The noise impact in the learning-teaching process in an elementary school

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***Abstract*—**Excessive background noise, or even noise emissions coming from the surroundings of the school environment, may become a barrier concerning communication within the school community. The aim of this study was to evaluate the impact of noise from outside, as well as the noise generated within the school building of a primary school and its influence on the performance of their students. The sample is constituted by the school EB1/JI in Prozela, an elementary school, located close the International Airport Francisco Sá Carneiro, in the municipality of Maia.

***Keywords*—** Aircraf Noise, Urban Noise, learning-teaching, impact noise.

I. INTRODUCTION

THIS study aims to assess the impact of noise from outside as well as the noise generated within the school buildings taking into deliberation it´s influence on students' performance in the Elementary School. Were studied the effects of aircraft noise on teaching and classroom activity in an elementary school close to Francisco Sá Carneiro Airport, both by direct measurements and by a survey of teachers' and students' opinions

II. NOISE IN SCHOOLS AND ITS IMPACT ON CHILDREN´S LEARNING ABILITY

Educational establishments in Portugal have been subject to an intensification of educational and technological equipment to help in the latest teaching methodologies. On the one hand, this situation provides a proactive action of the students with a recognized added-value from the educational system. On the other hand, it becomes imperative to prepare the physical environment for student and teachers receive these technologies and properly use them.

Fiorini [8] argues that the process of learning, the amount of given information is too large and, in fact, most of this information consists of new subjects for children. Thus, the attention that should be paid concerning the acoustic quality of the environment to ensure an adequate reception becomes very important. Intelligibility is reflected well in the process of speech reception by individuals. In this process, losses of any content transmitted may occur and these losses may be caused by several factors, including low-rate signal.

III. ACUSTIC STANDARDS IN THE CLASSROOM

The World Health Organization (WHO) proposes values, laid out in Table 1, as the reference values regarding the maximum noise-level and reverberation (echo) time in schools.

The level of background noise of 35 dB (A), is based on the assumption that the sound produced during teacher's activity is equal to 55 dB (A), measured at 1 m distance.

Table 1. Reference values for maximum noise levels and reverberation time in schools, according to the WHO

	Noise Levels, dB L_{Aeq}	Reverberation Time, sec.
Classrooms	35	0.6
Outside areas for leisure	55	-

Source: [13]

In Table 2, presented by the *American National Standards Institute (ANSI)*, we can find references of noise levels measured in areas where learning activities usually take place, such as classrooms, libraries, auditoriums and other, assuming that these spaces are furnished / equipped yet unoccupied.

Table 2. Maximum levels of background noise and reverberation time in places where learning takes place- ANSI S12.60-2002

Room Volume	Background Noise Levels, dB $L_{Aeq,\ 1\ hour}$	Reverberation Time, sec.
< 283 m^2	35	0.6
> 283 m^2 and ≤ 566 m^2	35	0.7
> 566 m^2	40	-

Source: [1]

The BB 93 is a document produced by the *Department for Education and Skills*, which sets out recommendations on heating, electrical, ventilation and acoustic systems for school buildings. It takes into account several indicators of noise level, reverberation time and acoustic insulation, with respect to more than thirty different kinds of spaces.

Table 4 summarizes the legally admissible parameters at national level, with respect to the acoustic requirements for school buildings.

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Table 3. Noise level limits in classrooms and reverberation times for a selection of school buildings - BB 93

	Noise Levels, dB $L_{Aeq,\ 30min}$	Reverberation Time, sec.
Primary School Classrooms	35 (*40*)	<0.6 (*0.5-0.8*)
High-school Classrooms	35 (*40*)	<0.8 (*0.5-0.8*)
Auditoriums (>50 people)	30 (*35*)	< 1.0

Source: James, 2002

Table 4. School Buildings (Law-Decree n.º 129/2002)

