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Hearing Loss

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Classroom Acoustics:

A Parent's Guide

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Assessing The Acoustics In Your Child's Classroom: A Guide for Parents

By Mike Nixon

Listening and learning for a child who is hard of hearing in a typical classroom can be a challenge under the best conditions. Poor classroom acoustics can be a roadblock to learning and understanding. The good news is that parents can help improve the acoustical environment in the classroom. Here's how you can look, see, listen, and advocate on behalf of your child.

With increasing frequency, parents are questioning the effectiveness of the acoustics in their children's classroom. In order to be effective in their advocacy efforts to question, and even improve, the acoustical environment in the classroom, parents need to be more knowledgeable in order to present an authoritive case to school officials. Assessing a classroom, more often than not is a simple matter of "look, see and listen."

Background noise and excessive reverberation are the primary elements that can interfere with a hard of hearing or deaf child's ability to understand correctly what is being spoken in the classroom.

Note that the emphasis is on understanding rather than hearing. Most hard of hearing children can hear but may not be able to distinguish exactly what was said. This might be due to excessive reverberation that smears the speech signal. Or, in the case of excessive background noise, it may be due to the background noise masking the speech signal.

Simply put, an assessment is a matter of common sense when you know what to look (and listen) for.

Background Noise Levels

Intrusive background noise can come from several sources and often can be easily detectable just by listening. In conducting a subjective assessment of a classroom, "**clearly audible**" is a relative term, which for the layperson may be hard to assess. On the one hand, clearly audible means that the sounds can be heard quite clearly with little effort. On the other hand, sounds may be heard, but only by really having to concentrate. The latter sounds are far less likely to be a problem than those that can be heard effortlessly.

In the unoccupied classroom, **look and listen**. Preferably, the heating and or air conditioning should be off, as should any other appliances that generate any level of noise. Can you hear sounds from the outside of the building such as playground noise or traffic noise from autos, trucks or aircraft? If you can hear such sounds clearly, the chances are that there is a problem.

Next, turn on the heater, unit ventilator or heating and air-conditioning unit. If the sounds are clearly audible, again this may be a problem. One of the most prevalent sources of background noise in the classroom is that which comes from the Heating, Ventilation and Air Conditioning Systems (HVAC). HVAC noise may be a little more difficult to correct but it can be done. In cases where the HVAC noise is excessive, school officials may have to enlist the aid of HVAC experts. Sometimes the solution may be as simple as proper maintenance or reducing the volume of the airflow or fan speed. In any event, it is to your advantage to be able to ascertain the source of noise so that school officials can tackle the problem.

Many classrooms today contain computers that are left on most of the time. Most computers have printers and CPUs (central processing units) with cooling fans that emit interfering sounds. With everything else turned off in the classroom, listen to the computer from several feet away. If the sound is clearly audible, the computer may be a contributing source of intrusive noise.

In the unoccupied classroom, listen for noises from adjacent spaces, the next classroom or the corridor or elsewhere. Note where these noises are coming from. If the school is unoccupied, it may be

necessary to generate your own noise sources, which can be done with the aid of a portable radio with the volume turned up loudly. If you can hear the radio from adjacent spaces, you will be able to hear children's voices.

Outside Sounds

Assuming that you have detected intrusive noise sources, what next? In the case of outside sounds, try to determine where they are coming from; most likely, it will come from the windows.

Think of sound and potential sound leaks as water and the walls, doors and windows as the bucket; if the bucket has a hole in it the water will leak out. So it is in the case of unwanted sound, which becomes noise.

If that is the case, take a close look at the windows and the outside noise source. Many times the windows may not be completely closed or the weather gaskets around the windows may be worn. Many windows have lever handles that snug the windows up to the frames when fully closed. If the windows rattle when pushed into the closed position, there is a strong likelihood of sound leakage through the window units. Often the problem can easily be corrected with a little maintenance and replacement of the weather gaskets.

In older schools without modern air-conditioning units, many times the windows are opened during class instruction periods to improve ventilation. In the presence of outside noise sources this often can be devastating to the child with hearing loss, as many hearing aids will simply amplify any background noise levels. Keep in mind that what may not seem intrusive to the teacher can be devastating to a child, often perhaps, without the child really knowing it.

