NOISE LEVELS IN MALAYSIA PRIMARY SCHOOLS: ARE WE MEETING THE INTERNATIONAL STANDARDS?

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ABSTRACT

Noise is increasingly becoming a problem in schools and affects the audibility of speech. The effects of noise hamper learning opportunities for students. Noisy classrooms affect students' academic performance and wellbeing. Studies have shown that children perform more poorly in noisy situations compared to adults. The current study was done to measure noise levels in classrooms in primary schools in Kuantan. A total of 31 classrooms from eight residential primary schools were selected as the place of study. The noise levels were measured using a sound level meter (SLM) in occupied and unoccupied conditions. On-site observations and checking were done and documented in each school and classroom. The results showed that the noise levels of occupied and unoccupied classrooms were higher than the values recommended by the World Health Organization (WHO) which are 35 dB(A) and 55 dB(A) respectively. The findings showed that the measured noise levels in the classrooms were high enough that it might interfere with the effectiveness of teaching and learning among students and teachers. The source of noise was mainly from the students' activities in the classes. The current study discusses a few possible suggestions to improve the classroom acoustics.

Keywords: classroom noise, classroom acoustics, primary school, occupied classroom, unoccupied classrooms.

INTRODUCTION

Access to education is one of the most important opportunities in a person's life. However, there are increasing evidence that excessive noise levels can create a negative learning environment (Woolner & Hall, 2010; Buchari, 2017). The presence of noise interferes daily communication which can be frustrating to the sufferers and family members (Besner et al., 2014). High noise levels in classrooms affect children's learning and teacher's wellbeing (Hygge, 1993: Airey & MacKenzie, 1999; Wall, 2015). Students' ability to hear and to understand speech are also reduced (Klatte et al., 2010; ASHA, 1994) which might affect their academic performance, reading ability (Hetu et al., 1990; Bulunuz, 2014), long term memory and comprehension (Evans & Lapore, 1993; Cohen et al., 1981). All these factors might reduce a student's motivation to attend school (Hygge et al., 1996; Fadeyi et al., 2014). Past studies have shown noisy classrooms lead to stress and depression among students (Sarlati et al., 2014) and reduced their cognitive tasks (Burgland & Lindvall, 1995; Shield & Dockrell, 2003).

In a noisy classroom, normally a teacher needs to elevate their voice levels that might cause stress, vocal fatigue and teacher absenteeism (Pearson et al. 1976; Gotass & Starr, 1993; ASHA, 1994; Sutherland & Lubman, 2001 Buchari, 2017). Many teachers complain of tired voices, vocal strain and health concerns because they need to speak at higher voice levels compared to quieter classrooms where teachers can speak at more comfortable levels and their voices still can be heard throughout the room (Nelson, Soli & Seltz, 2002; Dockrell & Shield, 2006). According to teachers, it was difficult and less effective to deliver lectures in noisy classrooms which later affected their job performance and satisfaction (Schneider, 2003).

There are two types of noise sources in a classroom: external and internal. The common sources of external noise are normally associated with traffic and street noises (Meiss et al., 2000; Evans et al., 2001), air crafts (Cohen et al., 1980; 1981; Hygge., 1993; Hygge et al., 1996; Haines et al., 2001), railways (Sargent et al., 1980; Sanz et al., 1993; Romero & Lliso, 1995) and busy housing areas (Ibrahim & Richard, 2000; Haines et al., 2001a; Lau & McPherson, 2002; Jamaludin & Ismail, 2019) whereas the sources of internal noise are from the students' activities in the classroom such as talking, moving around the class, reading aloud, reading along in loud voices lead by one person (teacher or student), group works, teachers' or students' voices, fan, ventilation and air conditioning systems (HVAC) (Trane, 2003; Shield & Dockrell, 2002; 2004).

The size and shape of the classroom, its location, surface treatment (which determines sound absorption) and construction of the ceiling, walls, and floor, the number, type and location of sound source, and the strength of the sound produced (Ibrahim & Richard, 2000; Trane, 2003) can also contribute to the level of noise in a classroom.

