

POLITECNICO DI TORINO
Master of Science in Sustainable Architecture
Honors Theses

The *Green School* project: Classroom acoustics and vocal load of teachers in high-schools. Maxwell and Avogadro institutes

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This work is part of the **Green School Project**, a cooperation between Polytechnic of Turin and the Province of Torino, which has the aim of developing methods and tools to facilitate the transformation of existing school buildings in *green schools* offering healthy and comfortable environments for students and teachers.

As a basic part of the research project, this thesis focuses on the evaluation of **acoustical quality** in learning environments of high school classrooms. For this research two case studies were considered, differing in location, period of construction and classrooms dimensions. School **A**, Avogadro institute, built in the first part of XIX century, is located in the city center, close to a high vehicular traffic road. Its façade is made by bricks and double-glazed windows and it is characterized by high volumes of about 210 m³ and 280 m³ and by some classrooms having acoustical treatment on false-ceiling. School **B**, Maxwell Institute, dating back to the second half of 1900, is placed in a suburban area, nearby a quite road traffic noise street. The facade is made of prefabricated concrete elements and double-glazed windows. It is composed by three types of classrooms with volumes of 170 m³, 210 m³ and 330 m³ and all classrooms had acoustical treatment.



Avogadro Institute, Torino.



Maxwell Institute, Nichelino.

To give acoustic comfort assessment in schools this work proposed a methodology, consisting in **objective in-field measurements** and **subjective impression evaluation**, aiming to create a standardized protocol that can easily be applied to extended campaigns in schools. To achieve a complete acoustic evaluation of school environments several parameters were considered: sound insulation of partitions, room acoustics, speech intelligibility and noise in occupied environments.

Measurements were performed in unoccupied and simulated occupied classroom condition, using proper instruments. Second part of measurements focused on teachers' vocal monitoring through the Voice-Care device, recently developed at the Polytechnic of Turin.

Teachers vocal load over several working days was monitored, analyzing their main vocal parameters expressed in sound pressure level at one meter from the teachers' mouth (SPL_{1m} , dB), fundamental frequency (F_0 , Hz), and phonation time percentage ($Dt\%$, %). Background noise (L_{A90} , dB) was also measured repeatedly for time intervals during the teachers voice monitoring and then related to the different teaching activities and subjects.



Voice-care device

Teachers were asked to give their impression of acoustical comfort in classrooms, answering appropriate surveys. Teachers' subjective perception regarded noise disturbance, vocal effort and reverberation after each monitoring and averagely across the overall teaching period.

At last a statistical approach was used to assess possible correlations and association between in-field measurements and self-reports. These analysis showed a possible correlation between classroom acoustics, background noise and teachers' vocal load, although it is necessary to increase the data sample in order to state any real correlation.

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