Proposed Reduction of Classroom Reverberation Time Criteria

ICC A117.1, SECTION 808
PUBLIC COMMENT

Agenda

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Rationale for Appropriate Classroom Acoustics

Cheryl Johnson

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On any given day, thousands of students are unable to understand 1/4 of the spoken words in classrooms due to poor acoustics

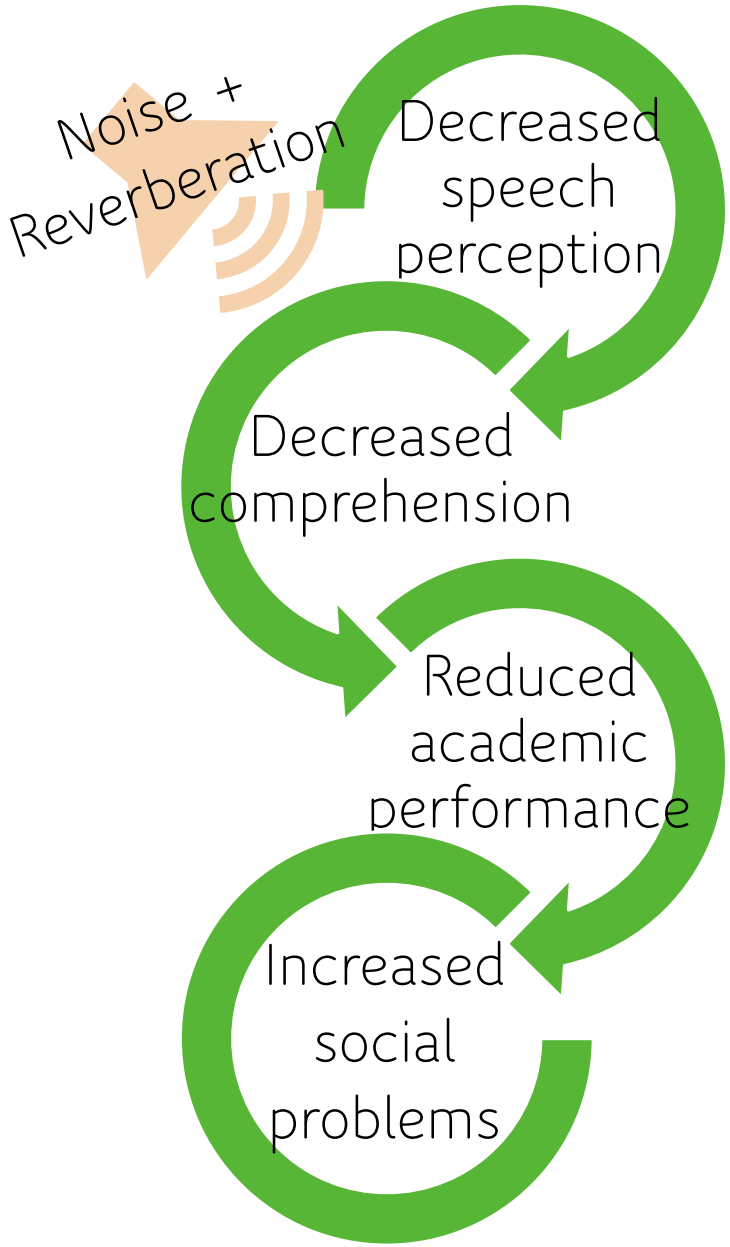
InformeDesign Research Desk

Clear Hearing: Classroom Communication & Instruction Considerations

Speaking and listening are the primary communication modes in classrooms

- 60-75% of the school day involves listening activities
- High noise levels and excessive RT reduce comprehension

Listening efficiency – a measure of the accuracy of speech intelligibility and listening effort (Prodi et al, 2010, 2013, Prodi and Visentin, 2015)



