A Classroom Accessibility Analysis App for Deaf Students

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ABSTRACT

Deaf and hard of hearing (DHH) individuals do not have equal access to audio information in most educational settings, even with visual translation accommodations such as sign language interpreters or captioners. As a result, their learning and retention rates lag behind in comparison with their hearing peers. Research shows DHH individuals lose lecture information due to two main factors largely unaddressed by the traditional accommodations: 1) increased cognitive load associated with processing the visual translation of audio simultaneously with other visual information sources, and 2) visual attention limits associated with viewing layouts that have widely dispersed visuals that may be far away or at awkward viewing angles. We discuss the impact of architectural visuals on the DHH student, accommodation team and discuss an automatic measure of a simple accessibility app and scale using face and body identification from a 360-degree video snapshot.

Author Keywords

American Sign Language (ASL); Deaf; Design.

INTRODUCTION

Classrooms are optimized for audio transmission and secondarily for visual transmission; visual space and line of sight of for deaf and hard of hearing individuals are rarely considered. As long as the classroom has good acoustics, class discussion is not impeded, as the participants can listen and talk from any angle and location. Bad architectural visuals do not noticeably disrupt hearing participants' learning. This is not the case for DHH participants, who have difficulty understanding or receiving auditory information in presentations or lectures and depend on visual translation of the auditory information. The visual translations can be a sign language interpreter or a real-time captioner. The visual translation introduces an extra visual information stream that has to be viewed simultaneously with presentation visuals such as the slides.

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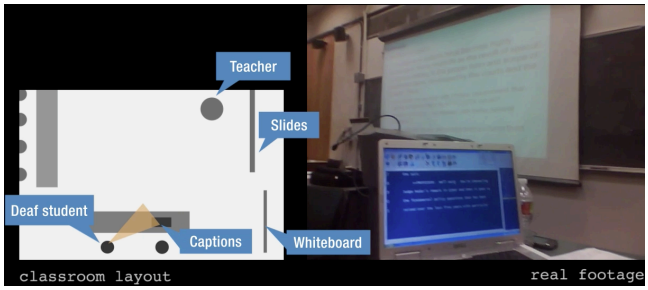

Figure 1: Visually inaccessible classroom that illustrates the inaccessibility of the multiple lecture information sources for deaf students.

VISUAL ACCESSIBILITY

The need to improve learning accessibility for deaf students is well documented [2,11,13,15]. Even with accommodation services, deaf students do not do as well in courses as hearing students [3,9,12]. Nearly fifty years after the first educational mandate for accessible services in the early 70s, only 16% of DHH individuals complete a bachelors' degree or higher, far less than the graduation rate of 30% for hearing individuals [6]. Part of this disparity can be attributed to lack of visual accessibility. While visual accommodations improve accessibility for DHH participants, these accommodations are not functionally equivalent. While accommodations can improve deaf students' inclusion and outcomes in higher education classrooms, it is not sufficient, because of poor visual accessibility. As a result, they lag behind hearing peers, and miss a substantial amount of information [8,13].

Classroom Accessibility

Most classrooms are aurally accessible but are not visually accessible from all directions as shown in Figure 1. An optimal view is usually obtained by sitting at a right angle and close to each of the multiple sources of information. However, as the information sources tend to be spatially distributed around the room, getting an optimal view for each and every of the information sources can be unattainable without the aid of technology unless the classroom is reconfigured. In other words, they are not optimized for visual access such as ensuring there are clear lines of sight and being close enough others clearly. Figure 2 shows a circular classroom layout that is visually accessible. Every possible information source is visually accessible by every student, and others, including the instructor and interpreters. Even so, not all information source viewing angles in this visually accessible classroom are optimal, because the angles to these visuals are not perpendicular to the student.

Figure 2: Circular layout typically found in classrooms designed for deaf and hard of hearing students.

Accessibility for DHH Students

As deafness is a low incidence disability, most deaf students are the only student in their class or even in the entire institution. The majority of post-secondary institutions – over 95%, serve one or more deaf or hard of hearing students, and most institutions serve fewer than ten deaf students [7]. This dispersion among institutions requires postsecondary institutions to identify and provide appropriate accommodations on an ad-hoc basis, to accommodate the large variation in functional ability among DHH students. DHH student accessibility needs are not uniform.

For example, some students may have attention-deficit/hyperactivity and have greater difficulty with inattentiveness, while others may struggle more with hyperactivity. Others may have poor English skills or low vision. Institutional factors, including the program capacity to provide appropriate accommodations, do play a significant role in program persistence for deaf students [4].

For a single enrolled deaf student, it is cumbersome for institutional technical staff to support specific classroom or distance learning solutions for deaf students. Also, deaf students typically attend lectures in multiple classrooms; yet throughout the semester, most classrooms in a given institution will not host a deaf student. Therefore, from both an institutional and student perspective, in terms of effort, availability and cost, the accessible technology should be centered on the student rather than the classroom.

The typical isolation of the deaf student becomes problematic not only in terms of institutional responsibility of meeting widely variable accommodation needs, but also in recognizing that the student may have reduced likelihood of involvement in collaborative learning while in class. Even when appropriate accommodations are provided, deaf students may ask fewer questions, feel less confident about their understanding of the material, and do not feel a part of the class setting [10].

Classroom participation is difficult for the deaf student, even with an ASL interpreter or captioner [1,5]. Part of the problem is the increased cognitive demands on the deaf student while in the classroom. Deaf students reported that they never accessed 100% of a lecture, and estimated their understanding from 50-90% [14]. Keeping up with visual demands is cognitively challenging in and of itself, leaving little room to engage in a learning environment.

Figure 3A: row layout

Figure 3B: Circular layout

EVALUATION

For the study, we recruited 15 participants who were all deaf or hard of hearing.

We asked participants to sit in three classroom layouts: a three-row layout similar to 3A, a circular layout similar to 3B, and a hybrid layout with two circles. We evaluated the accessibility of these layouts through (1) participant ratings and (2) automated classroom analysis of a 360-degree photo that was recorded from the classroom center. For the participant ratings, we asked the participants to rate the accessibility of the layout on a scale of 1-5, with 1 rated as not at all accessible, to 5 being rated as very accessible. For the automated analysis, we created an OpenCV Python script (Classroom Accessibility Analysis App) to scan and report the number of fully visible human bodies and faces.

Results

There was a strong correlation between participant ratings and the Classroom Analysis App for classroom accessibility.

Participant Ratings

Participants rated the circular layout as being more accessible than either the row or hybrid layout. For the circular layout, the participants rated it as being very accessible: 5.0 (SD=0), and for the row layout, the participants rated it as being somewhat not accessible: 1.86 (SD=0.74). Finally, for the hybrid layout, the participants rated it as being somewhat accessible: 3.2 (SD=0.88).

Classroom Accessibility Analysis

The script analysis of classroom layouts indicated more participants and their faces were visible for the circular layout compared to the hybrid layout and more visibility than the row layout. For the circular layout, the script returned 15 bodies and 15 faces (100%). For the hybrid layout, the script reported 13 bodies (87%) and 6 faces (40%). For the row layout, the script reported 6 bodies (40%) and 2 faces (13%).

Conclusion

The Classroom Accessibility Analysis app correlates well with self-reported accessibility ratings. All participants noted in their open-ended responses that it was important to see the faces and body language of other participants during discussion, and their ratings were consistent with their comments. The Classroom Accessibility App provides DHH students, faculty or staff a quick way to assess, document and report classroom accessibility.

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