Auditory Access in the Classroom: What teachers of the deaf/hard of hearing should know about classroom listening

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Instruction rarely occurs in a sterile environment
Typical Classroom Learning Situations: Dynamic... Interactive... Fast-Paced
Technology in the Classroom

Computers
Interactive White Boards
Mobile devices
Tablets/electronic readers
21st Century Learning

Learning and Innovation Skills
• Creativity & innovation
• Critical thinking & problem solving
• Communication & collaboration
Disruptive Education
(Christiansen, 2008)


- Hybrid & flipped classrooms
- Web instructional content: utube, videos etc.
- Tracking visual & auditory inputs
- Lighting, noise
- Universal design?
- Accommodations & connectivity with personal and assistive technology
ADA Title II: Effective Communication

• Provides for “effective communication” that is defined as communication that is as effective as it is for non-disabled peers
  – “affording an equal opportunity to obtain the same result, to gain the same benefit, or to reach the same level of achievement as that provided to others” [ADA Title II 28 C.F.R. 35.130 (b)(1)(iii)]

• Students in public schools have eligibility under both IDEA and ADA. In some cases ADA may provide a higher standard than IDEA.

• How do we evaluate “effective communication”?

Auditory Access

- Noise matters
- Reverberation matters
- Distance matters
- Visual access matters
- Diction matters

Many barriers are invisible!
Why is auditory access important?

- Most students use audition to communicate and access instruction
- Hearing aids and CIs do not mitigate the problems of classroom listening
  - Audibility may improve but not intelligibility in adverse listening situations
  - +15 - 20dB SNR improvement is needed for most students
  - Hearing Assistance Technology (HAT) can overcome many listening factors only if implemented correctly and consistently
- Output (e.g., learning) is only as good as the input (e.g., instruction)...and the access to the instruction
Communication Characteristics of DHH Students

99-2000 vs 2011-12

Gallaudet Annual Survey, GRI

http://research.gallaudet.edu/Demographics/2012_National_Summary.pdf
Degree of Hearing Loss
GRI National Summary Report 2011-12

Percent

- Normal (<27dB): 25%
- Mild (27-40): 21%
- Moderate (41-55): 14%
- Mod-Sev (56-70): 13%
- Severe (71-90): 15%
- Profound (>90): 12%
Functional Communication Continuum - Receptive

A  Av  AV  Va  V

Auditory Only  Auditory w/ visual support  Auditory/Visual (Simultaneous Communication)  Visual w/ auditory support  Visual Only

Considerations

• 1:1 communication, therapy
• Small Group & Peer-to-Peer
• Classroom – Lecture
• Classroom – Discussion

(D. Nussbaum et al, 2006)

• Classroom - Cooperative Learning Groups
• Home
• Car
• Theater
Auditory Access

• Noise & Reverberation
  – Masks speech sounds and other important information
  – Disconnects students from instruction and classroom communication
  – Increases auditory fatigue
  – Increases anxiety

• Distance
  – Critical distance: near field vs far field
  – Visual access for speech reading

• Diction
  – Poor audio in videos, internet, talkers

• Ted Talks video
We evaluate our students. Are we evaluating their classrooms / learning environments?
CEC-CED standards that address classroom listening (out of 45)

- DH5S4: Manage assistive technology for individuals who are deaf or hard of hearing.
- DH5S5: Design a classroom environment that maximizes opportunities for visual and/or auditory learning and meets developmental and learning needs.
Classroom Listening Assessment: Purpose

- To identify factors affecting classroom listening skills
- To identify a student’s listening and comprehension ability under various classroom listening conditions
- To provide evidence for accommodations (HAT, acoustical treatments, communication strategies) and supports (counseling, HA/HAT orientation and training, teacher inservice)
- To improve teacher implementation of recommendations
- To evaluate and validate the effects of accommodations and supports on classroom listening
- Teach students about the implications of their hearing status & taking responsibility for their accommodations
Classroom Listening Assessment

- Observation
- Classroom Acoustics
- Functional Listening Evaluation
- Classroom Participation

EVIDENCE
- Eligibility
- Services and Accommodations (IDEA, 504)
### Step 2. Classroom Acoustics Measurements

#### Variables
- Noise
  - SNR
  - type of noise
- Reverberation
- Distance

#### Analyze the listening environment
- Noise
- Reverberation
- Speech to noise ratios
- Critical Distance
- Distribution of talker’s voice throughout the classroom
- Evidence of benefit of classroom audio distribution systems
ANSI/ASA Classroom Acoustics Standards
Recommended Classroom Acoustical Standards for Core Learning Spaces

