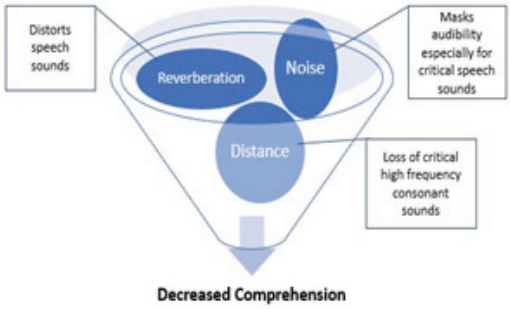
School-based Audiology Advocacy Series
Classroom Acoustics

(Approved by the Board of Directors of the Educational Audiology Association December 2020[1])

Classroom Acoustics and Hearing: Essentials to Learning

Children need to hear clearly to learn in the classroom. They spend 60-75% of their school day actively listening to their teachers and peers (Butler, 1975, Dahlquist, 1998). They can tolerate only so much background noise and reverberation for good perception of speech, and, therefore, comprehension and learning are compromised. Good acoustics require both environmental factors and appropriate room design.



Depending upon the classroom's walls, floor and ceiling surfaces, room size and shape, and seating configuration, the potential for loss of information transmitted from the teacher or other talker to the student can be extremely high. **Hearing and comprehension problems are most likely to occur as the distance increases between the teacher and student, when noise levels in the room are high and/or when the room is highly reverberant as shown in this illustration. Frequently these situations occur simultaneously. The resulting interaction multiplies the impact, further reducing speech understanding.**

Noise sources can be in the classroom, in the school building and outside the school as well as sound generated by occupants or noise from equipment in the room that can be turned on or off (e.g., computers, fans). The relationship of background noise levels to the teacher's voice level is referred to as the signal-to-noise ratio. Young learners, learners with reduced hearing, auditory processing deficits, and English language learners are among those students requiring speech to be heard at significantly greater levels than the background noise in their classrooms (Crandell, Smaldino, & Flexer, 2005). Classroom audio distribution systems are not sufficient for students with reduced hearing. These students require remote microphone systems connected to their personal hearing technology, and these personal systems can usually be connected to the classroom system.

Child vs Adult Listening

The impact of noise, distance and reverberation cannot be easily assessed simply by an adult listening in the classroom. Adults have a hearing advantage in adverse listening situations due to fully matured central auditory systems, background knowledge and a mature use of English.

Reverberation refers to the persistence or prolongation of sound within an enclosed space as sound waves reflect off hard surfaces. Excessive reverberation times frequently cause distortion of speech sounds may significantly impact a student's ability to understand spoken information, especially those learners described above. Information about the negative effects of poor classroom acoustics on learning, strategies to improve classroom acoustics, and accommodations to improve communication access should be discussed with all school staff and classroom personnel.

The educational audiologist is typically the most knowledgeable member of the school multidisciplinary team for assessing classroom acoustics and determining appropriate classroom modifications to best address students' listening needs. Educational audiologists should be actively involved in measuring background noise levels and reverberation times and determining the impact of these factors on a student's ability to access auditory information in the classroom. It is also important to know the individual signal-to-noise ratio requirements for students with auditory disorders or special listening needs to determine the most appropriate type of hearing assistive technology. Educational audiologists must always be involved when considering and selecting hearing technology including fitting personal hearing assistance technology or installing classroom audio distribution systems, as well as providing staff and student training in their use. For further information regarding assessment for classroom acoustics, hearing technology, and student support, contact your educational audiologist.

