

# Teaching Mathematics to Students with Hearing Loss

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# Goals

- Explain what kinds of people with hearing loss are out there.
- Explain how one can better teach students with hearing loss in a university classroom where English is spoken.
- Add some comments and tips specifically for mathematics.

# Overview of Hearing Loss

Types of deafness, communication methods, et cetera

# Terminology

- Hearing impaired
  - Outdated, used in medical and legal fields
- Person with hearing loss
  - Most inclusive, general term
  - Follows the “person first” philosophy
- (Lowercase) deaf person, hard of hearing person
- (Uppercase) Deaf person
  - Indicates involvement in the sign-language-using community
  - Not as strongly tied to being medically deaf

# Levels of Hearing Loss

- Hearing loss is measured across frequencies (hertz) and in terms of loss in decibels (shorthand: dB) (log-scale amplitude).
- Being “legally deaf” means at least a 70 dB loss in both ears on average across the central frequencies.
- “Hard of hearing” generally implies a 40-70/80 dB loss on at least one side.
- “Deaf” generally implies a 70/80 dB or greater loss on both sides.
- Totally stone-deaf people (120+ dB loss) are rare, even in the signing community.
- Audiologists have categories: mild, moderate, severe, and profound.

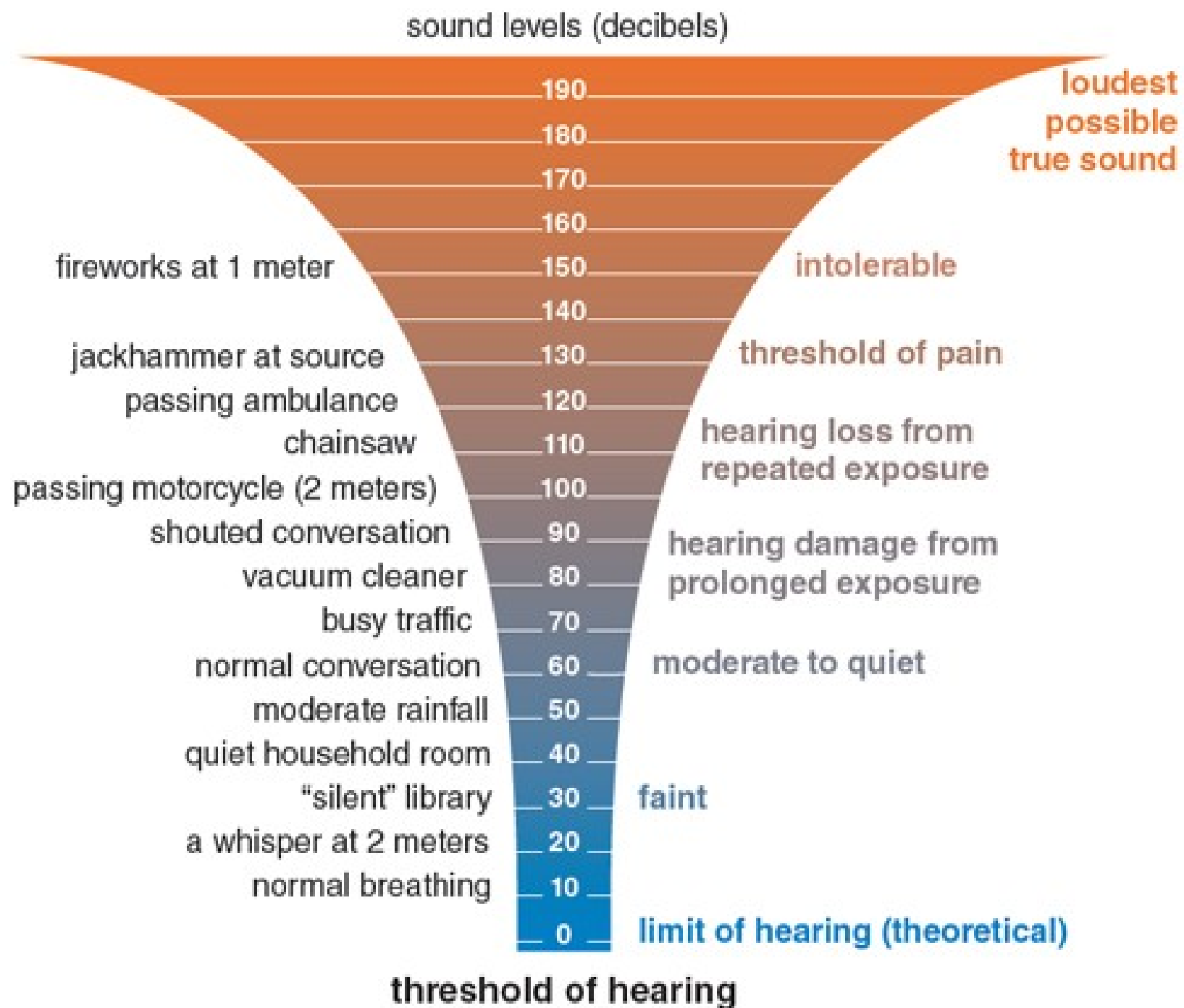


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# Communication Methods

- Oralism (Speech)
  - Auditory-Verbal Therapy
  - “Listening and Spoken Language”
  - Dependent on technology (hearing aids, cochlear implants)
- Manualism (Signing)
  - Sign languages
  - Signed versions of spoken languages
  - Rochester Method (Fingerspelling)
- Other methods exist (e.g. Cued Speech)

# Stereotypes and Reality

- The “deaf-mute” who signs and cannot speak and is stone deaf
- The “not really deaf” person with hearing aids or a cochlear implant
- The reality is that most people with hearing loss are in between these two stereotypes. Many deaf people can both speak and sign. Many deaf people only speak, but struggle with hearing a lot. Many deaf people who only sign can hear a little bit (but still not well).



# Mathematical Achievement

- (Nunes & Moreno, 2002)
  - Deaf children do not “pick up” ambient information that hearing students do.
  - Deaf students’ mathematical *delay* (not weakness) can be partially explained by an absent foundation from before they even start school.
  - Authors’ intervention program that taught “assumed” skills and focused on a more visual pedagogy succeeded in improving mathematical ability.
