WISCONSIN DEPARTMENT OF PUBLIC INSTRUCTION

Supporting Optimal Listening Environments for Learning

The purpose of this document is to increase awareness related to the effects of classroom acoustics on listening, learning, and student achievement for children throughout Wisconsin. There is considerable research illustrating that less than optimal classroom acoustics can be a significant barrier to learning for all children, but especially for children with disabilities, limited English proficiency, and middle ear infections. Schools are environments where learning relies primarily on listening. With less than optimal acoustics, all areas of learning can be affected. Increased awareness related to acoustic accessibility can help improve learning outcomes for all learners. It is hoped this information will help school staff evaluate their own classrooms and look for ways to optimize all listening environments.

1. What are classroom acoustics?

Every room has certain physical characteristics that contribute to the overall listening environment. Sound is governed by physics and is a very complicated phenomenon. Distance, noise and reverberation are the three primary dimensions that are most often investigated and their effects will be highlighted.

- **Distance** refers to the amount of space between the teacher and student. Simply stated, the farther the student is away from the teacher / source of instruction, the softer the sound is at the student's ear. Optimal listening occurs within six feet of the teacher, so those students seated closest to the teacher will hear the best.

- **Background noise** in a classroom is generated by multiple sources: students talking and moving; ventilators / heating and air conditioning systems; hallway traffic; adjacent classrooms; computers; overhead projectors; and even sources from outside the building like airports and busy roads. The presence of background noise is commonplace in all classrooms. Even low levels of noise can interfere with or overpower speech sounds, making them harder to hear or distinguish.

- **Reverberation** is sound reflected off hard surfaces like walls, ceilings, floors and windows. Reverberation affects sound by smearing the speech signal and making it less clear and harder to understand. Reverberation is most noticeable in large rooms with numerous hard surfaces like gymnasiums, auditoriums, and cafeterias, but occurs to some extent in all rooms. Rooms that have carpet, furniture, window coverings and lower ceilings will have less reverberation.

- **Signal-to-Noise (S/N) ratio** refers to the relationship of the teacher's voice to the background noise in a given classroom and its effect on speech intelligibility throughout the classroom. A decibel (dB) is the unit of measurement for sound intensity.

    - For optimal word recognition performance, most children require the teacher's voice to be 15 dB above the noise (+15dB S/N ratio).
    - Many classrooms have the teacher's voice equal to the noise (0 dB S/N ratio) or the teacher's voice slightly above the noise (+5dB S/N ratio).

2. How do classroom acoustics affect students?

Research has shown that access to intelligible speech is essential for brain growth. Neurologically, all children need a quieter environment and a louder speech signal than adults until approximately 15 years of age, when the higher auditory brain centers are fully developed. In addition, young children do not have the language base or experience to fill in missing information (as an adult might have) when the spoken message is incomplete or distorted. When speech is heard incorrectly or only partially, it can impact speech and language development, which in turn impacts the higher linguistic skills needed for reading and writing.

3. How do classroom acoustics affect teachers?

Teachers' must use their voices for many hours each day and often at elevated levels so that the students can hear them over the background noise in their classroom. A teacher's voice cannot consistently overcome the effects of distance, noise and reverberation equally for all students throughout the room. Speaking louder actually distorts speech; it does not make it clearer. Vocal fatigue of teachers can mean unequal speech production and volume throughout the school day. Vocal-related illness is a common health issue for classroom teachers.

4. What can be done to improve classroom acoustics, while minimizing the effects of distance, noise and reverberation?

There are a variety of activities that can be done to improve listening environments throughout a school. Some have little or no cost and are simply related to adjusting room arrangements, utilizing features and resources already present in a school, and minimizing noise sources. Others may require greater planning and financial support depending on the goals of the building or district. Contact your district or CESA educational audiologist for assistance specific to your district.

- Minimize noise sources such as computers, fans and overheads by turning them off when not in use.
- Arrange desks to be as far from heating and air conditioning units as is feasible. Have maintenance staff minimize noise output such as rattles and clanking as much as possible.
- Locate special education rooms away from larger noise sources like the cafeteria, gymnasium, playground and music rooms.
- Carpet rooms and hallways to provide excellent noise reduction.

- Explore the use of sound enhancing technology, also known as classroom amplification systems. This type of classroom technology has been successful in improving classroom listening environments for children, thus enhancing their learning and literacy skills. Research has shown improvements in academic achievement, phonemic awareness, speech recognition, attending behaviors, and self-esteem in classrooms with sound enhancing technology.

5. Are there resources available to obtain more in-depth information related to classroom acoustics?

Reference materials supporting the benefits of optimizing listening environments for learning are listed below and are just a sampling of available research.

a. Acoustical Society of America - *ANSI S12.60-2010/Part1: American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools* (2010)
http://scitation.aip.org/content/asa/standard/ansi/ASASTD.ANSI.ASA.S12.60.Part.1

b. Acoustical Society of America - *Classroom Acoustics I: A Resource For Creating Learning Environments With Desirable Listening Conditions* (2000)
http://asa.aip.org/classroom/booklet.html

c. American Academy of Audiology Position Statement: *Classroom Acoustics* (2011)
http://www.audiology.org/resources/documentlibrary/Documents/ClassroomAcousticsPosStatem.pdf

d. American Speech-Language-Hearing Association – *Classroom Acoustics Resources*
http://www.asha.org/public/hearing/classroom-acoustics-resources/

e. Educational Audiology Association: *Classroom Acoustics* (2009)
http://c.ymcdn.com/sites/www.edaud.org/resource/resmgr/imported/Advocacy_ClassroomAcoustics.pdf

f. *Back To School! 13 Facts Revisited, Thirteen Facts To Consider When Maximizing Listening and Learning In The Classroom*, J. Blumack & K. Anderson, The Hearing Review, September (2004) http://www.hearingreview.com/2004/09/back-to-school-13-facts-revisited/

For more information, questions or suggestions, contact:

Stacie (Anastasia) Heckendorf, Educational Audiology Consultant
WI Educational Services Program for the Deaf and Hard of Hearing
anastasia.heckendorf@wesp-dhh.wi.gov
608-355-2023 Voice
608-448-3634 Video Phone
262-749-6763 Cell
608-355-2042 Fax
www.wesp-dhh.wi.gov Website