CLASSROOM ACOUSTICS SURVEY WORKSHEET-BASIC[1]

Date _____ Audiologist/Surveyor _____

School _____ Room _____ Teacher _____ Student _____

_____ Grade _____

1. OBSERVATION INFORMATION

A classroom observation is a preparatory step for making classroom acoustics measurements. The observation provides information about acoustic parameters of the classroom as well as the style of instruction, seating arrangement and the status of communication access.

Background Noise

Listen in the classroom and check for the following; a "yes" is an indicator of potentially excessive levels of noise.

Classroom Features	Yes	No
Heating and ventilation system is audible		
Mechanical equipment must be turned off during important lessons		
Noise from playground is audible		
Noise from automobile traffic is audible		
Noise from air traffic is audible		
With heating and ventilation system turned off, sounds from other classrooms , learning spaces or hallway are audible		

Reverberation

Overall reverberation is determined by the volume of the room and the absorptive characteristics of the materials making up the classroom walls, floors and ceilings. Check the classroom for the following surfaces; a "yes" is an indicator of potential high reverberation times.

Classroom Features	Yes	No
A hard surface, flat ceiling without acoustic ceiling tiles		
Ceiling height is over 11 feet		
Acoustic ceiling tiles have been painted		
Walls are constructed of sound reflective materials (e.g., plasterboard, concrete, wood paneling)		
Floors are constructed of sound reflective materials (e.g. concrete, tiles, wood)		

Current Technology in the Classroom (if used)

- ☐ Personal FM Number of students ___ Type_____
- ☐ Individual Audio Distribution System Type_____
- ☐ Classroom Audio Distribution System Type_____

Teacher to Listener Distance: Nearest ____ Ft Farthest ____ Ft

Classroom Style: ☐ Traditional ☐ Open ☐ Portable/Relocatable

Primary Instruction Style: ☐ Lecture ☐ Large Group ☐ Small Group ☐ Individual Other_____

[1]*Source:* Adapted by C. D. Johnson, D. Ostergren, and J. Smaldino (2010) from Acoustic measurements in classrooms by J. Smaldino, C. Crandell, & B. Kreisman, 2005. In *Sound Field Amplification,* Crandell, Smaldino, & Flexer (Eds.) p. 131. Thomson Delmar Learning. Reprinted by permission. Updated 2024.

Seating Arrangement: ☐ Clusters ☐ Rows ☐ U-shape or Circle Other_____

Classroom schematic diagram: see attached

2. NOISE MEASUREMENTS

	Ambient Noise Levels (dBA)				Teacher Voice Levels (dBA): 0ccupied Classroom			
Location	Condition: **U**=unoccupied; **O**=occupied; **Hon**=HVAC on; **Hoff**=HVAC off _____ _____ _____ _____				Level	S/N ratio	with Classroom Audio Distribution System Level	S/N ratio
A*								
B								
C								
Average:								

* Target Student

3. REVERBERATION TIME

Estimated:

Room Volume (V) = _____ cubic feet

Area Floor _____ X ABS. Coef. _____ = A Floor _____

Area Ceiling _____ X ABS. Coef. _____ = A Ceiling _____

Area Side Wall 1 _____ X ABS. Coef. _____ = A Wall 1 _____

Area Side Wall 2 _____ X ABS. Coef. _____ = A Wall 2 _____

Area End Wall 1 _____ X ABS. Coef. _____ = A End 1 _____

Area End Wall 2 _____ X ABS. Coef. _____ = A End 2 _____

Total A _____

RT of classroom = .05X_____ (V)/ _____ (A) = _____ seconds

4. CRITICAL DISTANCE

Estimated level from Critical Distance Chart: _____ Ft

Recommended classroom acoustic standards for core learning spaces <10,000 ft volume (ANSI/ASA S12.60-2009, 2010): Ambient Noise Level: 35dbA; Reverberation Time: .6 seconds (adaptable to .3 s for children with special listening needs)

Directions for Classroom Sound Level Measurements

Equipment needed: Sound pressure level (SPL) meter or SPL Meter App that has a minimum lower limit of 35dbA, 20 ft measuring tape or laser device, reading material (e.g., reading passage from book).