Ref	Element/place	Mínimo regulamentar
1a)	Between outside and recipient compartments	D2m,n,w≥28dB – in sensitive zones D2m,n,w≥33dB – in mixed zones (if there is no classification -- consider mixed zone)
1c)	Among recipient compartments obtained from other places within the building	L´n, w≤60dB if the local transmitter is a local corridor with large circulation, gymnasium, canteen or workshop L´n,w ≤65dB if the local transmitter is a classroom or a contiguous room
1d)	Medium time of Reverberation (between 500, 1000 e 2000Hz), T, with furniture and without occupation	$T \leq 0.15xV^{1/3}$[s] in classrooms, multipurpose rooms, libraries, canteens and gymnasium
1e)	Average equivalent sound absorption area (between 500, 1000 and 2000Hz), A, in halls of great circulation	$A \geq 0.25xS_{planta}$, where $A=\alpha_{med}$ x $S_{envolvente}$, with $\alpha_{med} = \alpha_{sabine}$ average between 500 and 2000Hz
1f)	In recipient compartments the value of LAr of the particular noise from the building equipments must be:	Libraries LAr ≤38dB(A) if the working schedule is intermittent LAr ≤33dB(A) if the working schedule is continuous Remaining recipient compartments* LAr ≤43dB(A) if the working schedule is intermittent LAr ≤38dB(A) if the working schedule is continuous

IV. NOISE LEVELS AT EB1/JI PROZELA SCHOOL

The present study focuses on the elementary school EB1/JI Prozela. This educational establishment is located in the parish of Moreira da Maia, near the International Airport Francisco Sá Carneiro. This is the reason why this school was the subject of study in regard to assessing the impact of environmental noise (Fig. 1).

Source: Google maps

Fig. 1 Elementary School 1/JI Prozela

The building is a "Centenary Plan" type which consists in four rooms distributed for 2 floors. This school has 95 students enrolled, 5 teachers and 4 school assistants.

A. Methodology

The methodology considered two types of evaluation: a subjective evaluation that consisted in the application of surveys to the school population and an objective evaluation that consisted in measurements of noise levels *in situ*. This *in situ* measurements was carried out by the use of two sound level meters of type 1 (S1 and S2), checked and calibrated by the Portuguese Institute of Quality (IPQ).These were programmed to collect the following noise indicators: L_5, L_{95}, L_{max}, L_{min}, LA_{eq}, L_{IT}.

(a)

(b)

Fig. 2 Measurements *in situ*: (a) outside; (b) inside

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B. Measurement of Background Noise Level in the Inside and Outside of the School

a) School "on"

According to Tables 5 and 6 presented below, resulting from the outside measurements with the school "on", it can be observed that there is a notorious influence of air traffic (airplanes) in a way that the LAeq values are significantly higher when compared to the period with higher airplane circulation. The obtained results within the interior of the school are significantly higher than the outside results, since to the level of noise reaching the facade of the building can be added the "indoor" noise.

Table 5. Measurements in the outside – School "on"

Date of Measure	10-03-2010			11-03-2010		
Place of Measure	Spot 1			Spot 2		
Time	9:55	11:30	14:27	10:05	11:20	11:52
Sound Meter	S1	S1	S1	S1	S1	S1
LA_{eq}	56,5	51,9	51,2	50,3	52,3	60,2
L_5	57,9	57,3	54,7	54,9	53,7	66,1
L_{95}	45,9	41,8	40,5	43,3	43,1	44,6
Number of planes	59	57,8	56,3	56	56,1	64,9
Calib.Value.	5	2	3	1	2	5
	93,9 dB		93,8 dB	93,9 dB		94,0 dB

Table 6. Measurements in the inside – School "on"

Date of Measure	10-03-2010			11-03-2010		
Floor of Measure	1st Floor			Ground Floor		
Place of Measure	P1	P2	P3	P1	P2	P3
Time	10:00	11:30	14:30	10h	11:15	11:47
Sound Meter	S2	S2	S2	S2	S2	S2
LA_{eq}[dBA]	79	74	74	70	67	63
L_{max}[dBA]	98,6	96,4	98,9	92,8	88,9	85,5
L_{min}[dBA]	38,8	43,8	44,1	39,1	34,4	39,3
Calib.Value [dBA]	94,0	94,0	94,0	94,0	94,0	94,0

b) School "off"