Past studies showed noise levels in most classrooms were higher than the standard set by the World Health Organization (WHO) which is 35 dB(A). A few studies conducted in the United States reported that from the 56 classrooms measured, 28% of them showed noise levels exceeding 50 dB(A) (Sutherland & Lubman, 2001). A few studies conducted in London reported that children's school performance and reading ability were affected by the level of noise in the classrooms. The studies reported that the performance of the students from classrooms in schools situated in a higher noise level (63 dBA) were lower compared to their peers from schools located in a lower noise area (57 dBA) (Haines et al., 2001a; 2001b; 2001c).

In noisy listening environments, children may miss or mishear vowels and consonants due to unclear and distorted sounds. Tasks become even more difficult for unfamiliar sounds, such as new words or concepts which require extra effort; or students learning in a non-native language, coping with learning disabilities, or hindered by impaired hearing (Nelson & Soli, 2000). Children 16 years and younger do not fully understand speech in noisy situations due to their lack of experience and knowledge (Elliot, 1979; Soli & Sullivan,1997; Nelson et al., 2000).

The current study aims to measure the noise levels in primary schools in Kuantan, to compare the measured noise level with the WHO (1999) recommended values, and to investigate the sources of noise in the classrooms. Primary schools were chosen as past studies showed that young listeners performed more poorly in noisy situations compared to adults (Elliot et al., 1979; Nelson et al., 2000).

METHOD

Schools

Eight primary schools in Kuantan participated in this study. All schools were government-subsidized. One of the schools (H) is in the town center while the others are in the residential areas. For the purpose of confidentiality, the schools' names were referred to as A, B, C, D, E, F, G and H. The number of classrooms from each year of study (Standard) from eight schools is shown in Table 1.

Table 1: Number of classrooms in each Year of Study (Standard)

Year of Study (Standard)	Number of classrooms
One	3
Two	4
Three	5
Four	10
Five	3
Six	6

Procedures

Permission to conduct research in the schools was sought from the Ministry of Education (MOE) in Putrajaya and the State Department of Education, Pahang. The school principals were contacted and invited to participate in the study once the approval was obtained, Brief information on the purposes, objectives, procedures and protocols of the research were then given to the principals and related personnel in the schools. A written consent was obtained from each school prior to the noise level measurements.

Noise level measurements

Noise measurements were recorded in 31 classrooms from eight primary schools and measured in two conditions: unoccupied and occupied environments. In the unoccupied environment, the measurements were taken during recess or whenever there were no students in the selected classrooms. In the occupied environment, the measurement was conducted during the teaching and learning sessions. During the measurements, noise from adjacent areas were not controlled in order to reflect the real classroom conditions. For each school, four classes from different blocks (buildings) were randomly selected. If the school has less than 4 buildings, one classroom from each floor was chosen. The classes were separated and not located next to each other.

The noise levels in the classroom were measured at two minute-intervals over approximately 30 minutes of class lessons. The readings were averaged to get the mean values. Two-minute measurements of L_{Aeq} was taken as it seemed to be sufficient in providing information regarding noise level fluctuations and variations throughout a school session (Shield & Dockrell, 2004).

During the measurement, a sound level meter (SLM) was positioned at three points in the classroom where the students are seated. At each point, noise levels were measured three times. If the first and second readings showed equal or less than 3 dB differences, the third reading was not necessary. The handheld method was used to measure noise as to avoid distracting the students, teachers and for safety purposes (Shield & Dockrell, 2004). The equipment was placed at least one meter above the ground with its microphone directly facing the teacher. This was to avoid any walls or reflecting surfaces within one meter of the measurement point.

Observations on classroom activities were noted in a "Classroom Acoustics Documentation Form". Observations on sources of external noises (outside the classrooms and around the school) were also recorded. Thus, the number of students in the class and class activities can be associated with the measured noise levels (Shield & Dockrell, 2004).

The current study used 3M SoundPro-DL-2 SLM, sound calibrator, measuring tape and marker. The SLM was used to measure the occupied and unoccupied noise levels of the classrooms using parameters; 1) A-weightage scale is used because it measures in the same way our hearing system perceives the frequency responses by prioritizing mid and high frequencies more than low frequencies (WHO, 1999); 2) Slow time-weighting circuit which is suitable for steady-state noise levels recordings; and 3) Full octave band filter that has 11 bands with center frequencies ranging from 16 Hz to 16 kHz.

