

# Subjective Evaluation of Acoustical Conditions in Educational Buildings in Brazil

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## Abstract

This paper is part of a comprehensive study and presents the subjective evaluation of acoustical conditions in public state schools in southern Brazil. The final objective is to give design directives for new schools to accomplish, in order to achieve good acoustical quality. The evaluation comprises 1188 questionnaires applied to school users. The aim was to obtain the viewpoint of students and teachers about their schools. The results show that the situation is far from ideal. Firstly, students and teachers responses are very similar, showing good agreement to each other. Their perception is that the acoustics is not good: 79% of the students and 76% of the teachers can hear noise from adjacent classrooms, which shows a problem with the sound insulation of the partitions and an inadequate spatial planning. Secondly, as far as speech intelligibility is concerned, 38% of the students declare that they cannot hear well what are being said by the teachers. On the other hand, 40% of the teachers have the same complaints. Finally, 59% of the teachers state that they have vocal problems and using their voice on a daily basis can be a hard task.

## 1. Introduction

Noise inside classrooms has been an increasing problem. Noise levels from several sources, such as those from road traffic, recreational areas and adjacent rooms are rising constantly. On the other hand, buildings are not built to prevent intrusive noise [1]. The same applies to internal walls and partitions.

Another aspect is the internal quality of the classrooms. Considering the kind of activity performed, it is important to have an adequate acoustical environment or there is a serious risk of low student performance and a potential decreased in their learning abilities.

The effects of noise on the hearing system are largely discussed in the academic and scientific areas. It is not new that inadequate noise levels influence negatively the capacity of hearing. Other consequences of noise are presented by different authors [2],[3]. Some studies are not conclusive but there are strong evidences that noise

disturbs the neurological, hormonal, digestive and sleep functions [3],[4],[5] and [6].

An appropriate acoustical environment is a must either for students or teachers in schools. Martins et al [7] showed that hearing perception is very important for the development of children communication. If ideal conditions are not achieved, students on the initial grades can have troubles on their talking, reading and writing abilities. Russo [8] showed similar findings and also reported: *"it is not enough to hear, it is necessary to understand what is being said"*. This is an extremely important issue and it is related to the intelligibility capacity. Certainly it would be pretentious to affirm that only acoustical problems influence learning abilities, but it is undeniable that it has a major role on teaching-learning activities.

Teachers working on bad acoustic conditions find it difficult to talk, to teach and to be heard. Thus, it may appear that they have a vocal problem [9]. They need to raise their voice levels trying to fight against noise. Acoustically speaking, they are trying to get a better signal-to-noise ratio. One of the most important reasons of inadequate acoustic conditions can be the architectural characteristic of classrooms [9],[10], with poor sound insulation, highly reverberant spaces or probably both.

The social cost of acoustical problems in schools is sometimes hard to quantify. There are many indirect costs involved. Celani et al [11] stated that labour accidents researches normally include only those who had serious occupational hearing disorders, like damages from industrial noise, for example. On the other hand, students and teachers who spend many hours a day in school with high noise levels and present hearing or vocal related problems should be enrolled as occupational problems. There are serious financial matters to deal with, such as teachers in treatment of vocal disorders, students with learning difficulties and/or with poor achievement and the need of replacement of teachers. They are all examples of indirect costs and Aquino [12] reported that the costs of occupational accidents are four times higher than the direct ones.

Therefore, even if there is financial resources saved in careless building designs there will be costs later and health losses for educational workers.

## 2. Methodology

The survey was carried out by means of questionnaires applied to students and teachers, which were treated as different categories. They were given particular questions but with same structural meaning.

The majority of schools had all the “fundamental levels”, approximately from 7 to 14 years old, boys and girls. Only students of 7<sup>th</sup> and 8<sup>th</sup> grades answered the questionnaires, therefore, kids of around 13 to 16 years old, as they had a better understanding about the questions being asked. It was found in a preliminary research that younger students quite often could not understand the survey.

The questionnaire looked for the users opinion about the acoustical environment of the schools and classrooms, their intelligibility condition and the identification of vocal effort by the teachers. Subsequently, selected acoustical parameters will be measured in order to acquire information and comparison among schools and different architectural typology performed. Measurement results and research conclusions will be present in the short future.

## 3. Results and Discussion

Figure 1 shows that 79% of students hear noise from adjacent classroom. Similar results were found in teacher responses. For the latter, 76% can hear noise from adjacent classrooms, as it is presented in Figure 2. These values are considered very high and must be result of a low sound insulation performance of parting walls. Also, internal zoning of the schools was not a concern in the design stage as well.