Classroom Acoustics Standards

Standards for classroom acoustics are developed by the Acoustical Society of American for the American National Standards Institute (ANSI). The 2010 Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools is briefly summarized in the Appendix. The standard applies to permanent and relocatable classrooms and other core learning spaces with volumes not exceeding 20,000 ft^3 (566 m3) and to ancillary learning spaces of any volume. This standard does

[1]Updated from the 2009 Classroom Acoustics statement.

not apply to special purpose rooms (e.g., music rooms, auditoria with more strict requirements). Standards for physical education learning spaces up to 640,000 ft3 were adopted in 2019 to improve speech communication in physical education programs by eliminating acoustical barriers in gymnasia and outdoor learning spaces. Sound reinforcement systems should not be used to substitute for failure to meet acoustic design requirements.

These ANSI standards were adopted by the International Code Council (ICC) in 2017 and published in the *ICC A117.1-2017 Standards for Accessible and Usable Buildings and Facilities, American National Standard*. Each state must adopt the standard as part of school building codes for them to be formally incorporated into local school construction.

Applying the Standards with Students

Parents, professionals and advocates should ensure that these standards have been adopted in their states and that the adoption includes the specification that classrooms must be built to be readily adaptable to a reverberation time (RT60) as low as .3 seconds, if warranted, to meet the special listening needs of students within that learning space. If the standards have not been adopted, the Individual Education Program (IEP) team or 504 Plan may stipulate the classroom acoustics standards as a necessary accommodation for the student's classroom learning environment.

References

Acoustical Society of America (2009/2010). ANSI/ASA S12.60.2010. American National Standard Institute Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools, Part 2: Relocatable Classrooms Factors and Part 4 ANSI/ASA S12.60. http://asa.aip.org.

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Dahlquist, L. (1998). Classroom amplification: Not just for hearing-impaired anymore. CSUN 1998 Papers. Retrieved from https://files.eric.ed.gov/fulltext/ED420964.pdf

International Code Council, 2017. A117.1-2017 Standards for Accessible and Usable Buildings and Facilities, American National Standard. Section 808.

Appendix

Summary of ANSI/ASA (2010) Maximum A-weighted background noise and reverberation times in unoccupied, furnished learning spaces in permanent (P) and relocatable (R) and physical education (PE) learning spaces (2019).

Core Learning Space	One-hour average A weighted sound level of interior-source background noise (dBA)			One-hour average A weighted sound level of exterior-source background noise (dBA)		Maximum reverberation time for sound pressure levels in octave bands with midband frequencies of 500, 1000, and 2000 Hz*		
	P	R	PE	P	R	P	R	PE
Enclosed volume <10,000 ft^3 (< 283 m^3)	35	35	40	35	35	0.6 s	0.5 s	.6
Enclosed Volume > 10,000 ft^3 and ≤ 20,000 ft^3 (> 283 m^3 and ≤ 566 $m^{3)}$)	35	35	40	35	35	0.7 s	0.6 s	.8
Enclosed volumes > 20,000 ft^3 (566 m^3)	40	n/a	40	35	n/a	No requirement	n/a	
Enclosed volumes 20,000 – 40,000ft^3 (560-1120 m^3)			40					1.0
Enclosed volumes 40,000 – 80,000ft^3 (1120-2240 m^3)			40					1.2
Enclosed volumes 80,000 – 160,000ft^3 (2240-4480 m^3)			40					1.4
Enclosed volumes 160,000 – 320,000ft^3 (4480-8960 m^3)			40					1.6
Enclosed volumes 320,000 – 640,000ft^3 (8960-17,920 m^3)			40					1.8
Enclosed volumes– >640,000ft^3 (>17,920 m^3)			40					2.0
All ancillary learning spaces	40 dBA	40 dBA	40 dBA	35 dBA	40 dBA	No requirement	No requirement	NA

*Classrooms must be built to be readily adaptable to a reverberation time (RT60) as low as .3 seconds if warranted to meet the special listening needs of students within that learning space.

Source: Acoustical Society of America (2009/2010). ANSI/ASA S12.60.2010. American National Standard Institute Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools, Part 2: Relocatable Classrooms Factors and Part 4 ANSI/ASA S12.60. https://acousticalsociety.org/acoustical-society-standards/.