Having in consideration that the following analysis (Tables 7 and 8) was based on a premise that the school is "off", this being without the presence of students, teachers and non-teaching staff, the obtained values, whether inside or outside the school building, were significantly lower than those that were observed during the "on" mode. It is important to mention that this analysis was only possible during night-time, for opening schedule purposes.

Table 7. Measurement in the outside – School "off"

Date of Measure	26-04-2010			26-04-2010		
Place of Measure	Spot 1			Spot 2		
Time	20:23	20:55	21:27	21:59	22:30	23:00
Sound Meter	S1	S1	S1	S1	S1	S1
LA_{eq}	48,4	47,3	50,9	52,1	41,4	44,2
L_5	56,3	57,4	51,4	51,9	47,5	59,4
L_{95}	44,2	43,7	43	40,3	40	39,7
Number of planes	3	5	1	1	2	2
Calib.Value. [Dba]	92,8					92,6

Table 8. Measurement in the inside – School "off"

Date of Measure	26-04-2010			26-04-2010		
Floor of Measure	1st Floor			Ground Floor		
Place of Measure	P1	P2	P3	P1	P2	P3
Time	20:15	20:57	21:29	22:01	22:32	23:03
Sound Meter	S2	S2	S2	S2	S2	S2
LA_{eq}[dBA]	39	37	37	34	34	35
L_{max}[dBA]	72,2	64,7	68,6	64,4	62,7	63,9
L_{min}[dBA]	26,1	26	25,9	23,7	23,2	22,8
Calib.Value [dBA]	94,0	94,0	94,0	94,0	94,0	94,0

c) Comparison of measured values and the L_{den} noise map

In agreement with the established in Portuguese Legislation, the acoustic zoning map classifies the land in two classes: "sensitive areas", which have allocated existent or foreseen residential uses, as well as schools, hospitals, recreation and leisure; and "mixed areas", which overlap the uses of sensitive areas plus other ones like retail shops and services, parking, etc.. This legislation forces the consideration of outdoor noise levels in the planning process, namely in the elaboration of zoning plans. According to the provisions of the law, sensitive areas may not be exposed to an equivalent continuous sound level in all day-time (A-weighted average sound level – Lden(A)), higher than 55 dB(A) and 45 dB(A) in night-time (period between 9.00 p.m. and 7.00 a.m., Ln(A)); mixed areas may not be exposed to a Lden(A) higher than 65 dB(A) in all day-time and 55 dB(A) in night-time; and sensitive areas close to an big infrastructure such an airport may not be exposed to a Lden(A) higher than 65 dB(A) in all day-time and 55 dB(A) in night-time.

If we analyze the charts presented in Figure 3 one can conclude that the school building under study is located in a sensitive area close to an airport and is exposed at noise levels of Lden <65 dB for the period that comprises day-evening-night and Ln <55 dB for the night.

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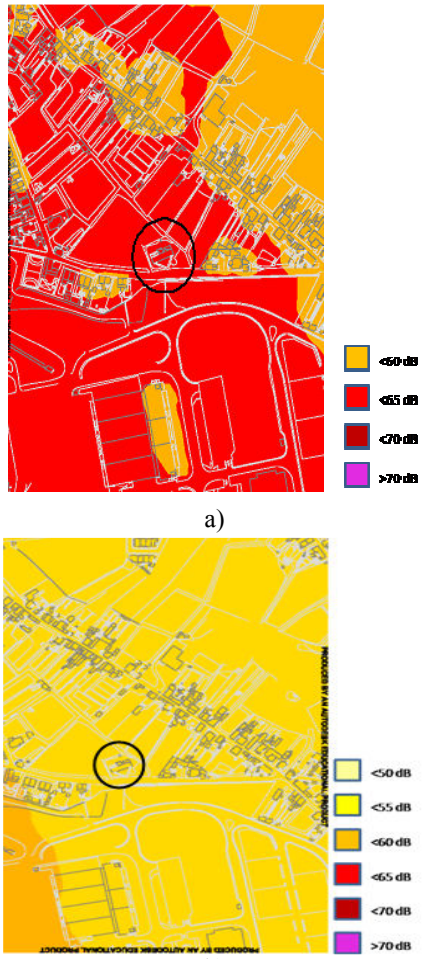