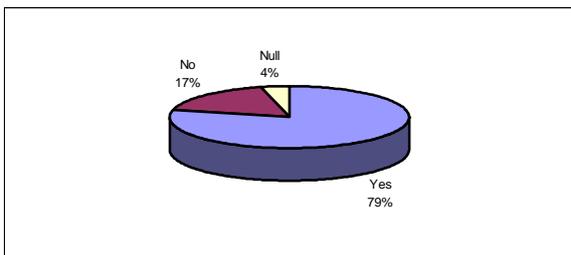


Figure 1: Students result for the question: “Can you hear noise from adjacent classrooms?”

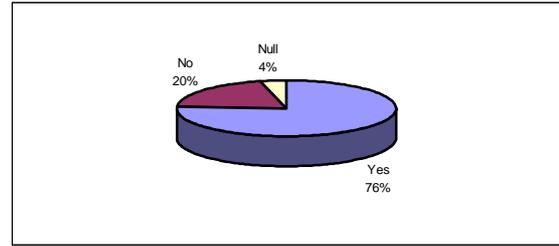


Figure 2: Teachers result for the question: “Can you hear noise from adjacent classrooms?”

Figures 3 and 4 show that 42% and 43% of students and teachers, respectively, consider their classroom a noisy place. It was considered extremely bad to have such a high percentage of users complaining about noise. This noise can come either from inside or outside the classroom. Most related sources are the adjacent classes, recreational areas and corridors. Also, it was reported that near doors and windows and at the back of the rooms are the noisiest places. It does not come as a surprise that close to openings are the areas with higher sound transmission and, therefore, where one would expect more complains. In Brazil, as a country of hot weather conditions, it is normal to have opened doors and windows during classes all year around. As for the back part of the room, this is the area where teachers have more difficult to control chats among students because is far from the blackboard, where the teachers stands.

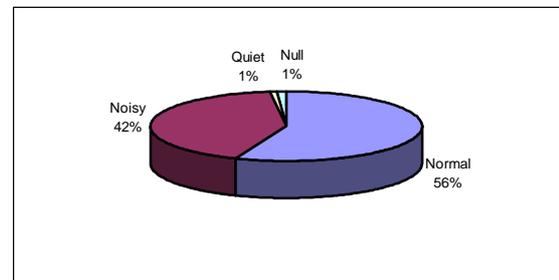


Figure 3: Students result for the question: “How do you consider your classroom?”

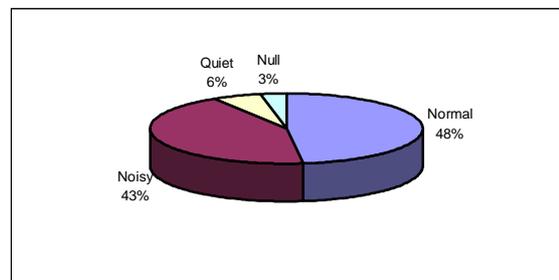


Figure 4: Teachers result for the question: “How do you consider your classroom?”

Figures 5 and 6 show teachers and students evaluation

of intelligibility 38% of students have difficulty in hearing the teacher and some of them pointed out that the teacher voice “sounds strange”. On the other hand, 40% of teachers have the same problem when students ask them questions. Nevertheless, it is well known that good intelligibility conditions can be achieved by the correct design of classrooms, that is to say, an appropriate sound insulated envelope and an adequate amount of sound absorption surfaces.

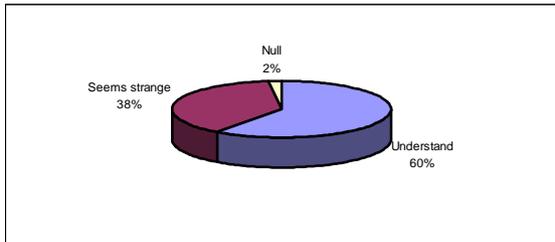


Figure 5: Students result for the question: “When the teacher is speaking, can you understand clearly what it is being said or does it sound strange?”

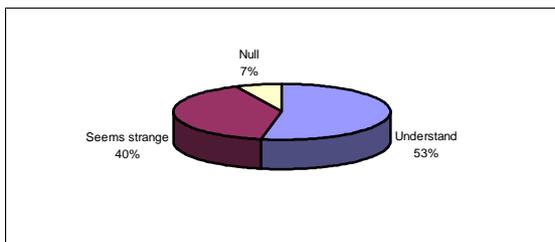


Figure 6: Teachers results for the question: “When the students are asking questions, can you understand them clearly or do they sound strange?”

Extracted from the students responses, Figure 7 shows that 68% consider that noise influences academic achievement. As far as the are teachers are concerned, 91% of them considered the same. It is important to have users that acknowledge the importance of acoustical conditions on the academic achievement.