Clear Hearing: Learning Environment Characteristics

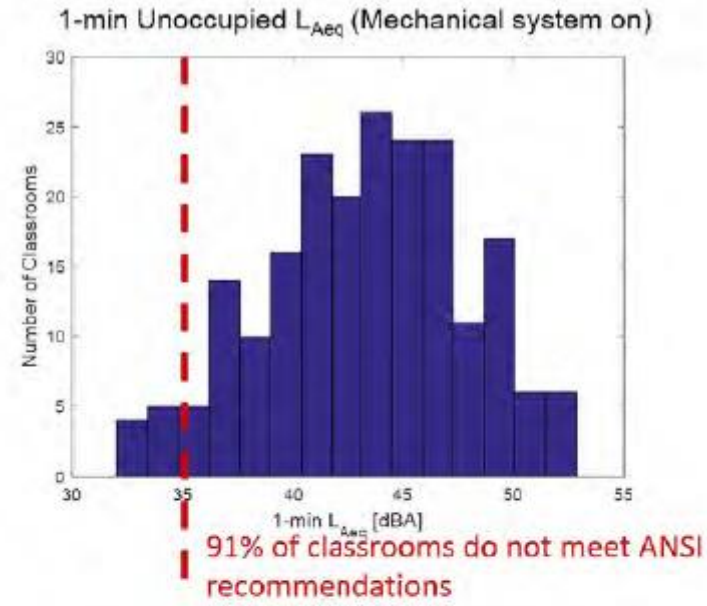
Enemies of Clear Hearing: Distance, Noise, Reverberation

Background noise and RT have more detrimental effects on *comprehension* than on speech recognition (Klatte et al, 2010; Valente et al, 2012; Lewis et al, 2014)

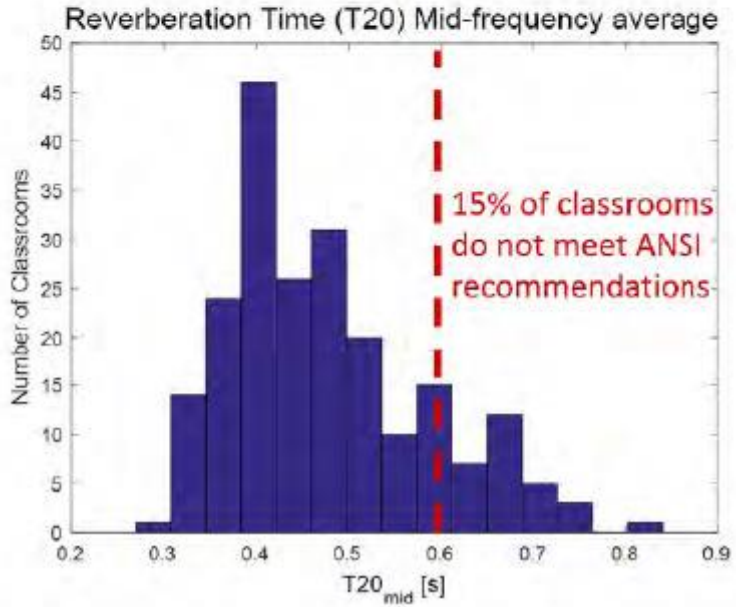
Classroom acoustic conditions impact *listening effort* as well as listening ability (Howard et al, 2010)

Need minimum of +15 dB SNR throughout every classroom for clear hearing for all students

Brill et al: most classrooms met .4 RT



Source: Brill, Smith, & Wang: 2018



Clear Hearing: Student Characteristics

Age and Developmental Factors (language competency, attention, working memory, cognitive level)

Learning Challenges & Disabilities (e.g., hearing loss, ear infections, auditory processing problems, learning disabilities, ADD/ADHD, language delay/ disorders, cognitive disorders, English Language Learners (ELL), Autism)

Program	Percent of Student Enrollment	Range by State
IDEA*	13.2%	9.1-17.3% (PR-28.2%)
ELL*	10.4%	.03-20%
504*	2.7%	0-6.3%
Total*	26.3%	
No program	15-20% (not identified & under-served)	
Estimated Total	**40% have special listening needs**	

*Data Source: Office of Civil Rights https://ocrdata.ed.gov/estimations/2017-2018

Universal Design for Learning (UDL) = Universal Classroom Acoustics Standards

Every Student Succeeds Act P.L. 114-95 (2015) (U.S. Department of Education)

States must provide appropriate accommodations for all students using principles of UDL which intentionally reduce barriers and improve flexibility in how students receive information and demonstrate knowledge (Sec. 1111 & 1204)

- States must incorporate UDL framework addressing fundamental physical, sensory, and cognitive accessibility requirements for all students (Sec. 1111)
- Student support and Academic Enrichment (SSAE) grant funds can be used to support UDL learning needs for all students

UDL Framework: Engagement of Learners

- "minimize threats and distractions"

Research and Universal Reverberation Time

FRANK IGLEHART

Our Proposal

In support of clear hearing and thus academic success for all students, we are petitioning for an improvement in:

ICC A117.1, Section 808 Enhanced Acoustics for Classrooms

Section 808.2 Reverberation time (RT) in classrooms (≤ 10,000 ft^3) – 0.6 s RT be replaced by 0.4 s RT.

