^3. The variation of the RTs in the different classrooms may be caused by the different furniture layouts and the toys, as well as usual experimental variations.

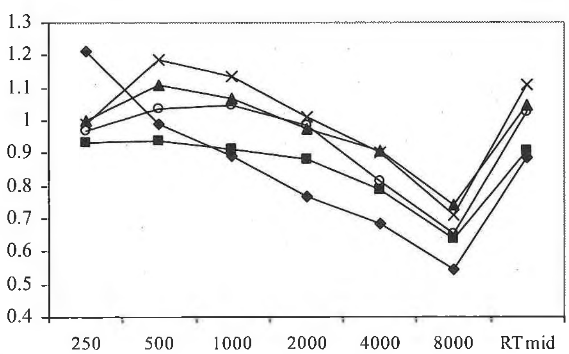


Fig 1. Measured reverberation times (♦:Rm1, ■ :Rm2, ▲: Rm3, ×:Rm4, ○:Rm5)

The background noise levels exceeded the 35 dB(A) limit of ANSI S12.60-2002 in all of the classrooms.

Figure 3.9 shows the range and average of the sound levels for each teacher and classroom. Average sound levels during various activities differed for the different classrooms and teachers. This difference may be caused by the different noise levels made by children, and teacher's different teaching styles. Considering the microphone's position in the measurement, children in the classroom were exposed the sounds over 70 dB(A), and teachers were exposed to sounds over 83 dB(A) for 5 hours a day.

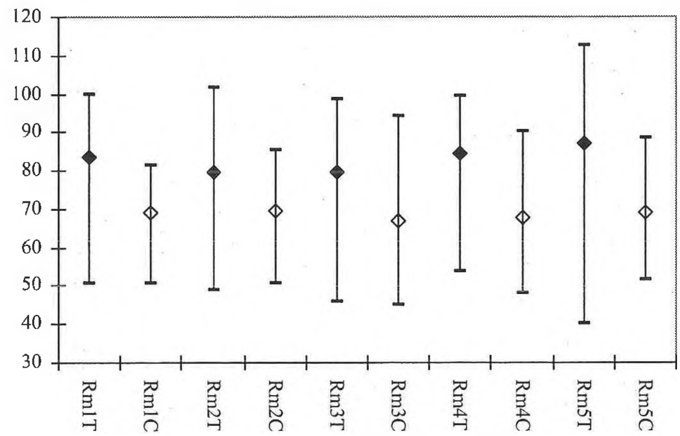


Fig 2. Average sound levels during the school activities (♦: teacher, ◊:classroom)

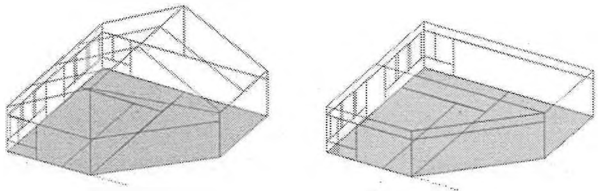
2.2 Subjective Survey

Eleven of a total of thirteen teachers in the Preschool responded to the questionnaire. The listening environments in the classrooms were considered less acceptable than the non-listening environments.

Teachers were asked about their perception of the consequences of a poor listening environment in the classrooms. 'Increased fatigue' was frequently experienced by most teachers in the classrooms. Teachers were also asked to assess the interference with their ability to hear because of different sources of noise inside and outside the classrooms. In particular, children's talking was considered as a major source of noise in the classrooms.

3. SIMULATION

Basically, acoustical treatment of the classrooms involved controlling the material and the volume of the classroom. The basic materials for the floor, wall, and ceiling were selected based on the current classroom materials, and each component was changed to a different material, one by one. CATT room acoustical simulation software was used for prediction.



(a) Current (b) Lowceiling

Fig 3. Classroom models

Table 1. Classroom configurations

Control	Name	Area (m^2) by material					
		Rubber sheet	Thin carpet	Plywood	¾" porous	Ceiling tile	Glass
No treatment	Current	52.2	21.0	177.2	-	-	11.2
Floor	Floor	73.2	-	177.2	-	-	11.2
	Carpet	-	73.2	177.2	-	-	11.2
Wall	Wall	52.2	21.0	144.8	32.4	-	11.2
Ceiling	Ceiling	52.2	21.0	95.4	81.8	-	11.2
Volume 178m³	Lowceiling1	52.2	21.0	147.5	-	-	11.2
	Lowceiling2	52.2	21.0	95.4	52.2	-	11.2
	Lowceiling3	52.2	21.0	95.4	-	52.2	11.2

Figure 4.6 shows the predicted RTs in the 125 Hz to 4000 Hz octave bands, as well as RT_{mid}. Both changing to higher absorptive material and reducing volume were effective at decreasing the RT in the classroom, to acceptable values.

The speech level of the speaker is a major component of speech intelligibility. However, it is inversely related to the total absorption of the room. Adding absorption decreases both speech levels and RT.

Figure 4.8 shows the RASTI with background noise in unoccupied classroom. None of them exceeded 0.75 which corresponds to excellent speech intelligibility. Therefore, the classroom does not have good conditions for speech even when it is unoccupied. The RASTI was simulated in more realistic condition with classroom activity noise as shown in Figure 4.9. With the higher background level, the RASTI was higher when the RT was longer in general.

4. DISCUSSION

None of the classrooms in the preschool was acceptable according to the criteria relevant to this study: ANSI S12.60-2002. Based on the in-class sound levels, teachers apparently always talked with loud voices during the class. The sound levels to which the teachers were exposed were close to typical occupational noise limits. Teachers agreed that the non-acoustical environments in the classrooms were fair, but the acoustical environments had problems.

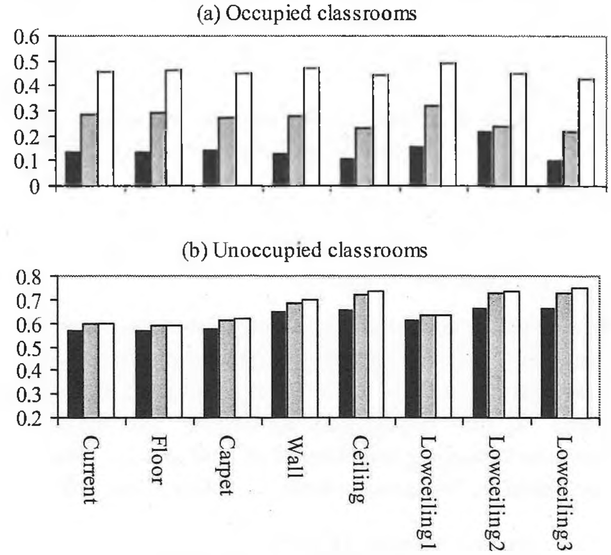


Fig 4. RASTI (■: normal voice, ▒: raised voice, □: loud voice,)

In noisy environment, the speech level and volume of the space were dominant factors for speech intelligibility; however, in quiet environment, the absorption was more effective than speech level or volume. Ceiling heights are critical as well. While the existing heights created interesting looking spaces, they were problematic in terms of noise levels and reverberation.

Decreasing the volume of the classrooms would be the most effective solution. Installing a suspended acoustical ceiling would be an option. They decrease the RT and increase RASTI.

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