The calibration of the SLM was done using a sound calibrator for each of the measurement to ensure the accuracy of the measurements (OSHA Standards, 2008). The measurement points were determined by measuring the length and width of the classrooms, which must be at 1 meter above the floor.

Data files were analyzed using a 3M Detection Management Software (V1.5.65) and analyzed using Microsoft Excel version 2010.

RESULTS

Schools and number of students

The number of students in the classrooms are shown in Table 2. Based on the table, school B has the least number of students in the classroom (16) and the greatest number were seen in schools E and H (39).

Table 2: Number of students in the classrooms according to schools.

Schools	Number of students in classrooms
A	21-32
B	16-34
C	24-32
D	19-37
E	23-39
F	24-29
G	23-30
H	32-39

Sources of noise

Details like student age, the number of occupants, type of activities in the classroom were recorded. From the observation, the sources of the classroom noises were mainly from the students' activities in the classroom and the teachers' voices. The teachers had to raise their voices to be heard by the students. The activities that contributed to the sources of noise recorded during the observation are shown in Table 3.

Table 3: Classroom activities.

Activities	Description
1	Examination
2	Student sitting at desk or on the floor, with one person speaking at a time (teacher or student)
3	Student sitting at desk doing own work, with some talking
4	Students do own work, moving around the class, with some talking
5	Students do work in groups, sitting at desk, with some talking
6	Students do work in groups, moving around the class, with some talking
7	Read along in loud voice lead by one person (teacher or student)

Noise level of unoccupied classrooms

Figure 1 shows the noise levels measured in eight unoccupied classrooms. Based on the table, the noise levels measured in all classrooms in the eight schools exceeded the standard value recommended by the WHO (1999) which is 35 dB(A). The mean level ranged from 58.66 (lowest) to 62.89 (highest).

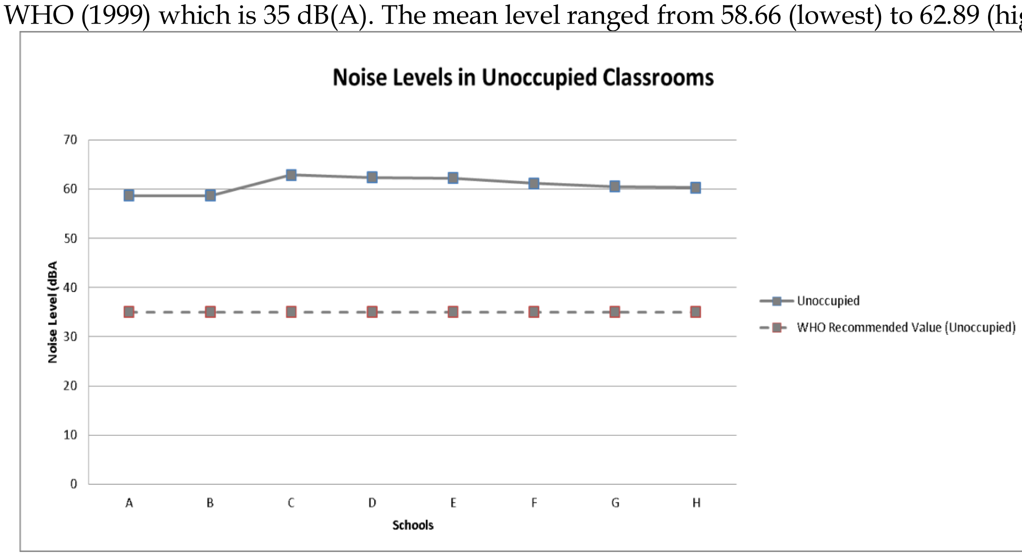

Figure 1: Comparison of the measured noise levels in unoccupied classrooms in Kuantan and the WHO recommended level, 35 dB(A).

Noise level of occupied classrooms

Figure 2 shows the noise levels measured in the occupied classrooms in schools A to H. Based on the table, the noise levels measured in the unoccupied classrooms exceeded the levels recommended by the WHO (1999) which is 55 dB(A). The mean level ranged from 63.21 (lowest) to 75.71 (highest). The sources of high noise levels were related to the classroom activities during the measurement. The highest level was recorded during the read-aloud lead by one person, either the student or the teacher. The comparison of average noise levels between unoccupied and occupied classrooms is shown in Figure 3.