<10,000 ft³ volume (ANSI/ASA S12.60-2009, 2010):

Permanent Classrooms
- Ambient Noise Level: 35 dBA
- Reverberation Time: .6 seconds*

Relocatable Classrooms
- Ambient Noise Level: 41dBA, [38 dBA by 2013, 35 dBA by 2017]
- Reverberation Time: .5 seconds*

*Note: Core learning spaces in permanent classrooms shall be readily adaptable to allow reduction in reverberation time to .3 seconds to accommodate children with special listening needs. Relocatable classrooms are generally not suitable for any child with special listening requirements due to higher noise levels.
CLASSROOM ACOUSTICAL SCREENING SURVEY WORKSHEET

Date ___________________  Audiologist/Surveyor ____________________________
School __________________ Room __________________ Teacher __________________
Student Name (if applicable) ___________________ Grade ______

This worksheet is intended to be used to screen for acoustical problems in classrooms. When noise and/or reverberation levels are suspected of exceeding those recommended by ANSI/ASA S12.60-2009/2010, the screening survey data is an indicator for further assessment. This assessment may include a referral to an acoustical specialist who can perform a comprehensive acoustical analysis and suggest solutions.

1. OBSERVATION INFORMATION

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

Background Noise

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

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

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 long reverberation times.

<table>
<thead>
<tr>
<th>Classroom Features</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A hard surface, flat ceiling without acoustical ceiling tiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceiling height is over 11 feet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acoustical ceiling tiles have been painted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walls are constructed of sound reflective materials (e.g., plasterboard, concrete, wood paneling)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floors are constructed of sound reflective materials (e.g. concrete, tiles, wood)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Current Technology in the Classroom (if used)

- Personal FM [Number of students ____ ] Type ____________________________
- ADS: Whole Classroom Type ____________________________
- ADS: Targeted Area 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 ______

Sound Level Meter Apps

- Quick for screening classrooms
- Inexpensive
- Non-intrusive
- Fun
- Recommendation: SPL Meter (Andrew Smith, developer)
  - A weighted dB scale
  - Auto-calibrates to microphone of device (iPhone, etc)
### Classroom Ambient Noise Levels at target student’s placement

<table>
<thead>
<tr>
<th>Condition</th>
<th>Unoccupied, HVAC off</th>
<th>Unoccupied, HVAC on</th>
<th>Occupied, HVAC on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighting</td>
<td>A</td>
<td>C</td>
<td>A</td>
</tr>
</tbody>
</table>

### Teacher’s Voice & SNR w/o CADS (HVAC on)

- *35 dBA (HVAC off)*
- *45 dBA (HVAC on)*
- *50 dBA (Close) 42 dBA @ 12 ft*
- +5 to – 3 SNR

### Teacher’s Voice & SNR w/ CADS (HVAC on)

- *60 dBA (HVAC on)*
- +15 SNR
3. REVERBERATION TIME

Measured: Sound stimulus used: .................................................................

<table>
<thead>
<tr>
<th>Frequency</th>
<th>500 Hz</th>
<th>1000 Hz</th>
<th>2000 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Locations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT-60 Ave Seconds:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Estimated:

Note: On-line RT-60 calculation programs may also be used for this calculation (e.g., www.sengpielaudio.com/calculator-RT-60.htm, www.mcsquared.com/hometeng.htm)

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 ______

Estimated Average RT of Classroom = .049 x (V) / (A) = ______ seconds

Comments:

4. ESTIMATED CRITICAL DISTANCE: ______ Ft

Recommended Classroom Acoustical Standards for Core Learning Spaces

<10,000 ft² volume (ANSI/ASA S12.60-2009, 2010):

Permanent Classrooms: Ambient Noise Level: 35dBA/55dBC; Reverberation Time: .6 seconds*

Relocatable Classrooms: Ambient Noise Level: 41dBA, [38 dBA by 2013, 35 dBA by 2017]; Reverberation Time: .5 seconds*

*Note: Core learning spaces in permanent classrooms shall be readily adaptable to allow reduction in reverberation time to .3 seconds to accommodate children with special listening needs. Relocatable classrooms are generally not suitable for any child with special listening requirements due to higher noise levels.
# Estimated Critical Distance Chart