Background

- How well a person understands speech depends on how clearly the talker speaks, how far away the talker is, and on the acoustics of the room.
- ICC 117.1, Section 808 addresses acoustics for classrooms.
- Acoustics refer to background noise and reverberation.
- Background noise is important, but will not be addressed today.
  ICC A117.1, Section 808 already addresses well this issue for classrooms.
- Reverberation is sound reflecting off hard surfaces in a room.
- Reverberation time is how long it takes reverberation to quiet.
- Usually measured in tenths of a second.

Peer-reviewed Research

- Speech perception in
- Children
- Listening in classroom reverberation.

Research and Universal Reverberation Time

- What is an appropriate RT for a classroom?
- ICC A117.1, Section 808 specifies 0.6 s RT.
- What does the research say?
  - Near-universal finding: more listening benefit from RTs shorter than 0.6 s.
- We are petitioning for A117.1, Section 808.2.1 to change to 0.4 s RT.

Research and Universal Reverberation Time

Points to remember when looking at the research results:

- Different studies use different classroom RTs.
- The purpose of the studies: to examine the effects of change in RT.
- Only a few studies used 0.6 or 0.4 s RT.
- Key is the overall effect of shorter RTs on the perception of speech.

Research and Universal Reverberation Time

For children with normal hearing, statistically significant benefits are seen with reductions in RT from:

- 1.2 to 0.4 s (and to 0.0 s): Finitzo-Hieber and Tillman (1978)
- 0.6 to 0.4 s: Neuman and Hochberg (1983)
- 0.8 to 0.6 to 0.3 s: Neuman et al. (2010)
- 0.4 to 0.0 s: Wróblewski et al. (2012)

Research and Universal Reverberation Time

For children with normal hearing, non-significant results in reduced RT:

- 0.6 to 0.3 s (and n/s decline to 0.0 s): Iglehart (2016)
- Slight peak at 0.68 s and RTs as short as 0.3 s are “acceptable”: Yang and Bradley (2008)

Recommended based on multiple acoustic factors including RT:

- Reduce from 0.7 to between 0.5 and 0.4 s: Bradley (1986)

Research and Universal Reverberation Time

Mathematical models of classroom acoustics for children with normal hearing (no children participating).

Optimal speech intelligibility will occur in RTs:

- 0.3 to 0.1 s: Bistafa and Bradley (2000). (for cost: 0.4 to 0.5 s)
- 0.6 to 0.3 s: Reich and Bradley (1998)
- 0.3 s: Sato and Bradley (2008)

Research and Universal Reverberation Time

Statistically significant benefits when RT reduced for –

Children: hard of hearing and using hearing aids:

- 1.2 to 0.4 to 0.0 s: Finitzo-Hieber and Tillman (1978)
- 0.6 to 0.3 to 0.0 s: Iglehart (2020)

Children: deaf and using cochlear implants:

- 0.6 to 0.3 to 0.0 s: Iglehart (2016)
- 0.6 to 0.0 s: Neuman et al. (2012; not peer reviewed)

Research and Universal Reverberation Time

Statistically significant benefits when RT reduced for –

Children with normal hearing for whom English is a second language, no cognitive issues known:

- Children, 1.2 to 0.3 s: Hurtig et al. (2016)

Summary: Research and Universal Reverberation Time

All peer-reviewed research: classroom RTs shorter than 0.6 s benefit

- Children with normal hearing.
- Children who are deaf or hard of hearing.
- Children with normal hearing listening to English as a second language.

Summary: Research and Universal Reverberation Time

We petition for a change in ICC 117.1
Section 808 Enhanced Acoustics for Classrooms
Section 808.2. Reverberation time
Subsection 808.2.1. Performance method
1. Classrooms of volume of 10,000 ft^3 or less,
0.6 s RT be replaced by 0.4 s RT.

For classrooms of various sizes and configurations,

- Reasonably attainable,
- Materials are widely available,
- At reasonable cost.

Financial Considerations for Enhanced Acoustics

STEPHEN WILSON

Typical Classroom Treatments

Acoustical Panel Ceilings

- Typical industry standard for new classroom design and remodeling
- NRC 0.9 panels are readily available and commonly specified
- No cost increase anticipated to meet the enhanced 0.4s RT standard

