



Evaluation of Educational Buildings in Southern Brazil

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Noise pollution in cities has been an ever increasing problem. Several noise sources, specially those from road traffic, are rising constantly. On the other hand, buildings have not been designed in such a way to avoid noise break-in, as well as internal partitions and walls do not offer enough insulation. In Brazil, architects and engineers responsible for the school designs do not take into account the sound quality of educational buildings. Considering the kind of activity performed in the premises, it is extremely important to have an adequate acoustical environment, otherwise it might contribute to low student performances and a decrease of learning abilities. For the teachers, high noise levels make them uprising their voices, even if this attitude does not guarantee better listening conditions. This research presents the evaluation of public state schools in the state of Santa Catarina, southern Brazil, by means of architectural evaluation and questionnaires. The results show that the situation is far away from the ideal, since there are many acoustical problems originating from bad building design or the use of inadequate materials. The questionnaires show that the users have the perception that the situation is not good.

1. INTRODUCTION

The school has the main purpose the education of children, young and even adults in some cases. It is undeniable that it has a great importance in the community. The school buildings shall have the adequate conditions for its use by the students, teachers and workers. The adequate environment is a must considering the following aspects: protection in different climatic conditions, temperature, wind and humidity; acoustical quality, protection against external and internal noise, intelligibility by students and teachers; good visual and illumination conditions, natural or artificial, protection against air pollution and good internal air quality; structural stability, hygiene, security, comfort and others.

Nowadays, there is a decreased of learning's quality, mainly in the public state schools in Brazil. This is the result of many aspects such as the low investment on the buildings and infra-structure, in the teachers qualification, on the implementation of efficient pedagogical methodologies, in the acquisition of materials or in the general maintenance. Considering the importance of the subject, the acoustical quality has a major importance in the guarantee of adequate environments for teaching and learning, considering aspects of classroom acoustics or building acoustics.

This paper is part of a bigger study and it evaluates the situation of the (elementary and junior high) public state schools in the state of Santa Catarina, in southern Brazil, more specifically located in the city of Florianópolis. The present study shows the results of the architectural survey and the questionnaires applied to students and teachers. The acoustical measurements will be presented in later meetings since its results are now in process.

2. THE CONSEQUENCES OF NOISE IN SCHOOLS

2.1. Users related aspects

Silva [1], reported that the first reactions of those people under noise conditions are irritability and restlessness. Also, the author related that noise affects the intellect, specially the ability of concentration, decrease the ability of working, intellectually and physically.

Celani, Bevilacqua & Ramos [2] on its study about noise in schools, presented that the process that children uses the redundancy of information to understand the voice signal in noisy conditions gets prejudiced. It occurs because younger children does not have the codes of language and information developed, and the result is that they cannot understand very well the noise signal under low signal to noise ratios. Lukas, *apud* Bradley [3], in one of the first studies with respect to noise and schools, found that the performance of students under noise environments, on reading and math tests was diminished. The reading test scores of the sixty grade students exposed to noise were 0,7 years behind comparable to those from quiet schools. Vallet [4] pointed out that the problems that arise from people who are under noise conditions are: a) decreasing of intelligibility of lessons; b) diminished in attention and mental fatigue; c) delay on learning ability for reading, d) lack of interest in hearing the teacher and e) vocal fatigue among teachers.

Certainly, it would be pretentious to say that only acoustical aspects are responsible for low student performance. The difficulty to correlate this aspects with the performance of students is elevated and it makes possible to use only subjective results. There are many aspects in a school that can contribute for low student performances, such as environmental comfort, psychological, pedagogical and even politics. Although it is undeniable that bad acoustical conditions in schools influences in the school people in a negative way.