1. Draw a schematic of the classroom on the back of the form and mark the locations of the measurements (A-C). Generally, measurements should be taken from student desks at the four corners, the middle and the middle back of the room. If there is a target student, use location A to mark that student's position and eliminate middle back of room. Additional positions can be added if necessary.
2. Turn on the SLM; if there is an option, be sure it is set on the A-weighted scale and on slow response. If you can set the range of the meter, set it to accommodate 40-60 dBA to begin.
3. Ambient Noise Levels (HVAC=heating, ventilation, air conditioning)
    a. Measurement 1: *Unoccupied classroom, HVAC system off* (HVAC systems often cannot be turned off- therefore this condition is not always possible). Ambient noise levels should be measured at several locations in the classroom as levels may vary according to distance from noise sources. Be sure that the A* measurement is taken at the location where the target student sits. Indicate condition in the column header: **UHoff** (unoccupied, HVAC off). If it is not possible to make measurements when the room is unoccupied, have the students be quiet. Record the results in the first column on the table.
    b. Measurement 2: *Unoccupied classroom, HVAC system on* (*if possible).* Repeat measurement 1 indicating in column header: **UHon**.
    c. Measurement 3: *Occupied classroom, HVAC system on (if possible)*. Measure the ambient noise levels at the same locations as in Measurement 1 & 2 with the students present in the classroom while they are doing a quite activity such as working at their desks; record levels in the next column of the table and label the column: **OHon** or **OHoff** depending on the condition. If the noise level fluctuates greatly, take three measurements at 1-minute intervals, and average the readings and record those on the form. These measurements will provide an estimate of the ambient noise level during an instructional period. If measurements can only be taken when students are not in the classroom you may convert the unoccupied noise levels to occupied by adding 10dB to each unoccupied measurement. This conversion is roughly equal to the known difference in noise level between *average* unoccupied and occupied classrooms.
    d. Calculate and record the average ambient noise level for each condition measured.
4. Teacher Voice Levels:
    a. Position the teacher in the typical instructional position in the classroom. The students should be seated in their normal seats for instruction. It is important that the measurements are made in the time period when instruction occurs so that the acoustic conditions are representative of actual instructional environments.
    b. Orient the SLM to approximate the center of each selected student's head while he/she is seated at his/her desks. Point the SLM toward the teacher position, taking care to avoid placing your body in the sound path between teacher and student, which can produce inaccurate measurements.
    c. Ask the teacher to begin reading the selected material and record the teacher voice levels on the form at the same locations using the same procedures outlined in 4b. These measurements provide an estimate of the speech level (e.g., teacher's voice) during an instructional period.
    d. Determine speech(signal)–to-noise ratio (SNR) of the classroom by subtracting the ambient noise level from the teacher voice level at the selected student locations. For example, a student location with a teacher voice level of 60dBA and an ambient noise level of 50dBA would have a SNR ratio of +10dB. One with a teacher level of 60dBA and a noise level of 70dBA would have a SNR of -10dB.
    e. Averaging all teacher voice levels and subtracting from the average ambient level for the various conditions will calculate an average SNR level.
5. Teacher Voice Levels – with Classroom Audio Distribution System:
    a. Repeat the steps 5a-e above.
    b. Compare results to the condition without the system to determine the benefits of the audio distribution system. The goal is even distribution of the teacher's voice throughout the classroom demonstrating an improvement of 8-10dBA.

Directions for Estimating Classroom Reverberation

Equipment needed: 20 ft measuring tape or laser tape; calculator.
Formula to estimate classroom reverberation time: RT=.05 V/A where RT=reverberation time in seconds, V=volume room, and A=total absorption of the room surfaces in Sabins.