a)

b)

Fig. 3 Noise maps, L_{den}(a) e L_n (b)

C. Perceptive evaluation

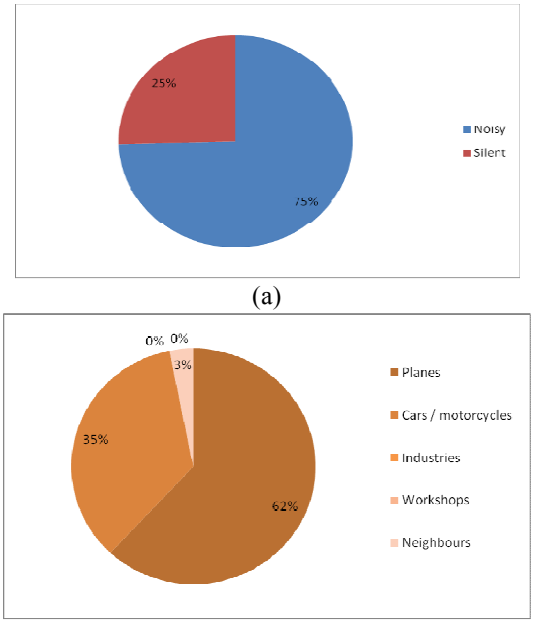
The impact evaluation of the noise in the learning process was carried out with two distinct surveys. One was conducted with a sample of 6 teachers and another one for 63 students from different grades (1st grade, 2nd grade, 3rd grade and 4th grade).

a) **Students´ Perception**

In this study, only 3 of the questions stated in the questionnaire will be stated, as well as its results and they intend to express the main indicators that shall be analyzed.

Thus, Picture 4a is representative of the question "Is your classroom noisy or quiet?", in which can be observed that 75% of students answered "NOISY" and the other 25% of the surveyed students answered "QUIET".

This result is clearly influenced by the noise from the students attending classes and by the teacher. Moreover, it depends, in a rather subjective way on the subject that is being taught at the moment (requiring higher or lower concentration).



(a)

(b)

Fig. 4 Assessment of noise perception inside the classroom

Regarding the question *"What is the noise coming from outside the school that you hear the most in your classroom?"* (Fig. 4b), the largest percentage of answers indicates airplanes (62%). This number is clearly influenced by the proximity to the Airport Francisco Sá Carneiro. Only 35% of students considered that cars and motorcycles were also significant in terms of noise-making and the rest 3%, consider that the neighborhood was to be blamed for the blare. Industries and workshops were not mentioned.

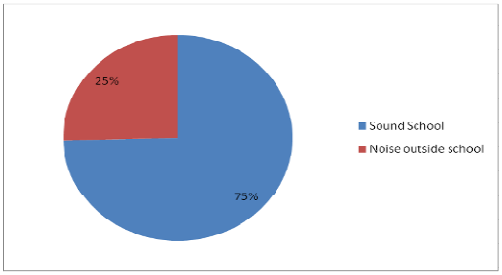


Fig. 5 Predominant noise within the classroom

When asked about the noise that they hear more in the classroom (Fig. 5), 75% of the students answered that it is for all intents and purposes the noise derived from the entire school that affects them the most. However, only 25% of the responses argue that it is, in fact, the noise coming from outside the school that disturbs the most. These results are justified by the indicators mentioned above, influenced mainly by the number of students, provision of school spaces (contiguous classrooms) and the teacher's pedagogy. On the other hand, it is inseparable from the dichotomy between the indoor noise and outdoor noise, since the outdoor noise influences the behavior of students and teachers in the classroom.