For the teachers, the worse problems that come from excess of noise are related with vocal disorders. The communication is part of the teacher's job, and he uses it for his education profession. Hence, any problem with this ability of using the voice, will bring problems not only for himself but also for the children who will have difficulty on understanding. Airey [5] concluded that many teachers suffer with voice disorders and throat diseases with respect of bad acoustical designs of classrooms. The high noise levels combined with high reverberation times provide a bad environment where the teachers have the need of increasing their voices to be heard and understood by the students. Naturally, it is going to appear some vocal problem with passing the years such as loosing the ability to talk, throat and voice disorders, and other consequences for the students. As bigger the problem gets, more chances to be a permanent problem it has.

It is not difficult to find cases that teachers have to retire or slow down the work hours to have the opportunity to recover their ability of talking. Vocal treatments are needed, but they are not the solution, since there is no value a teacher recovered from its vocal problem, coming back to work in the same and noisy environment that he used to have before. It is necessary to correct the real cause of the problems or he could lost all the treatment benefits.

2.2. Building Related Aspects

2.2.1. Road traffic noise

The schools part of this study are mostly located in a urban area which the traffic from streets can be considered one of the main noise sources or even the main source in many cases. Priede [6] reported the following parameters that influence on traffic noise: a) engine; b) road excitation; c) air buffering. Also he said that the most important are confined to a) and b). Dockrell [7] carried out a research with primary students in two thousand schools in London and concluded that the following noise sources were heard inside classrooms, and the students were annoyed by it: cars (71%), sirens (61%), trucks (58%), motorcycles (56%), airplanes (55%), helicopters (54%), and buses (36%). In the same way, he concluded that the three first sources are annoying the students. Considering as a noise source, the traffic is not under the building planners responsibility. This one cannot do many actions on the way to control it on its source.

2.2.2. Neighbors

There are many sources coming outside the school besides the traffic. Small industries, dog barking, garbage truck, building constructions and neighbors can influence the school.

In another way, the school can be a noise source for its neighborhood. The noise produce inside school areas can come from patios, parking lots, sports court and the playground. There is one case in the city of Blumenau, where a school was obligated from the court, to make an adequate acoustical treatment of the gym, because it was a noise source and the community beside were bothered by it. Through this case, it is clear that there is a “two-way” trouble about acoustics of educational buildings. There is a need to make acceptable spaces inside and also spaces that does not interfere outside.

2.2.3. Sports, recreational and circulation areas

In sports courts there is a great amount of noise being generated from steps, balls hitting the floor, players screaming, cheers and whistles. In many schools the space for the recreational activities is located in front of classrooms, in central halls, what is a very problematic situation. The doors and windows have not enough insulation normally and it makes one of the worse situations. It is easy to find schools where the noise from this areas are even worse than that from traffic. Inside gyms, the main problem is the lack of absorbing surfaces creating a very reverberating environment, and the intelligibility decrease a lot.

The circulation areas are also an important noise source inside schools. People passing, children running and talking, all of this activities are normal in corridors that link classroom to other spaces inside school. The patios are places where leisure, sports and general activities happen. These places are very noise because it concentrates many people producing noise.

2.2.4. Canteens, cafeterias and snack bars

The preparation of food can be noisy, depending on the way it is fixed. Fried food, electrical appliances and silverware can be very noisy, specially when combined with the noise from the students during the meal. There is a tendency of people to be noisy in meals because it is not

only a time to eat but also a leisure time. Niederstaetter [8] reported that in these areas, there are noise sources from impact of plates and glasses, colliding pots, moving tables and chairs.

2.2.5. Adjacent classrooms

When any noise or sound is produced in a classroom, depending on architectural and constructive characteristics, it can be possible to interfere on adjacent rooms, having a negative influence on it. Also, buildings with more than one floor have the special need of a resilient layer in the floor, in order to avoid structural noise from steps, moving chairs or objects falling in the room above.

2.2.6. Water pipes installation

In cases where the water pipes are located in walls between restroom-classroom, the noise produced can propagate through the building structure and reach near rooms. Also, walls not designed properly can facilitate the leaking of sound. Bistafa [9] pointed out, among others, the noise sources from water equipment and installations: a) vibrations of pipes, b) water passing throughout curves and valves, c) fast close of valves after using it, and others.