  - Deaf students struggle with time or sequence-of-events based problems.
    - Why?
- (Tilak, 2005) Only 23 hearing-impaired mathematicians since late 1800’s
- (Solomon et al., 2012) White paper from Gallaudet, 13 deaf or hard-of-hearing people earned math doctorates from 2006-2010 (not in Tilak!)
  - Self-reported versus community-identified?

# General Advice

Applies to all students with hearing loss

# General Advice

- Write on the board a lot!
- What makes a lecture better than reading the book?
  - Side comments
  - In-depth explanations
  - Intuitive expert perspective
- Writing these down is much more valuable than writing down extra notation or anything else that's already in the book.
- Do not assign or show videos or clips with no captions.
- Only allow one person to speak at a time (no fast back-and-forth).

# General Advice

- If another student asks a question, repeat or rephrase the question before answering.
- When showing work (especially in undergraduate courses), use colors or comments between steps rather than just saying what you did out loud but leaving the work “plain”.
- Use a visual example or visual diagram when possible.
- If possible, share your lecture notes.
- If possible, follow the textbook closely and clarify when you are going “off book”.

# Signing Students

Advice for when you have a student who uses sign language

# Deaf students who sign

- If you write and talk at the same time, the Deaf student cannot watch the interpreter and watch you write simultaneously
  - Avoid using vague words that require the eyes to be on you, for example:
    - This, that, here, over there, under here, “this guy”
- If using presentation slides, when you bring up a new slide, *pause* and let your students *read* the slide before talking.
  - Otherwise the Deaf student has to quickly switch between the interpreter and reading your slides and will miss information.
  - Do not repeat or read out loud the lines on the slide. Only add explanatory and supplementary comments. (This might contradict other advice.)

# Using a sign language interpreter

- Never say “tell them”, “tell her”, address Deaf students directly.
- If the interpreter asks you for clarification, usually it is the interpreter who did not understand. Do not assume the student doesn’t know the material based on this alone.
- Interpreters are bound by a professional code of ethics and will not discuss what they interpret outside of the classroom or office. Be honest and direct with your student as though the interpreter were not there.