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b) Teacher´s Perception

Of all the inquiries made to teachers in this study we will address only two questions as we consider these to be the most pertinent for this analysis. In fact, the questions are related to discomfort coming issued from the outside noise and its interference in the classroom. As illustrated in Fig. 6, when asked about the annoyance caused by external noise, teachers clearly indicate that the responsibility for that noise should be claimed by the airplanes. Still, in the scale of values assigned, the number of answers is based solely on the word "LOW", which demonstrates that despite the proximity to the airport, according to teachers, it is not significantly disruptive in the classroom. One factor underlying is that they got used to having this type of noise, as they lecture in this school for more than one year.

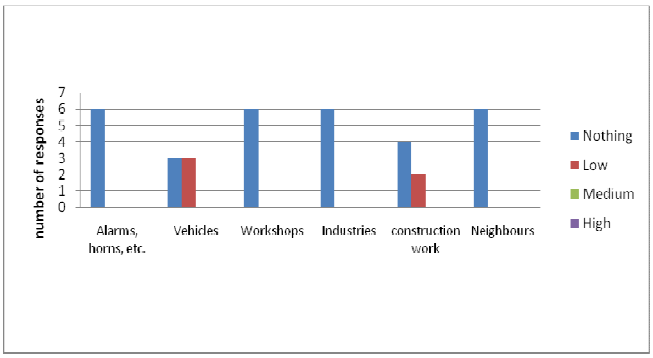

Fig. 6 Assessement of the perception of outside noise

Regarding the noise interference in the context of the classroom, it is perceptible a great number of different answers (Fig. 7). On the scale of values that has been used, it can be observed that the blare of all the students is a major noise that affects them most, as well as the noise from other classrooms. However, one should highlight the fact that the level of external noise was found to be "LOW" in the scale of values, which indicates that there is an interference of the noise levels caused by the take-off and landing of airplanes located near the school.

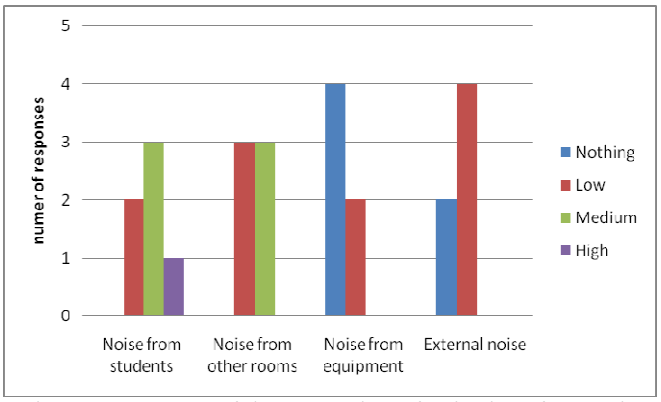

Fig. 7 Assessment of the perception of noise interferance in the classroom

V. CONCLUSION

There are innumerous factors that can have an influence on the noise-levels that were obtained during this study. Having in consideration that every procedure was dully accomplished within each technical norm, we can conclude that indeed this school presents and respects the normal-levels of noise, established for the local area. However, these levels can definitely have a consequence in the teaching-learning process of the students that are enrolled.

The proximity from a major infra-structure such as the Francisco Sá Carneiro Airport is a crucial factor in obtaining important noise-levels. It can also be concluded that the existence of social factors such as the urgent need of special educational support for some students is, indeed, an influential factor of the noise-levels that are below to the levels taken as normal. The surveys have proved to be fundamental for the validation of the obtained measurement values a, through this perceptual evaluation there is a clear identification of a convergence of values collected and how noise is perceived by users of space.

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