Acoustical Wall Panels

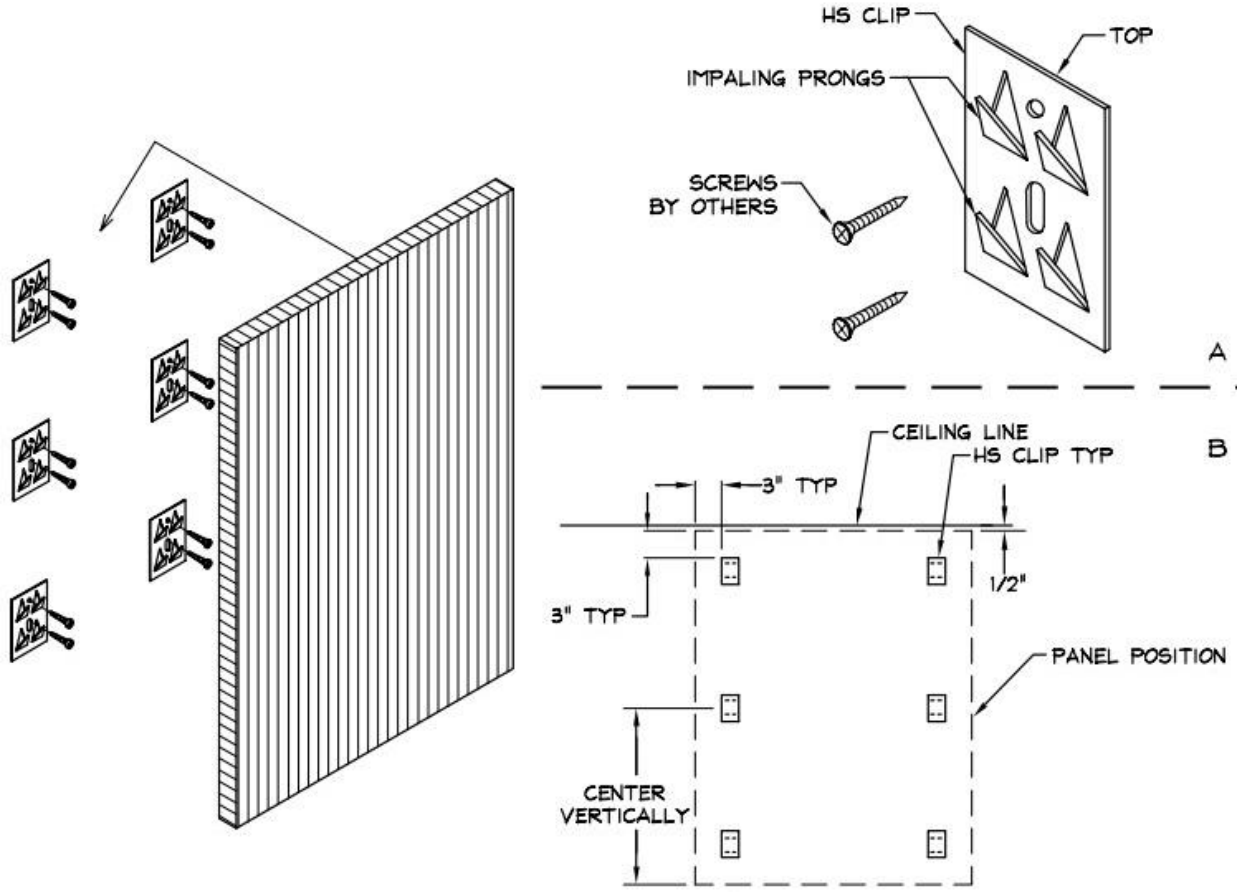
- Simplest method of providing additional noise absorption to reduce RT
- Products are commonly used and available from many manufacturers, in a variety of aesthetic options
- Typical NRC values ranging from 0.6 to 1.0

Typical Classroom Example

Sample Unit Cost

- Basis of Design: Kinetics “Hardside Panel”
- 1” thick panel, NRC = 0.8
- Impaling Clip Mounting
- $25 / SF (New England market, 2022, Union Labor)
- Cost includes material and installation

Many other comparable manufacturers and materials are available



Typical Classroom Example

Sample Classroom Size:

- 24’ x 30’ x 10’
- 720 sq. ft. / 7200 cu. ft.
- Assume NRC 0.9 ceiling

Without acoustic panels:

- RT: 0.6s

Adding 216 sq. ft. wall panels (NRC 0.8):

- RT: 0.4s
- Cost: (216 SF x $25/sf) = $5400 per room

Cost Impacts on a New Elementary School

Cost extrapolation on a new school building:

- Example: New 2021 Classroom Building
- 2-story, 86,000 SF school
- 35 classrooms

Total Budget: $22,000,000 (construction cost)

Estimated total cost to implement enhanced acoustics on a building this size:

- (35) x $5,400 = $189,000
- 0.88% of total construction cost
- (< 1% total budget)

Reflections, Additional Comments

ANDY CARBALLEIRA

Discussion