If you can hear sounds from the corridor or from an adjacent classroom you will need to look at the entry door units and the walls. First, consider the doors. Classroom doors should not be left open as this permits the passage of sound from adjacent spaces. Oftentimes, even with the doors closed, sounds can still be heard.

When this happens check the doors, are they sealed or gasketed around the frame and is there a big gap under the door? Far too frequently, the answer will be "yes." In such cases a simple application of a foam gasketing around the frame will provide a good sound seal. Insofar as the gap at the bottom of the door is concerned, this should be sealed with a "Drop Seal." A drop seal is a device that is applied to the bottom face of the door and contains a pin-activated seal that closes the gap under the door when the door is closed. Drop seals are readily available and can be quite effective in reducing noise through door units.

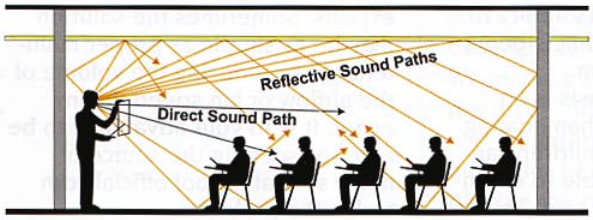
Sound can be quite directional when you are really paying attention to it, so if the sounds appear to be coming through the wall between your child's classroom and the adjacent classroom, you will need to take a closer look. You may have to look at the wall above the suspended ceiling in cases where a tee bar ceiling (drop ceiling with tiles) has been used. With the lights off, lift up a tile and check the wall, if you can see light there is a sound leak.

Next, check the base of the wall. Many times, where the walls have been constructed of drywall, the installing drywallers will jack the sheetrock up off the floor. When the baseboard is applied no one is any the wiser that there is a gap or sound leak under the wall. This often can be detected by simply inserting a knife blade under the baseboard. If the knife blade goes in more than about a half inch, there could be a sound leak which can be sealed by removing the base and caulking the leak.

REVERBERATION

The time it takes for reflected sound to die down by 60 decibels from the cessation of the original sound signal (measured in seconds).

- Reflected sound tends to "build up" to a level louder than direct sound. Reflected sounds **MASK** direct sound.
- Late arriving reflections tend to **SMEAR** the direct sound signal.

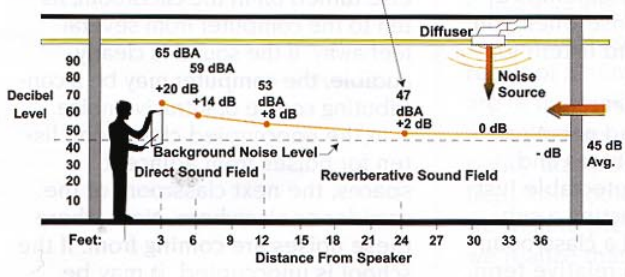


The Direct Sound Path is the shortest distance from the speaker to the listener in which intelligibility of speech is the highest. When the reflected sound "Build Up" becomes louder than the direct sound, the listener is said to be in the reverberative field. As shown in the diagram, the reverberative field in a typical classroom starts approximately at a 12" distance from the speaker. Appropriate acoustical treatment on the ceiling and walls can reduce reverberation.

SIGNAL-TO-NOISE RATIO (SNR)

The sound level at the listener's ear, above the background noise level.

If the Signal at listener's ear is 47 decibels and the background Noise level is 45 decibels, the S/NR = +2 dB.



The average voice level for a teacher is about 65 decibels as measured at a distance of three feet from the teacher. When the student is closer to the teacher or conversely when the teacher positions him/herself closer to the students, the students will experience a higher S/NR. Note that the teachers voice diminishes with distance at a predictable rate.

Quantifying the Background Noise Levels in the Classroom

Once it has become abundantly clear that the background noise levels are intrusive it may be necessary to quantify the noise levels. This can be achieved very simply by measuring the noise levels with a sound level meter.

As defined in the new ANSI Classroom Acoustics Standards, the background noise should not exceed 35 dBA in the unoccupied classroom for good speech intelligibility to occur. While many older classrooms far exceed this recommended sound level, so do classrooms in brand new school facilities. Sadly, room acoustics and noise control do not rate high on the architectural design agenda for school facilities.