2.2.7. Electrical equipment and building elements

Besides general noise sources, there are others that can be originated from electrical equipment such as fans, a/c, computers and printers, grass mower and many goods used in the every-day. In another way, the use of the building can generate noise. Doors and window closing and hitting the wall, moving furniture and toys.

2.2.8. Own students

The students inside classroom can be a great source of noise. Many aspects related to the control of the students by teachers can influence on it. A class that a teacher have difficulty to keep the attention can be much noisier than another one where the students keep concentrate in what the teachers talks. The noise originated from the sources above can be considered as a competing sound for the teacher. This one has to speak louder than the other sources to make chance to be heard, elevating the signal-to-noise ratio, and also, creating problems to its own voice when the level is moderate or high.

3. METHODOLOGY

It is part of the methodology first review the literature and make previous visits to the schools, interviews with the architects that design the schools, the engineers and others institutions related with the study. Secondly, it was made an architectural survey of the conditions of the school sites and buildings and the materials used to construct those buildings. A specific table was made for it. After that, two groups of questionnaires were distributed for students and teachers. The population of the respondents was about 35% of a group of 7th and 8th grade students. It was decided that only this older students would answer the questionnaires because they can have a better comprehension of the study and its objectives. Younger students could have difficulty to answer and also they could have a wrong comprehension of the subject as it was found out in previous analysis.

3. RESULTS

The architectural survey found out that there is a standard building design as presented in Figure 1. The same figure shows the noise sources. It can be seen that many sources are very close to the classroom, space that requires minimum ambient noise.

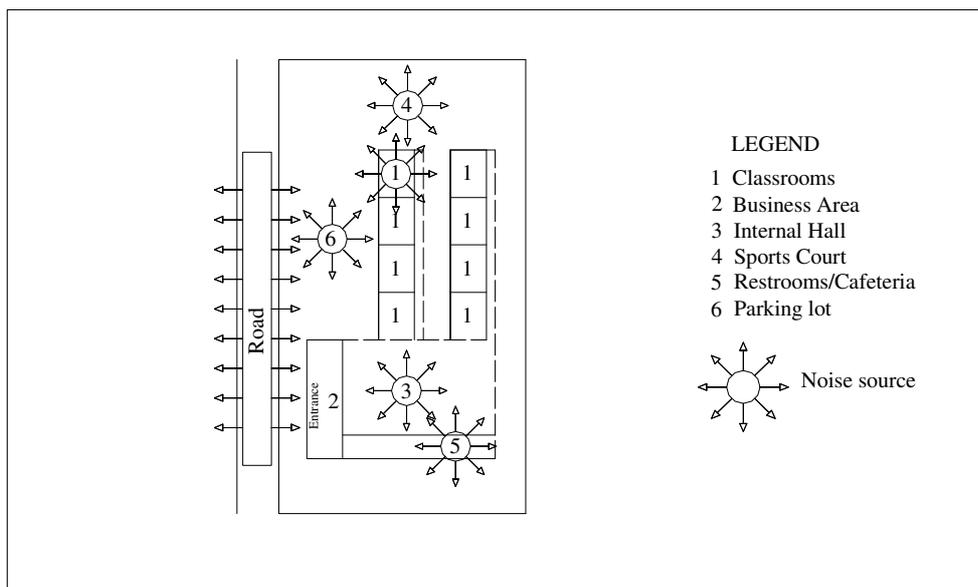


Figure 1 – Sketch of a standard school building with its noise sources.

The questionnaires show that most of the student can hear sound from adjacent classes, as shown in Figure 2 below.