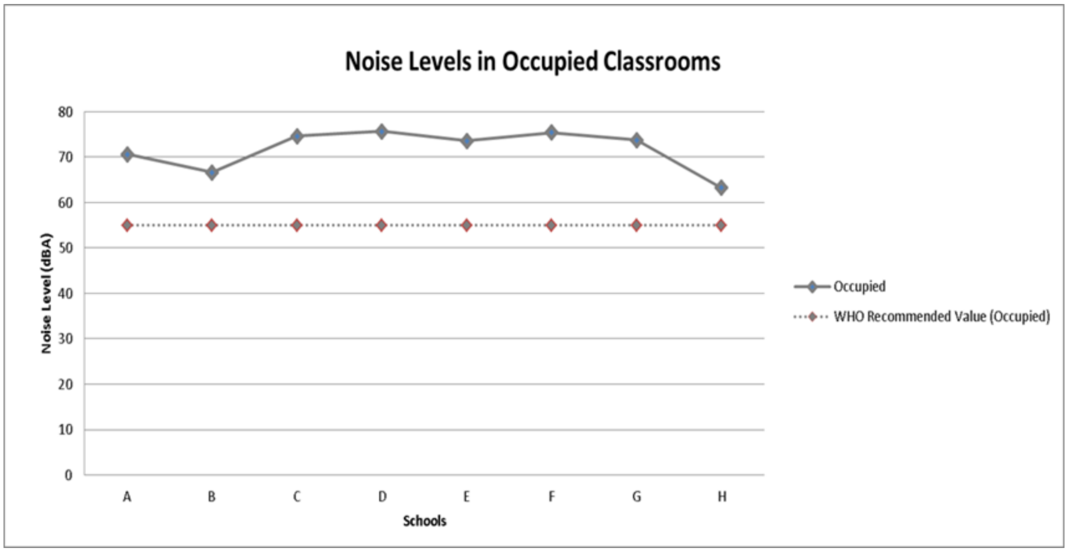

Figure 2: Comparison of the measured noise level in occupied classrooms in Kuantan and the WHO recommended level, 55 dB(A).

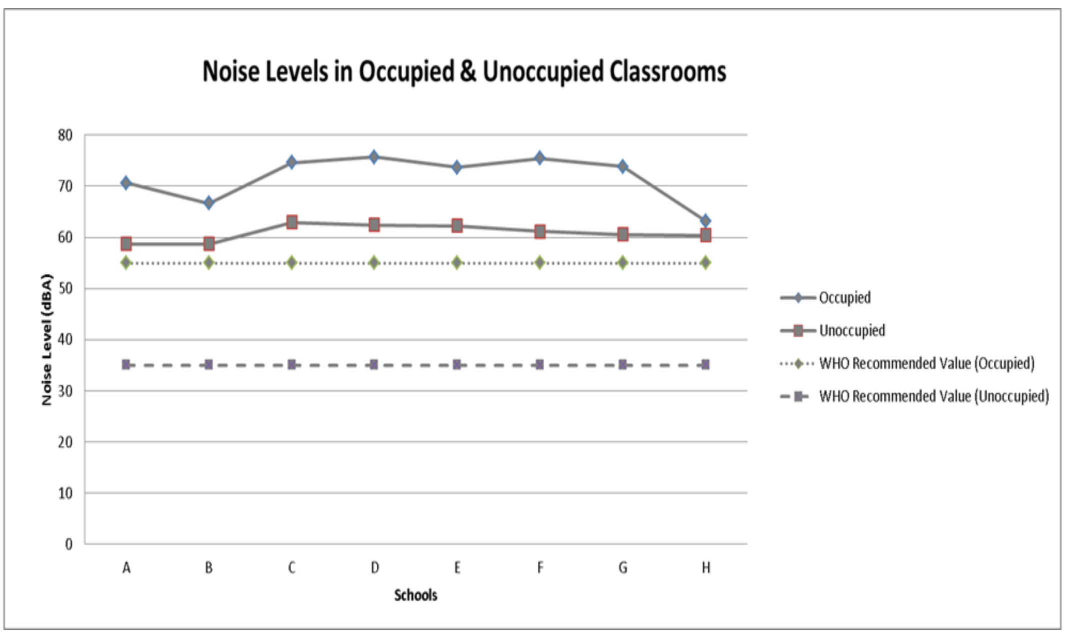

Figure 3: Comparison of average noise level between occupied classrooms and unoccupied classrooms in residential primary schools in Kuantan, Pahang.