<table>
<thead>
<tr>
<th>Room Size (Cu Ft)</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>5.2</td>
<td>4.5</td>
<td>4.0</td>
<td>3.7</td>
<td>3.4</td>
<td>3.2</td>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>4000</td>
<td>7.3</td>
<td>6.3</td>
<td>5.7</td>
<td>5.2</td>
<td>4.8</td>
<td>4.5</td>
<td>4.2</td>
<td>4.0</td>
</tr>
<tr>
<td>6000</td>
<td>8.9</td>
<td>7.7</td>
<td>6.9</td>
<td>6.3</td>
<td>5.9</td>
<td>5.5</td>
<td>5.2</td>
<td>4.9</td>
</tr>
<tr>
<td>8000</td>
<td>10.3</td>
<td>8.9</td>
<td>8.0</td>
<td>7.3</td>
<td>6.8</td>
<td>6.3</td>
<td>6.0</td>
<td>5.7</td>
</tr>
<tr>
<td>10,000</td>
<td>11.5</td>
<td>10.0</td>
<td>8.9</td>
<td>8.2</td>
<td>7.6</td>
<td>7.1</td>
<td>6.7</td>
<td>6.3</td>
</tr>
<tr>
<td>12,000</td>
<td>12.6</td>
<td>11.0</td>
<td>9.8</td>
<td>8.9</td>
<td>8.3</td>
<td>7.7</td>
<td>7.3</td>
<td>6.9</td>
</tr>
<tr>
<td>14,000</td>
<td>13.7</td>
<td>11.8</td>
<td>10.6</td>
<td>9.7</td>
<td>8.9</td>
<td>8.4</td>
<td>7.9</td>
<td>7.5</td>
</tr>
<tr>
<td>16,000</td>
<td>14.6</td>
<td>12.6</td>
<td>11.3</td>
<td>10.3</td>
<td>9.6</td>
<td>8.9</td>
<td>8.4</td>
<td>8.0</td>
</tr>
<tr>
<td>18,000</td>
<td>15.5</td>
<td>13.4</td>
<td>12.0</td>
<td>11.0</td>
<td>10.1</td>
<td>9.5</td>
<td>8.9</td>
<td>8.5</td>
</tr>
<tr>
<td>20,000</td>
<td>16.3</td>
<td>14.1</td>
<td>12.6</td>
<td>11.5</td>
<td>10.7</td>
<td>10.0</td>
<td>9.4</td>
<td>8.9</td>
</tr>
</tbody>
</table>

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Classroom Listening Assessment

Observation

Classroom Acoustics

Functional Listening Evaluation

Classroom Participation

EVIDENCE
- Eligibility
- Services and Accommodations (IDEA, 504)
Step 3. Functional Listening Evaluation  
(Johnson & VonAlmen, 1993, revised 2010)

- Required by IDEA to conduct a *functional evaluation of the child in the child’s customary environment*
- Compares student’s listening ability if a variety of situations to identify effects of noise, distance, and visual cues
- Provides authentic sample of student’s abilities for teachers, parents, and others
- Provides evidence for hearing assistance technology
- May support choice of most appropriate hearing assistance technology
- Validates benefit of hearing assistance technology
  - Does it meet amplification goals for student?
### The Functional Listening Evaluation

**Name:** AW  
**Date:** April 18, 2008  
**Examiner:** MS Audiologist  
**DOB:** October 26, 2000  
**SCHOOL:**

#### Audiometric Results

**Hearing Sensitivity:** Mild sensorineural loss .5 to 2 kHz right ear & .5 to 1.5 kHz left ear

- **Pure Tone Ave:** Right Ear 30 dB HL  
  Left Ear 20 dB HL  
- **PTA used:** 500, 1K, 2K  
  1K, 2K, 4K

- **Word Recognition:** Right Ear 100% @ 50 dB HL  
  Left Ear 92% @ 40 dB HL

- **Sound Field:** Unaidei  
  Noise 86% @ 50 dBHL  
  Noise 0% @ 50 dB HL @ 0 SN

#### Functional Listening Evaluation Conditions

- **Amplification:** None  
  Hearing Aids  
  FM  
  Cochlear Implant  
  Sound Field

- **Classroom Noise Level:** Occupied N/A  
  Unoccupied SPL:

#### Interpretation Matrix

<table>
<thead>
<tr>
<th>Noise Level</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>quiet</td>
<td>close</td>
</tr>
<tr>
<td>noise</td>
<td>distant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>close-aud</th>
<th>quiet</th>
<th>aud-quiet</th>
</tr>
</thead>
<tbody>
<tr>
<td>close-aud</td>
<td>85</td>
<td>90</td>
<td>95</td>
</tr>
<tr>
<td>quiet</td>
<td>95</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>distant-aud</td>
<td>90</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>quiet-aud-vis</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>noisy</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>noise-aud-vis</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
</tbody>
</table>

- **Average of above:** 87.5%  
  66.25%

#### Functional Listening Scorebox

<table>
<thead>
<tr>
<th>auditory-visual</th>
<th>close-quiet</th>
<th>close-noise</th>
<th>distant-quiet</th>
<th>distant-noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>auditory</td>
<td>95%</td>
<td>85%</td>
<td>90%</td>
<td>95%</td>
</tr>
<tr>
<td>visual</td>
<td>85%</td>
<td>95%</td>
<td>80%</td>
<td>95%</td>
</tr>
</tbody>
</table>

**Presences of noise and distance from the speaker as well as lack of visual cues all have a significant detrimental effect on AW’s speech reception. These are common elements in most classrooms. Use of an FM system significantly reduces these negative effects.**

**Recommendations:**

- Provide AW with use of an FM system in the classroom
- When possible, reduce noise, decrease distance from AW, and provide visual cues in the classroom setting.

Interpretation Matrix: Effect of FM

<table>
<thead>
<tr>
<th>Condition</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Far</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Auditory-Visual</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>
Step 4. Classroom Participation

Classroom Participation Questionnaire (Antia, Sabers, & Stinson, 2007)

• Self-assessment of access to teacher and peer communication in classroom & ease of communication

• 4 areas:
  – Understanding teacher
  – Understanding students
  – Positive effect
  – Negative effect

• Counseling tool
SAC-A & SOAC-A
(Elkayam & English, 2003)

- Self Assessment of Communication-Adolescent (SAC-A)
- Significant Other Assessment of Communication-Adolescent (SOAC-A)
  - 12 questions covering aspects of hearing and communication from “self“ and “significant other“ perspectives
  - Rating scale 1-5
    - Hearing and understanding at different times
    - Feelings about communication
    - Other people’s perception of my/your hearing loss
Summary: What TODs Need to Know

- **Audiogram Interpretation**
  - Audibility vs intelligibility
  - Degree of HL does not equal auditory access
- **Classroom Acoustics Screening**
- **Functional Listening Evaluation**
- **Benefit of HAT**
  - Effective communication in the classroom
  - +15-20 SNR
  - Candidacy, HAT options, and readiness to use
  - Proper implementation & support to teachers
- **Teaching students personal audiology and self-advocacy access skills**
Count-the-Dot Audibility Audiogram
Killion & Mueller (2010)

Audibility Index = 20%
Summary: What TODs Need to Know

• Audiogram Interpretation
  – Audibility vs intelligibility
  – degree of HL does not equal auditory access

• Classroom Acoustics Screening

• Functional Listening Evaluation

• Benefit of HAT
  – Effective communication in the classroom
  – +15-20 SNR
  – Candidacy, HAT options, and readiness to use
  – Proper implementation & support to teachers

• Teaching students personal audiology and self-advocacy access skills
Demos are Powerful

No FM

FM

Recordings by T. Derr & S. Bradley, U of Wisconsin - Whitewater
New Phonak technology for people with hearing loss outperforms those with normal hearing in noise and over distance.

SPEECH RECOGNITION IN PERCENT

- Transmits the voice of the speaker wirelessly in crystal-clear sound quality to the hearing aids.
- Automatically adapts its settings to the noise and speakers around.
- At noise levels of 65dB and higher, hearing aid users equipped with Roger could hear better than those with normal hearing.

Hearing aid users equipped with Roger
People with normal hearing

55dB
65dB
75dB

[Noise levels mentioned in db]

55dB
65dB
75dB

[Noise levels mentioned in db]
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• Classroom Acoustics Screening
• Functional Listening Evaluation
• Benefit of HAT
  – Effective communication in the classroom
  – +15-20 SNR
  – Proper implementation & support to teachers
• Teaching students personal audiology and self-advocacy access skills
References


Protocols

www.ADEvantage.com

• Classroom Acoustics Worksheet
• Functional Listening Evaluation (FLE)
• Classroom Participation Questionnaire (CPQ)
• Placement And Readiness Checklists (PARC)
• Audiology Self-Advocacy Checklists