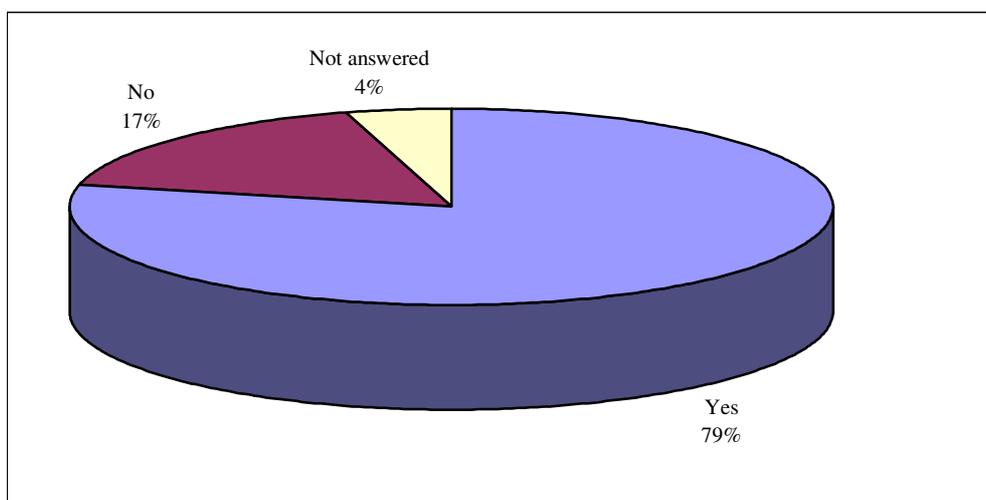


Figure 2 – Results for the question: “Can you hear any noise from adjacent rooms?”

4. CONCLUSIONS

This paper presented the evaluation of primary schools in the state of Santa Catarina, southern Brazil. After architectural analysis it is concluded that the buildings are not planned considering to provide adequate acoustical environments. Among the facts, the distance from the architects designers and the site of the building is a negative aspect, and normally they do not even know the site of the school and its noise sources before the construction. Also, internal zoning and planning of the building are not considered. The materials are not properly chosen to avoid noise break-in and control reverberation. It is common to use single windows panels beside a very noisy street. The maintenance is far away from the ideal and it collaborates to make the situation worse. Many doors does not even close because there are no lockers due to bad maintenance.

The results of the questionnaires show that the users of the school – students and teachers – are aware about the bad acoustical situation of schools and classrooms. This results have the same conclusion suggested in the architectural survey. Also, the results between the answers of students and teachers are very similar, what makes the results more reliable since different groups of users have the same opinion in the subject.

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REFERENCES

1. P. Silva, “Os efeitos “Pernilongo e cascata”. *Revista Acústica e Vibrações*, 9(jun) pp.19-25. 1991.
2. A. Celani; M. Bevilacqua; C. Ramos, “Ruído em escolas”. *Revista Pró-Fono*. 6(2) pp.1-4. 1994.
3. J. S. Lukas, “Effects of noise on academic achievements and classroom behavior”. *State of California Report FHWA/CA/DOHS-81/01*, Berkley. 1981. *Apud* J. S. Bradley, “Speech intelligibility Studies in classrooms”. *Journal of the Acoustical Society of America*, 80 (3), pp.846-854, 1986.
4. M. Vallet, “Some European standards on noise in educational buildings”. In: *Proceedings of the International Symposium on Noise Control for Educational Buildings*. Istanbul, 2000. pp.13-20.
5. S. Airey, “The effects of classroom acoustics on school teachers”. In: *Proceedings of the International Symposium on Noise Control for Educational Buildings*. Istanbul, 2000. pp.21-29.
6. T. Priede, “Origins of automotive vehicle noise”. *Journal of Sound and Vibration*. 15(1), pp.61-73. 1971.
7. J. Dockrell, et al. “Children’s perceptions of noise in schools”. In: *Proceedings of 17th International Congress on Acoustics*. Rome. 2001.
8. C. Niederstaetter, “Acoustics of primary school canteens”. In: *Proceedings of 17th International Congress on Acoustics*. Rome. 2001.
9. S. Bistafa, “Conscientização para o problema do ruído nas instalações hidráulicas prediais”. *Revista Acústica e Vibrações*, 9(jun) pp.5-17. 1991.