A SURVEY ON THE ACOUSTICAL CONDITIONS IN A SPANISH SECONDARY SCHOOL

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RESUME. Cette communication donne une détaillée information sur les conditions acoustiques d'une école de baccalauréat de Gandia (Espagne). Les niveaux de bruit, les temps de réverbération et les coefficients d'intelligibilité on été mesurés in différent salles de classe. Les opinions des professeurs et étudiants sur les conditions acoustiques de cette bâtiment scolaire ont été aussi évalués.

ABSTRACT. The present paper reports on a study of the acoustical conditions in a secondary school of Gandia (Spain). Our data include a complete information on noise levels, reverberation times and speech intelligibility of classrooms, together with the results of two social surveys adressed to teachers and students in order to know their attitudes towards this problem.

INTRODUCTION

The schools are established to promote learning, which is acquired largely by voice and listening. Therefore, acoustics is one of the most important physical properties that determine how well the school buildings can serve their primary function (1).

During the last decades some effort has been devoted to determine the effects of environmental noise on schools (2)(3)(4). Most of these investigations are based in the subjective responses given by the teachers to a specific questionnaire. A number of these studies have also indicated that excessive noise can influence the speech intelligibility, performance and even behaviour of school students.

The present communication reports on a pilot survey, carried out in a secondary school of Gandia (Spain), and includes the data obtained in detailed acoustical measurements, together with the results of two social surveys adressed to teachers and students in order to know their attitudes to this problem.

ACOUSTICAL MEASUREMENTS

The Institute Ausias March is one of the three secondary schools

of Gandia, a medium size city located about 60 km south of Valencia (Spain). The two floor building was constructed about 1930 and it is situated in the city centre. This school consists of 28 classrooms and laboratories of small and medium capacity, one general purpose lecture room, one recreation courtyard, one professors room and a number of offices, stores and service rooms. At the present, there are about 60 professors and 800 students in this school.

Noise levels have been measured along several consecutive days in five different points of the school. Three locations correspond to the external facades of the building (two streets and one corner), with quite intense road traffic. The two other measurement points were situated in an internal corridor and in the open air recreation courtyard. All these measurements were carried out using a 1/2 inch condenser microphone (BK4165), a noise level analyzer (BK4426) and an alphanumeric printer (BK2312). The hourly values of L_1 , L_{10} , L_{50} , L_{90} , L_{99} and Leq have been obtained in all cases.

The noise levels measured in external facades show the typical day variations found out in many noise surveys (5). For instance, the values of equivalent sound levels Leq measured in the most exposed facade range from 50-55 dBA (during night) to 70-75 dBA (during day). The values of Leq measured during the activity period in the internal corridor and in the recreation courtyard of the school are about 72-76 dBA and 65-70 dBA, respectively.

In the classrooms facing to the noisiest street internal noise levels are about 55 dBA (windows closed) and 65 dBA (windows open), far away from the acceptable level of 40 dBA. The average noise insulation of the building facades is about 20 dBA. Average noise insulation of walls between adjacent rooms is about 30-35 dBA.

The reverberation times RT have been measured in some typical classrooms using a sound power source (BK4205), a precision sound level meter (BK2230) with octave filter (BK1625) and a portable level recorder (BK2306). Obviously, the values obtained depend of room size, furniture and finish of walls and ceiling. For instance, in an empty classroom of about 200 cubic meters, the reverberation time is 2.1 seconds at a frequency of 1000 Hz.

Finally, a number of measurements of speech intelligibility, (using the method of rapid speech transmission index or RASTI) (6), have been carried out in ten different classrooms. For unoccupied classrooms, RASTI values range from 0.40 to 0.45. For occupied classrooms in actual working conditions (from 15 to 40 students depending of room size), RASTI values range from 0.57 to 0.67.

SOCIAL SURVEY (TEACHERS)

A total of 33 teachers have completed the questionnaires (55% of total). The respondents were male (61%) and female (39%), with a wide age range: from 20-30 years (16%), 30-40 years (42%), 40-50 years (32%) and older than 50 years (10%). About 30% of respondents are teaching less than 10 years and 70% more than 10 years.