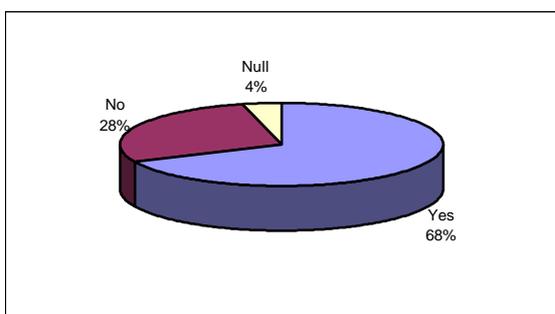


Figure 7: Students results for the question: “Does noise influence academic achievement?”

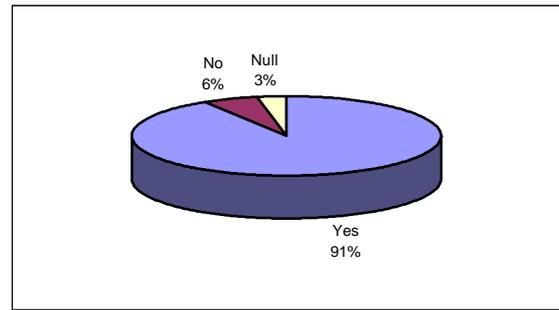


Figure 8: Teachers results for the question: “In your opinion, does noise influence academic achievement?”

The next figures are related to vocal aspects of teachers in classes. Figure 9 shows that 59% of them have some kind of vocal disorder. Figure 10 indicates that 72% raise their voice to teach. Therefore, the latter may be the explanation for the vocal disorders.

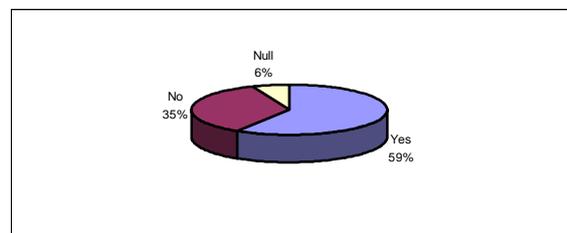


Figure 9: Teachers results for the question: “Do you have or had vocal disorders related to the use of voice as a teacher?”

Figure 11 presents that 55% consider the excess of noise as the main cause of vocal disorders, followed by the classroom architecture (19%) and their own way of speaking (23%).

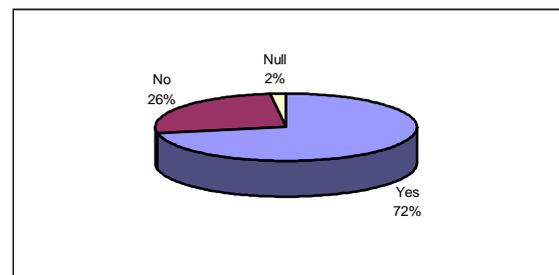


Figure 10: Teachers results for the question: “Do you consider necessary to raise your voice to teach?”

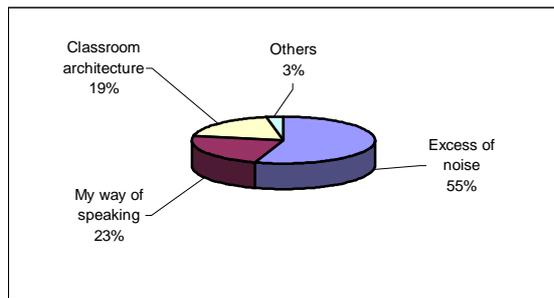


Figure 11: Teachers results for the question: "In your opinion, which are the causes for your vocal disorders?"

#### 4. Concluding Remarks

The questionnaires applied to students and teachers showed that both users have similar perception about the acoustical environment in their school and classrooms. Their opinion is that the conditions are far from what would be desirable. The majority of them hear noise from adjacent rooms. In addition, 42% of them consider their classroom a noisy place. These results show a bad sound insulation performance of partitions and an inadequate internal layout planning of the schools. Rooms with different acoustical needs are close to each other.

As far as intelligibility is concerned, 38% of students and 40% of teachers say they have problems to hear one another. Considering that only 2% mentioned hearing problems, it is a major concern to have such a large amount of people with difficult to understand what is being said. The expected consequence is a decrease in the learning ability of the students.

The effect of high noise levels and large reverberation and early decay times make an inadequate environment for teaching-learning. Both individually reduce intelligibility and their combined outcome extremely bad.

An important information is that 59% of teachers had or have some kind of vocal disorder originated from its use in teaching. It was stated that the causes of their problem come from high noise levels in the classroom (55%) and from bad architectural design of the classes (19%). Both considerations are under the architect responsibility at the time of the school design. Thus, health treatment are necessary for the workers but the cause must be treated i.e. architectural conditions are to be altered.

#### 5. Acknowledgements

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