A good sound level meter for this purpose is one that can measure sounds as low as 30 - 35 decibels in an A-weighted scale. The A-weighted scale records sounds much the same way as our ears perceive sound, that is to say our ears are less sensitive to low frequency sounds and thus the A weighting electronic circuitry in the meter measures the sounds similar to the way we hear them.

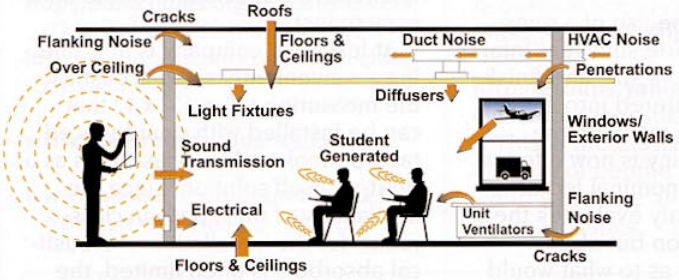
The school district may have a sound level meter (SLM) or it may be necessary to rent one for a day or so. Alternatively, a local manufacturing company might have one for monitoring sound levels in their manufacturing facilities; and, if approached, may be willing to lend it to you.

Taking sound level measurements is a very simple way to determine the background noise levels and need not involve the high costs for a professional acoustical consultant with very sophisticated equipment to make the initial assessment

Armed with an SLM, check the sound levels with all noise sources off in the classroom. Then turn on only the computer; next, turn on only the heating ventilation unit. This way you can begin to establish the sound level contribution of each individual element so that appropriate action can be taken.

AMBIENT OR BACKGROUND NOISE LEVEL

This is the totality of all sounds within the room when the room is unoccupied.



Background noise is the totality of all potentially intrusive noise sources measured in an unoccupied classroom. The sound paths are architectural in nature, due to poorly designed or constructed walls, windows, doors ceilings and mechanical equipment. Sound leakage through doors and windows may be due to long-term wear and tear.

EFFECTS OF SOUND LEAK ON PARTITION SOUND INSULATION

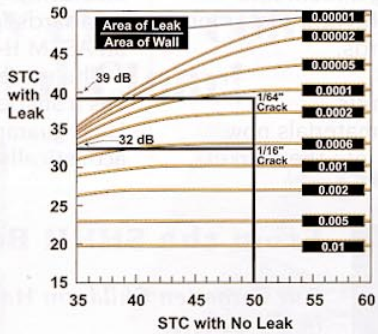
The Relative Area of the Leak for Each Curve is Shown in the Rectangles.

Example:
120" x 96" wall = 11,520 sq. in.

Leak along bottom of wall at 1/16" = 7.5"

Percentage of Wall = .0006%

50 STC Wall Reduced to STC 32



This graph illustrates how a small hole or crack left during construction can reduce the performance of the structure significantly. A hole or crack representing 6/1000 percent of the total wall area can reduce the acoustical performance of the wall from a very good 50 STC rating to a very poor 32 STC rating.

Therefore, it may be up to you, the parents, to assess your child's classroom as an effective learning space that is as free from excessive noise as possible.

Reverberation (RT60)

Reverberation is the sound that persists in a room once the sound source has ceased. Technically it is the time (in seconds) that it takes for a sound to die down by 60 decibels or to 1/1,000,000 of its level at the moment the sound source ceases.

In a large, hard-surfaced gymnasium, for instance, the reverberation can be heard quite distinctly as an echo or persistent sound for several seconds once the original sound has stopped. Though less easy to hear in the average classroom, reverberation is still present and can interfere with speech intelligibility through a smearing effect. That is to say that the reflected sounds are still present and interfere with newly uttered sounds thus causing an overlap that smears the speech signal.

The new ANSI Classroom Acoustics Standards state that for the average classroom (up to 10,000 cubic feet in size) the reverberation time (RT60) should not exceed 0.6 seconds at each of the frequencies of 500, 1,000 and 2,000 hertz. Reverberation is controlled by the amount of acoustical absorption in the room and is determined by the volume of the room and the absorptive characteristics of the room finishes.