A five point semantic scale has been used to rate the subjective evaluation of the classrooms conditions (in a general sense). About 28% of interviewed teachers declare that these conditions are "very good" or "good", 40% "fair" and 32% "bad" or "very bad". The opinions about a number of specific conditions of the classrooms are quite positive in general. However, the classroom noise background deserves

a most negative evaluation: about 85% of the respondents consider that the classrooms where they are teaching are "noisy".

According to the teachers, the noise perceived in the classrooms is originated mainly outside the classrooms (76% of responses). Road traffic is the most annoying noise source: about 32% of the total sample declare to be "very much annoyed" by traffic noise, 36% "rather annoyed", 28% "moderately annoyed" and only 4% "little" or "not at all annoyed". Another quite disturbing noise sources are the students in the own classrooms, the school courtyard and the adjacent classrooms (in this order).

Most of the respondents declare that environmental conditions of educational centers are an important factor of their work. All of them know are conscious that this building is not sound insulated. They experience that noise is much more disturbing at the end of the academic course (April/June), when classroom windows are usually open. Related to this point, many teachers declare that they keep windows closed in warm weather to reduce the outside noise immission. On the other hand, the practice of raising the voice to overcome noise seems to have a high cost: about 26% of teachers declare to suffer "often" some throat disease (aphonia, hoarseness, etc.).

Most of teachers consider that noise disturbs significantly (two upper steps in a five step scale) the attention of students (89%), interferes the communication teacher-students (92%), produces an additional stress in the teachers (88%) and make nervous to the students (76%); absolutely all respondents opine that noise is a negative factor of educational process (100%).

SOCIAL SURVEY (STUDENTS)

A total of 602 students have completed the questionnaires (75% of total). The respondents were male (44%) and female (56%) from 14 to 19 years old, attending to four different teaching levels.

Above all, the analysis of responses shows that the general evaluation of the classroom conditions is more positive for students than for teachers. About 50% of the students opine that classroom conditions are "very good" or "good", 34% "fair" and 16% "bad" or "very bad". In coincidence with teachers, most of students consider that the classrooms of this school are spacious, tidy, pleasant, luminous, etc. They coincide also in that noise is the most negative feature of classrooms (66% of responses).

Regarding to the origin of noise perceived in classrooms, the coincidence with the teacher responses is almost perfect: about 74% of students opine that noise is mainly generated outside the own classrooms. Although the students coincide in that road traffic noise is a very important noise source, the corresponding annoyance seems to be lower than experienced by teachers. In addition, the responses of the students reveal that the disturbance produced by the noise originated by the own students inside or outside the classrooms is also lower.

Not surprisingly, the criticism of students about noise effects is not as strong as teachers. However, they consider also that noise disturbs their attention (61%), interferes the communication (75%) and make them nervous (45%); about 73% of students opine that noise is a "very" or "rather" negative factor of educational process.

Most probably, the differences in the responses of teachers and

students are related to a different general sensitivity towards noise in general in these two population groups. In the answers to a direct question on this subject, about 23% of teachers declare to be "very much" sensitive to noise, 62% "rather", 11% "moderately", 4% "little" and 0% "not at all". The corresponding percentages for students are 7%, 29%, 40%, 19% and 5%, respectively.

The hearing sensitivity of a reduced sample of students ($n=20$) has been also measured using a Maico A40 audiometer. Mean hearing loss of this group is 19 dB for 500 Hz, 9 dB for 1000 Hz, 4 dB for 2000 Hz and 8 dB for 4000 Hz; in some particular cases, the observed hearing losses are astonishingly high. Although the sample is too reduced to be conclusive about the real causes of such hearing losses, it should be mentioned that 90% of students assist "often" to discos, pubs or pop concerts, 60% drive "often" a motorcycle and 20% uses "often" earphones to hear music. More work on this important subject is now in progress.

CONCLUSIONS

The results obtained in a series of physical measurements (noise levels, reverberation times and speech intelligibility) and in two social surveys (teachers and students), carried out in a secondary school of Gandia (Spain), have revealed that the acoustical general conditions of this school are quite deficient and, in some cases, they are clearly unacceptable. There are reasons to believe that the excessive noise and reverberation of the classrooms are very negative factors for the educational activities of this center.

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