Mean noise level (in dB SPL) at different frequencies

Figure 4 shows the mean noise level (dB SPL) in all (31) classrooms based on frequencies of 250 Hz to 8000 Hz. As shown in the figure, there was an increase of low frequency mean noise levels up to 1000 Hz frequency. The reading of mean noise levels decreases in value from 2000 Hz to 8000 Hz.

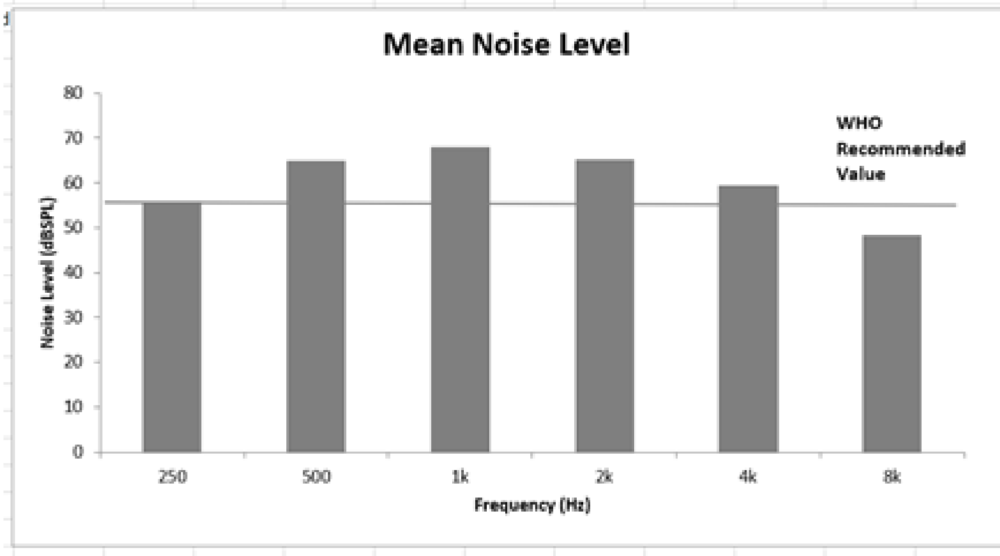

Figure 4: Average noise levels at different frequencies (250, 500, 1000, 2000, 4000, 8000 Hz)

DISCUSSION

The current findings showed that noise levels in unoccupied and occupied classrooms in all primary schools in Kuantan did not meet the standards set by the WHO (1999) and ASHA (1994) guidelines, which are 35 dB(A) and 55 dB(A) respectively. The measured levels ranged from 55 dB(A) to 63 dB(A) for the unoccupied classrooms and between 60 dB(A) to 76 dB(A) for the occupied classrooms (Figures 1 and 2). The sources of high noise levels in the classrooms were from the teaching and learning activities and numbers of students in the classrooms. Similar findings were reported in past studies conducted in Hong Kong, India, Iran and Saudi Arabia (Yee, 2001; Golmohammadi et al., 2010; Alsubaie, 2014; Bulunuz, 2014).

The average noise levels at different frequencies in the 31 classrooms are shown in Figure 4. Based on the recorded readings, the highest levels occurred in the mid frequencies ranging from 1 to 2 kHz. The effect of high noise levels includes masking of important cues in speech signal which are mostly concentrated in mid frequencies. Thus, information from teachers during the teaching and learning process might be distorted due to the smearing effect of masking (Nelson et al., 2000; Buchari, 2017). The result was inconsistent with a study done in Hong Kong where the sources of noise in classrooms were centered at low frequencies. The reason mentioned was due to the presence of air-conditioning units (Yee, 2001), which was not applicable in most classroom settings in Malaysia.

