Preschool room acoustics - collected and analysed data in the research project SPACE (Supportive Preschool AcoustiC Environment)

Data collection and analysis

The data set contains the result of room acoustic measurements and additional information from 57 rooms in 19 different public preschools in the Gothenburg municipality (Sweden). The measurements were conducted during 2019-2020. Children at preschool are divided into units commonly, but not always, based on age. The presented data covers in total 31 different units aimed at older children. Up to three rooms per unit were measured, focusing on the main playrooms and the meal room. In cases where these rooms were the same, only one room per unit was measured.

The preschools are divided into three groups, strata, based on the year when they were built: 1980-1994, 1995-2006, and 2007-2018.

To reach an even distribution with respect to socioeconomic factors we used an existing preschool-specific index acquired from the central preschool administration [Jorsäter, M., Resursfördelningsmodell Göteborg 2019. 2019, Statistics Sweden (SCB)] (attached as a PDF file). The index is based on a model from Statistics Sweden (SCB) where school performance after elementary school is linked with explanatory variables related to the socioeconomic background of the individual child and her/his parents. When these factors are known for the children at a specific preschool, an averaged index is calculated, centred around 100: Preschools with an index over 100 have a larger share of children with a risk of not qualifying for high school (gymnasium). Preschools with an index less than 100 have a smaller share of children with a risk of not qualifying for high school. The purpose of the index is to prioritize economic support to school units with the highest need and increase equity.

Room acoustic parameters and unoccupied noise levels were measured in each room using a laptop and an external 8-channel sound card (HEAD acoustics SQuadriga II). An omnidirectional sound source with a built-in generation of pink noise (50-20000 Hz) was used to excite the room. A modification was made to the device in order to extract the electronic signal from the loudspeaker.

Unoccupied noise levels were measured in accordance with ISO 16032:2004. In some rooms the contribution from the ventilation could be estimated by conducting the measurements with the ventilation unit turned on and off separately.

Room acoustic measurements were conducted following the precision method in ISO 3382-2:2008. Three microphones were used simultaneously with predetermined height intervals (1±0.2, 1.4±0.2, 1.6±0.2). The standard's recommendation to use natural source positions were implemented by placing the loudspeaker where we estimated that a child would have its head during sitting and standing activities in the room. In addition, a corner position was always used. Impulse responses were calculated by the software ArtemiS SUITE using the loudspeakers extracted electronic signal as the reference.

Impulse responses and unoccupied sound pressure level spectra were exported to Matlab. Octave band room acoustic parameters were calculated for 125 – 8000 Hz from the impulse responses with the ITA-toolbox 8.6 [Berzborn, M., et al., The ITA-Toolbox: An Open Source MATLAB Toolbox for Acoustic Measurements and Signal Processing, in DAGA 2017. 2017: Kiel.]. The analysis was done for reverberation time T20 and EDT (Early decay time), and Speech Clarity, C50. An addition to the code was made to evaluate the Clarity index with a shorter time, C35, which uses 35 ms instead of the default 50 ms [Whitlock, J.A.T. and G. Dodd, Speech Intelligibility in Classrooms: Specific Acoustical Needs for Primary School Children. Building Acoustics, 2008. 15(1): p. 35-47.]

Sound strength, G (dB), was calculated from the sound power of the loudspeaker LW (measured according to the ISO 3741 standard) and the resulting sound pressure level Lp in a measurement point: G=Lp - LW + 31 [SS-EN ISO 3382-1:2009].

Additional information collected during the measurements:

- Dimensions and shape of the room
- The floor and wall type of construction material is classified into heavy or lightweight
- A subjective evaluation of the degree of furnishing and categorized as sparse, normal or dense.
- Material type of the acoustic treatment in the ceiling: porous type (typical white mineral wool) or other various types, e.g. perforated gypsum boards
- Sound absorption on the walls* and their approximate total area

*The concept wall absorption is interpreted as a fabric or porous material mounted on, or in the vicinity of a wall and which was subjectively judged as acoustically absorbing.

The SND-data set, files and variables

General

The dataset consists of seven spreadsheet files where each row contain data from one preschool room. Each preschool room is identified with 4 numbers:

- ROOM_ID1: Represents building year interval:
  "1"=1980-1994, "2"=1995-2006, "3"=2007-2018
- ROOM_ID2: Represents the number of the preschool within each building year interval
- ROOM_ID3: Represents the unit number within each preschool
- ROOM_ID4: Represents the room number within each unit

Missing data is indicated with an empty cell.

Collected information

XLSX-file "INFO"

- SES = Socioeconomic index of preschool
- Volume = Volume of room in (m^3)
- FloorA = Floor area (m^2)
- Height_min / Height_max = height to inner ceiling (m)
- FurnDeg = Subjective furnishing degree, 1 = spares, 2 = normal, 3 = dense
- FloorConst = Floor construction, 1 = lighweight, 2 = heavy (concrete)
- WallConst = Wall construction, 1 = lightweight, 2 = heavy, 3= mixed
- CeilingAbs = Acoustic ceiling, 1 = porous (mineral wool), 2 = other (commonly perforated boards)
- wallAbs = Amount of wall absorbers (m^2)

Room acoustic parameters

Measured room acoustic parameters are presented as room-averaged for the three different microphone heights separately: low = 1±0.2, mid = 1.4±0.2 and high = 1.6±0.2 m and for the octave bands from 125 Hz to 8000 Hz. An example is shown in Figure 1 for the parameter Sound strength, G, provided in the spreadsheet file "G.xlsx". Sound strength in the octave bands 125 Hz and 250 Hz are displayed for the two rooms [1 1 1 1] and [1 1 1 2], the results from the different microphone heights are separated.

RoomID_1	RoomID_2	RoomID_3	RoomID_4	G_125_low	G_125_mid	G_125_high	G_250_low	G_250_mid	G_250_high
1	1	1	1	19.3	18.2	19.2	20	20	19.9
1	1	1	2	21.9	20.5	20.7	21.5	21.9	22.6

Figure 1: *An example of the structure of the room acoustic data, here from the spreadsheet file "G.xlsx". Sound strength, G (dB), in the octave bands 125 Hz and 250 Hz are displayed for the two rooms [1 1 1 1] and [1 1 1 2]. The results from the different microphone heights are separated.*

XLSX-file "T20"

Reverberation time T_{20} (s)

XLSX-file "EDT"

Early decay time (s)

XLSX-file "G"

Sound strength (dB)

XLSX-file "C50"

Speech Clarity (dB)

XLSX-file "C35"

Speech Clarity with integration time 35 ms (dB)

Background noise level

Unoccupied noise levels are presented as L_{eq} levels in 1/3 octave bands from 25 Hz to 10000 Hz in the spreadsheet file "BKG.xlsx". For some rooms there is also an estimated contribution from the ventilation system to the background noise equivalent level.

XLSX-file "BKG"