1. All the reverberation estimates can be conducted in an unoccupied classroom. Because a formula is used that is based on surface absorption co-efficients, no improvement in accuracy is obtained with students and teacher present. With more detailed measurements, the presence of the room occupants would be desirable.
2. Calculate the volume of the classroom by measuring the length, width, and height of the classroom in feet and multiplying them together (volume=length of room x width or room x height of room)

3. Record the resultant room volume in cubic feet on the classroom documentation form.
4. Multiply the volume of the room by the constant .05 to obtain the numerator for the RT=.05 V/A equation. Record the results on the classroom form.
5. To obtain the denominator of the equation, the area of the walls, floor, and ceiling of the room must first be calculated in square feet. If the walls, ceiling, or floor are irregularly shaped, each section must be measured separately. The area of the floor and ceiling is determined by multiplying the length of the floor or ceiling times its width. The area of the walls can be obtained by multiplying the length of each wall by its height. Enter the values for the area of each on the classroom documentation form.
6. The absorption coefficient (Abs. Coef.) is the ratio of reflected energy to the amount of energy absorbed of a specific material. The coefficient, expressed in Sabins, must be determined for the material composing the walls, ceiling, and floor. Average absorption coefficients are given in the table below for the most common construction materials. If a different construction material is encountered and you use another absorption coefficient table, average the coefficients given in the other table for 500, 1000, and 2000 Hz for the purpose of these calculations. Enter the average absorption coefficient in the appropriate place on the documentation form.
7. Multiply the area of each floor, ceiling, and wall times the absorptive coefficient of the material composing the surface. Add up all the resultants of the multiplications to obtain the A (total absorption of the room in Sabins) in the RT=.05 V/A formula for the room and record it on the form.
8. Take the numerator from Step 3 (.05 x V) and the denominator from Step 6 (A=total absorption in Sabins for the room) and divide them to determine the estimated reverberation time of the room in seconds (RT=.05 V/A). Enter the estimate on the documentation form. A more accurate and detailed (frequency specific) RT of a room can be obtained using a reverberation meter or phone application.

Sound Absorption Co-Efficients for Common Classroom Materials

Material	Ave. Absorp Coefficient	Material	Ave. Absorp Coefficient	Material	Ave. Absorp Coefficient
WALLS:		FLOORS:		CEILINGS:	
Brick	0.04	Wood parquet on concrete	0.06	Plaster, gypsum, or lime on lath	0.05
Brick painted	0.02	Linoleum on concrete	0.03	Acoustic tiles (5/8")- suspended	0.68
Concrete block painted	0.07	Carpet on concrete	0.37	Acoustic tiles (1/2")- suspended	0.66
Window glass	0.03	Carpet on foam padding	0.63	Acoustic tiles (1/2")- not suspended	0.67
Plaster on concrete	0.03			High absorptive panels- suspended	0.91
Plaster on studded walls	0.05				
Plywood paneling over studs	0.07				

Directions to Determine Critical Distance

Using the table below, match the room volume and estimated reverberation time; the resulting value is the critical distance. Up to and including this distance from the speaker, reflections from the sound reverberating in the room will enhance the speech signal; beyond this distance the speech signal will be degraded by the later reflections of the sound reverberations. For example, for a room of 10,000 cubic feet and a reverberation time of .4 seconds, the critical distance is 10 feet. It is important that students with special listening requirements are not positioned any further than 10 feet from the speaker in this situation.

Estimated Critical Distance Table

Room Volume (Cubic Ft)	Reverberation Time (seconds)							
	.3	.4	.5	.6	.7	.8	.9	1.0
2000	5.2	4.5	4.0	3.7	3.4	3.2	3.0	2.8
4000	7.3	6.3	5.7	5.2	4.8	4.5	4.2	4.0
6000	8.9	7.7	6.9	6.3	5.9	5.5	5.2	4.9
8000	10.3	8.9	8.0	7.3	6.8	6.3	6.0	5.7
10,000	11.5	10.0	8.9	8.2	7.6	7.1	6.7	6.3
12,000	12.6	11.0	9.8	8.9	8.3	7.7	7.3	6.9
14,000	13.7	11.8	10.6	9.7	8.9	8.4	7.9	7.5
16,000	14.6	12.6	11.3	10.3	9.6	8.9	8.4	8.0
18,000	15.5	13.4	12.0	11.0	10.1	9.5	8.9	8.5
20,000	16.3	14.1	12.6	11.5	10.7	10.0	9.4	8.9
	Critical Distance (feet)							