Based on the observation during the visit to the schools, it was found that all classrooms had poor room acoustics. Some of the classrooms were separated by wooden walls, which might cause a sound leakage between classrooms and contribute to the high noise levels. According to Crandell, Smaldino and Flexer (2005), the usage of cork bulletin boards, doubled-glazed windows, acoustically modified furniture, partitions, heavy drapes, acoustic ceiling tiles or carpets helps in noise reduction. In the current study, it was noted that all classrooms were built with hard walls and high ceilings causing high reverberations that contributed to the high noise levels. Sounds reflect off hard walls and surfaces. The reflection of sound causes the presence of the sound even after the source itself stops. Excessive reverberations make the sound overlap each other, causing them to be more difficult to understand by the listener or in this case, the students and teachers (Nelson et al., 2000; Yee, 2001). The usage of ceiling fans with open windows and doors in the classrooms was not effective in the teaching and learning process.

Crandell, Smaldino and Flexer (1995) suggested the use of thick carpeting as one of the solutions to weaken the noise generated by shuffling of hard-soled shoes and movements of desks and chairs. The use of these materials was recommended due to their nature that are highly absorbable which can reduce reverberations. However, in the current study, none of the classrooms was carpeted. It was observed that there were curtains hanging on the windows, but the purpose was more for aesthetics than for reducing noise. Past evidence demonstrated that speech is not well understood by listeners when the overall sound levels exceed 69 dB(A) (Studebaker et al., 1999). If the sound levels exceed 69 dB(A), listeners require more favorable signal-to-noise ratios (SNRs) in order to maintain full understanding of the speech (Nelson et al., 2000).

The use of carpets and heavyweight drapes, or acoustically treated venetian blinds are not common in classroom settings in Malaysia due to the extra cost for the installation, maintenance and cleaning. Allocation for classroom's acoustic modifications is not commonly tabled in the school's budget. It is common practice that teachers and students use their own creativity and funds to purchase curtains, but they are more for decoration rather than acoustical treatments. Good classroom acoustics is essential for the acquisition of academic, social and cultural skills (Sutherland & Lubman, 2001, Schneider, 2003). The provision of conducive classrooms must adhere to special criteria, in line with their specific characteristics and requirements to maximize learning process (Ahmad et al., 2015).

Regular maintenance of ceiling fans is necessary to ensure they are in good condition and do not produce high noise when in use. Maintenance of fluorescent lighting systems such as replacing the light ballast if they are broken is also important to take into consideration. Recycled materials and natural fibers such as egg cartons (Crandell & Smaldino, 2005) and kenaf fiber (Sarlati et al., 2014) might be used as construction material to replace synthetic fibers as they are also able to reduce noise. Egg cartons have shown a high value for absorptive coefficient with more than 0.6 for 2000 Hz and above frequencies (Antonio, n.d.). Another advantage of using egg cartons is that they require only a minimal budget for installment. It can be placed on the legs of desk and chairs or placed on the walls and ceilings to help absorb noise and reduce reverberation time.

Another technique that might be considered is the use of curtains or heavyweight draperies which has high value of absorptive coefficient for higher frequencies, which are 0.72 for 1000 Hz and 0.70 for 2000 Hz (Crandell & Smaldino, 2005). This is important as speech cues are concentrated at most in 1000 Hz and 2000 Hz. Linen or muslin hanging on the windows also can help reduce the reverberation time. By reducing reverberation time, speech perception can be improved.

Apart from room acoustics, it was also thought that creating awareness on the effects of noise on hearing and learning should be stressed among schoolteachers and students in Malaysia. Awareness can be encouraged through seminars or by the hearing healthcare professionals and educators. For example, in Switzerland, a campaign called "All Ears" was introduced by the Ministry of Health to preclude and educate their people about self-produced noise (Schick, Klatte & Meis, 2000). In this campaign, students were educated on the conditions that can interrupt learning or divert their attention.

CONCLUSION

The results showed that none of the schools studied met the WHO (1999) recommended noise levels either for the occupied and unoccupied classrooms. A high noise level in the classrooms was due to the internal noise that was related to the students' activities. It is recommended in the future to include schools located in busy areas such as in the middle of the city. It is hoped that this study able to be a part of an ongoing effort in improving classroom acoustics in Malaysia. By recommending appropriate and cost-effective acoustical treatments in primary schools, the objective to provide an optimal and sustainable environment for children to learn effectively is achieved.

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