The reverberation time can be calculated quite accurately or can be measured with sophisticated acoustical test equipment. Taking reverberation measurements can be quite costly; costing several hundred to several thousand dollars as it normally requires the services of a consultant or expert along with expensive sound measuring equipment. Alternatively, the RT60 can be calculated very

simply through the use of a questionnaire to provide sufficient information on the room size and finishes that is then entered into a computer program to calculate the RT60. One company is now offering this service for a nominal fee of $250 which not only evaluates the room reverberation but also includes a report as to what would need to be done to correct excessive reverberation.

Correcting excessive reverberation is relatively simple, as it requires only additional acoustical treatment to bring a room into compliance with the new Classroom Acoustical Standards.

Acoustical Materials

New acoustical materials now being introduced into the marketplace are designed with the classroom in mind. Not only do acoustical materials need to be acoustically effective but also affordable and easy to install.

At least one company is now offering a conveniently sized acoustical tile measuring 12" x 12" x 1" that can be installed with double-faced tape or hook and loop fasteners as a do-it-yourself solution. Since the availability of wall space in classrooms for the installation of acoustical absorbers is often limited, the convenience of small-sized tiles can be invaluable. These new tiles, which are manufactured from recycled cotton, are not only lightweight and highly durable; they also comply with building code standards for fire safety and carry an ASTM E-84 Class A certification.

The mere fact that a classroom has a suspended acoustical ceiling is no guarantee that it will be acoustically effective. Indeed many acoustical ceilings fail to produce sufficient absorption to comply with the ANSI acoustical standards. If the classroom has a hard-surfaced or tile floor, the reverberation time should be assessed. Carpet does not add a great deal of acoustical absorption, but every little bit helps. However, carpet does provide significant protection against floor-generated noise by students in the occupied room.

Often, the act of bringing a classroom into compliance with classroom acoustical standards may simply involve adding acoustical treatment to the walls or furniture fixtures.

Distance of the Student with Hearing Loss from the Teacher

It is extremely important for the parent of a child with hearing loss to understand that that the distance of the child from the teacher is important. While such a statement makes good sense, there is a law of physics that teaches us that for every doubling of the distance from the sound source, the sound level will diminish by six decibels. For example: with a teacher voice level of 60 decibels at three feet, the same sound will be only 54 decibels at six feet; or 48 decibels at 12 feet; and 42 decibels at 24 feet.

Audiologists tell us that the sound signal of a teacher's voice should be +15 decibels above the background noise level. With sound levels in the average classroom often in the 45-50 decibel range, it is important for the child with hearing loss to achieve a good Signal-to-Noise Ratio (S/NR). This is best achieved when the hard of hearing student is close to the teacher.

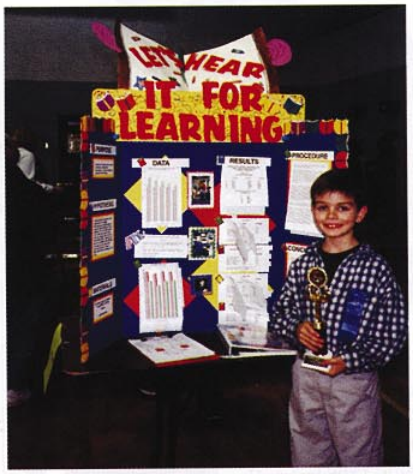
Being Informed and Being Prepared

Parents of children with hearing loss can be much more effective advocates for their children when they are well informed and can explain to school officials why acoustics and noise control in the classroom are important to their children's academic endeavors. Many times, school officials have no idea what to expect or, for that matter, what is involved in bringing a classroom into compliance. Thus,

"Let's Hear it for Learning!"

Connor Bailey Receives Top Award for His Science Project on Classroom Acoustics

By Barbara Kelley



Connor Bailey, nine-year-old researcher, concludes: "Sometimes it isn't so much what we don't hear, but what we don't understand. It was like fireworks going off when I realized this fact. If I could make teachers, principals and school boards understand that, then I would feel that I have really accomplished something."

Connor Bailey is deeply concerned about noise, hearing damage, and how well students can hear and understand in the classroom. The amazing part is that Connor is nine years old! His curiosity and research won him First Place in the Third Grade Division of Parkside Elementary School's science fair for his project "Let's Hear It for Learning." He went on to the Tri-State Competition on March 8 where he was second in his age division.