# Using a sign language interpreter

- If you are curious about sign language or a sign, ask the Deaf person directly through the interpreter. Do not ask an interpreter about sign language unless the Deaf person is not around.
- Very often a Deaf student may sign to an interpreter in the middle of class, but the interpreter says nothing. Usually the student is clarifying something *with the interpreter directly* or teaching the interpreter a sign. They are not usually “chatting”.
- Interpreters are there to facilitate communication for everyone. It is commonly misunderstood that interpreters are there to “translate”, but that is just how they do their real job – their real job is providing access for the Deaf student *and* for you.



# Sign Systems

- American Sign Language (ASL)
  - Grammatically distinct from English
  - Origins in France, not based on American English
    - Mutually intelligible with French Sign Language, almost not at all with British Sign Language.
- Signed Exact English (SEE)
  - Invented system using English grammar and invented signs or modified ASL signs.
  - Often dependent on mouthing / lipreading.
- “Englishy” Sign
  - Mixture of ASL and SEE, usually more on the ASL side. It’s a spectrum.
  - Various names include “contact sign” and “Pidgin Signed English”
  - Common form of communication among signing Deaf people and interpreters.

# Difficulties with Signing Mathematics

- Even basic signs are not uniform in the community
  - “Addition” isn’t even standardized!
- No large community of ASL users discussing math rigorously
  - No place for standardized mathematical signing to grow
  - Consider “2 divides 6” and “6 divided by 2”
- Interpreters do not understand mathematics
  - They cannot genuinely translate math, especially at a higher level
  - Forced to use *very* “Englishy” sign to tell the Deaf student what you literally said, instead of what you “mean” (no genuine translation).

# Oral Students

Advice for when you have a student with hearing loss who speaks English

# Oral students with hearing loss

- Face the class when speaking, as much as possible.
- If asked to repeat yourself, repeat *exactly* what you said the first time. Do not rephrase or you may confuse the student, unless they ask for clarification more than once or twice.
- Repeat what students ask during class before answering.
- If a new word or name is uttered, write it and its spelling on the board. Oral students can have difficulty identifying new words.

# Oral students with hearing loss

- An oral student may nod their head or say they understood you when they didn't. Why would they do that?
  - Oral students are trained to “listen” with less than perfect hearing.
  - They do this by receiving partial information from hearing and lipreading.
  - They then attempt to guess what you said based on this information and the context.
  - Their guess may be wrong, but they may not want to verify it and embarrass themselves.
  - Oral students may take longer to answer questions – their processing time is longer than hearing student's because they need to “figure out” what you said for a longer time period.
- Oral deaf are *very* good at faking a conversation with partial information.
- Make sure they genuinely understand you. Ask clarifying questions but do not make them feel like you doubt their ability to understand you.

# Lipreading

- Commonly stated claim that “only 30% of speech can be read on the lips” is misleading.
- It is very easy to lipread small-talk. Context is a massive informer for what people will say next in a conversation.
- It is almost impossible to lipread a *single* word.
  - Lipreading requires medium-length simple sentences.
- Technical or complicated sentences are very difficult to lip-read.
- Do **not** depend on a deaf person’s ability to lipread!

# Hearing Technology

- Hearing Aids
- Cochlear Implants
- FM Systems
- CART / Live Captioning

# Oral students in a mathematics classroom

- Try not to give proof lines only in spoken English. Write more than you speak.
- Depend more on written notation than on verbal expressions.
  - Example: Don't ponder about "two x squared minus four" out loud to your class, write it down first.
- If you are reading a line out loud, point at the words you speak as you say them.
- Allow the student to sit in front if possible.
- If you are asked to use any technology (e.g. a microphone), *use it*.



# Final Remarks

- In the end, everything is up to the student in regard to communication. Students with hearing loss vary greatly, respect their choices.
- Although it is important to accommodate students with hearing loss, I am fairly sure you cannot (legally) directly ask students if they have a certain disability in general. Tread carefully. If they tell you, great. If not, it is not your problem. Many of these tips improve pedagogy in general, regardless of the presence of a deaf student.
- Even I do not follow all of my own advice all the time. Just do your best!

# End of Slides

- Questions?
- Comments?
- Thanks for coming!