ABSTRACT

Speaking and listening are the two main functions in classrooms and the children should be able to hear and understand what the teacher is speaking to them. Unfortunately many of the classrooms including those in advanced countries suffer from “teaching in the dark” which is similar to students reading in the dark. This study is the evaluation of classrooms for young children in India, to assess their acoustical environments for better learning. The schools under consideration are located in an educationally advanced locality in India - a district in the southern part of India, namely Kanyakumari. Situated in a warm humid climate, the classrooms have open windows and doors with the possibility of noise intrusion from outside. In this study, depending on the location of the schools and their external surroundings, the schools are classified into three categories: a) schools located near roads with heavy traffic (Noisy-sites), b) schools located within Housing sites, c) schools located in zones far from public roads and away from residences. External and internal noise surveys have been conducted to evaluate the ambient noise (background noise) within the classrooms.

A total of 120 classrooms in 25 schools in the three categories are studied. The surveyed schools are attended by children from the 1st to the 8th grades (6-14 years old) of the fundamental educational system, which corresponds to primary and middle schools. Many of the schools surveyed
were exposed to noise from road traffic; the average external noise level $L_{Aeq}$ dB was measured outside the schools. Detailed internal noise measurements were made in the classrooms in different conditions such as when the classrooms were empty, when classrooms were occupied by students and when the teacher was speaking. External noise levels were compared with internal levels to determine the influence of external noise on the internal noise environment of the classrooms. The noise levels in different classrooms near the noise source and away from the source were measured to compare the acoustic conditions in the classrooms.

The reverberation times in the classrooms were measured when the classrooms were empty and when classrooms were occupied by the students, together with the classroom observations to verify the acoustical conditions of the classrooms. Comparison with the national and international standards of background noise and reverberation time was made to assess the acoustic condition in the classrooms.

To hear properly the lessons taught by the teacher, the speech intelligibility in the classroom that is the percentage of words clearly understood by the students should be more than 90%. Using available software ClassTalk, the speech intelligibility parameters like, Speech intelligibility, Signal to Noise level difference and Speech Transmission Index in the classrooms was evaluated to assess the acoustical quality of the classrooms. The measured RT was compared with the calculated values and they were found to be quite close. The influence of BN and RT in determining
the speech intelligibility in the classrooms was studied and it is seen that BN has a bigger role in improving the speech intelligibility in the classrooms.

Some of the conclusions from this study are detailed below. The external noise has an important influence on the background noise in classrooms, which in turn would be the basis for determining the speech intelligibility of classrooms. When external noise of such magnitude as measured in this study exists, this noise would intrude into the classrooms through the open windows and door. The BN in the classrooms would be of the order as measured in these cases which are above the national/international standards. But for a few of the schools at Quiet site, the average BN is around 45 dB A which is the upper limit of BN for school classrooms as stipulated by National Building Code, India, 2005. The international guidelines for Background noise of 35dBA are difficult to achieve in countries of warm-humid climate where schools with closed enclosures for classrooms are not practicable. The background noise in the classrooms is influenced by the external noise in the environment around. If proper care is taken to locate the schools away from noisy surroundings, the acoustic performance of the school class rooms can be improved.

The intelligibility of speech in a classroom is influenced not only by the background noise, but also by other parameters like Reverberation time, and the distance between the teacher and the students. The mean Reverberation Time for the unoccupied class is around 1.3 s, and the average RT in the occupied class is 0.7 s.
The RT values are higher than the international standards; however, they are closer to the value of RT stipulated by the Indian standard namely 1.25 s for the unoccupied class. For the occupied classrooms the average RT is below 0.75 s, the value stipulated in the Indian standard. As the classrooms are of smaller size, (the length and breadth of the classrooms are around 6 m), the Early Reflection Time of the speech signal of a teacher would be about 35 ms, and this can enhance the speech intelligibility of the classroom.

It was found that 90% of classrooms at Quiet sites were in the acceptable range of speech intelligibility and at Housing sites 68% of the classrooms were acceptable. However, at Noisy sites which are located near highways on public roads, the BN in classrooms in the occupied condition reached about 61.1 dB A and hence only about 28% of classrooms were acceptable. When the students occupied the class, the noise level raises by about 9 dB A in classrooms at all sites, and so the Speech Intelligibility was reduced to the ranges discussed above. However, as shown, if this increased noise level of 9 dB A can be reduced by a small amount, the resulting intelligibility in classrooms can be enhanced to ‘Good’ and ‘Fair’ conditions. Some cost effective means to reduce the BN and RT in classrooms were tried and the values were measured and it is established that the speech intelligibility can be improved, by providing floor mat and wall curtain.