Connor wanted to do his science project this year about prolonged exposure to noise on the bus or in the lunchroom, so he searched the Internet and finally contacted Mike Nixon, acoustics expert. Mike said the decibel level would have to be excessive to cause any hearing damage, but he suggested Connor test the acoustics in his classroom as it was a "really hot topic right now."

Connor took Mike's guidance and the offer to borrow a sound meter and got to work. Here is Connor's description of his methodology:

"First, I couldn't have done the project without the meter. I can't thank Mike enough! I tested sound levels in four different classrooms: the background noise levels; then, the teachers' speaking levels.

"My purpose was to find out: If noise levels in the classrooms at Parkside Elementary were high enough to affect our learning.

"What I learned is that sometimes it isn't so much what we don't hear, but what we don't *understand*. This is *speech intelligibility*. The effect that speech intelligibility can have on our kids (special needs kids, English as a second language students, and those who might have a hearing loss) is gigantic. It was like fireworks going off when I realized this fact. We fill in a lot when we don't quite understand the words someone is saying. But, if you don't have the vocabulary to fill in those spots, the brain shuts down, you eventually stop listening all together, and learning stops.

"If I could make teachers, principals and school boards understand that, then I would feel that I have really accomplished something. This project already got my teacher talking about sound distractions and our principal read my entire project from top to bottom and was very impressed.

"I concluded that the speech intelligibility rating at my school was consistent at 89 percent (the national standard is 90 percent). You know the special needs kids are suffering to some extent, but, overall, the school didn't do so badly. We were pretty much right in the middle — not great but not horrible either. "

Connor's mother, Peggy, said the project was so detailed and some of his insights were so "awesome," that is was really hard to get Connor to boil it down for this article. One judge said this was one of the best projects he has seen in the last seven years out of any grade. Another said that Connor knew his subject extremely well.

What's Next?

Last year, his project was measuring CO^2 in the classrooms (also placed first locally and at the state level). Next year, Connor hopes to do another project involving the environment and learning. He wants to put all three years of research together for his fifth grade year because, as Connor says," If I win the Tri-State in fifth grade, then I get to compete in Washington, D.C.!"

Connor lives in La Grange, Indiana, with his mom and dad (Peggy and Chris) and his seven-year-old sister, Nicole. When he's not doing science projects, he takes tap and jazz dance and participates in plays and musicals. He is an avid reader (recently the Harry Potter books and the Lemony Snickets series). He collects Nutcrackers and Beatle memorabilia. (Peggy adds, "Yes, even he realizes those are strange collections for a nine-year-old."). And, he truly hopes one day to attend Notre Dame University in his home state.

Connor Bailey…congratulations! You have opened the eyes of many with your research on this "really hot topic." □

Barbara Kelley is editor of Hearing Loss: The Journal of Self Help for Hard of Hearing People.

teachers and administrators may well adopt an adversarial stance due to fear of the unknown.

Very often, the acoustical environment is a simple thing to fix and an informed parent can often allay any fears on the part of school officials just by being able to explain the problem and potential solutions. Certainly, there will be some situations that may be more complicated and costly to remedy but establishing an informed and cooperative relationship with school officials can be very productive in the long run. □

Mike Nixon is an acoustical/marketing consultant, currently on assignment to Acoustical Surfaces, Inc. (ASI), a Chaska, Minnesota, based national distributor of acoustical and noise-related products and services for school facilities. He is a member of the ANSI Classroom Acoustics Standards working group and a member of SHHH and a long-time advocate for classroom acoustical accessibility. He can be reached at mtnixon@aol. com, or through ASI on their HELP LINE at 1-800/448-3134.

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http://edfacilities.org/rl/acoustics.cfm
This website displays many links, articles, papers and books on classroom acoustics.

www.classroomacoustics.com

www.nonoise.org/quietnet/index.htm
You can download a copy of the Acoustical Society's booklet on Classroom Acoustics at this site.

http://groups.yahoo.com/group/classroomacoustics
This is the Classroom Acoustics Listserv of people from all over the world who have an interest in classroom acoustics.