

## Campus Community Partnerships with People Who Are Deaf or Hard-of-Hearing

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**Abstract:** In 1997, the Moores University of California, San Diego (UCSD) Cancer Center and advocacy groups for people who are deaf and hard of hearing launched a highly successful cancer control collaborative. In 2006, faculty from the Computer Science Department at UCSD invited the collaborative to help develop a new track in their doctoral program. This track would train computer scientists to be culturally competent when working with people who have hearing and visual challenges, with the ultimate goal of developing assistive living devices that would be welcomed by, and useful to, the anticipated end users. Faculty and students began developing ideas for technological advances that were anticipated to benefit people who are deaf and hard-of-hearing. Computer science graduate students and faculty worked with the medical school faculty, staff, and undergraduates to design culturally competent focus groups for people who were deaf and hard-of-hearing. The focus groups were designed to gather opinions of these presumed end users about three, very promising ideas for assistive listening devices. The result was a productive interchange between the computer science team and focus group members. The insights garnered have subsequently been used to refine the three devices. This paper provides an overview of how computer science students were trained to present their technological innovations to people who are deaf and hard-of-hearing and

to gain feedback on how their devices might best serve them.

**Keywords:** Deaf and hard-of-hearing, Assistive technology, Computer science, Focus groups

In 2006, computer science faculty at the University of California, San Diego (UCSD) recognized the need to develop a cadre of doctoral level-trained computer science graduates who were interested in developing technological devices to improve the quality of life of people who had visual or hearing challenges. While they had the necessary faculty to provide the scientific training, they lacked faculty who could assist their students to develop the cultural competency needed to work with people who were visually or hearing challenged.

In their search for colleagues to help them work with each of these groups, they discovered colleagues at the Moores UCSD Cancer Center who had been successfully collaborating with deaf and hard-of-hearing advocacy groups since 1997 to create cancer control education programs for people with hearing challenges. Thus, the computer science faculty had found not only faculty colleagues, but through them, access to the nationwide network of deaf and hard-of-hearing advocacy groups that the Cancer

Center had found to help them achieve their educational vision.

Meanwhile, the Moores' faculty and staff and their colleagues from the community-based advocacy groups for people who are deaf or hard-of-hearing had been searching for other UCSD researchers who might be interested in working with them to expand the research on behalf of people with hearing challenges. The core research team that resulted from this new collaboration included faculty members from Computer Science, Bioengineering, and Public Health, doctoral students in Computer Science, and undergraduates with prior experience with the Moores UCSD Cancer Education for people who are deaf and hard of hearing.

Hearing loss is the 6th most common chronic condition in the United States, and affects between two and four of every 1,000 people in the United States (Barnett, 2002; Pleis & Lethbridge-Cejku, 2006). These individuals offer computer science researchers many opportunities to create devices that will further their pursuit of innovation, while discovering ways to improve people's immediate quality of living.

The aim of this study was to conceptualize assistive listening devices that might be feasible and beneficial to people who are deaf and hard-of-hearing. Focus groups were conducted to assemble people who were deaf and hard-of-hearing together with laboratory-based researchers in order to exchange ideas about the assistive listening devices and to determine which would be of greatest value for deaf and hard-of-hearing people. This paper offers readers an introduction to understanding the differences in groups along the spectrum of deafness and describes the focus group structure, which the team tested and found to be very useful in gathering data from the people who were intended to derive

greatest gain from the technological innovations being developed.

## Method

### *Review the Literature*

For the first step in the process of preparing students to collaborate effectively with people who are deaf or hard-of-hearing, faculty gave students a collection of articles to help them understand the many subtle distinctions that exist among people with audiological differences (Eckhardt & Anastas, 2006; Iezzoni, O'Day, Killeen, & Harker, 2004; Lane, 2002, 2005; Levy, 2002; Padden, & Humphries, 1988; Phelan, & Parkman, 1995; Pollard, 1992; Stebnicki & Coeling, 1999). The reading material was intended to help the students learn how to interact in a culturally competent manner with people who are deaf and hard-of-hearing. These articles were derived from a larger collection of articles that were being used to create a cadre of physicians who would help people with hearing challenges gain better access to health information and care (Farber, Nakaji, & Sadler, 2004).

*Distinctions in terminology.* The students learned that the spectrum of people with hearing deficits range from those who are hard-of-hearing to people who are deaf. Generally, people who are *hard-of-hearing* will have been educated in standard classroom settings and provided with accommodations when possible. Their hearing loss may have occurred early in life or later, as an accompaniment of the aging process. This subgroup can also include people who are deaf. They will only rarely have learned sign language and will culturally align themselves with the other members of their ethnic group. They communicate with speech and use either one or a combination of oral, lip reading, and signing methods (Stebnicki & Coeling, 1999).

People who are *culturally deaf* will likely have had very different education and social experiences from people who are hard-of-hearing. Distinctions among these individuals are influenced by whether the person became deaf before or after the full acquisition of speech and whether they were educated in schools for the deaf or mainstream schools with accommodations. Deaf with a capital 'D' refers to a cultural group as opposed to deaf with a lower case 'd' which refers to people with a hearing loss (Padden & Humphries, 1988; Stebnicki & Coeling, 1999). Members of the Deaf community share a common language (i.e., American Sign Language [ASL] in the U.S.) and a culture (i.e., Deaf culture). The Deaf community is rooted in a rich culture, having their own clubs, social networks, and traditions. The Deaf community may include individuals who have been deaf or hard-of-hearing since birth or those who have acquired hearing loss later in life, but gaining membership requires the use of ASL, an important quality of Deafness (Padden & Humphries, 1988).

#### *Approval of Study*

Institutional Review Board (IRB) approval was secured for this study, since the opinions and ideas of human participation were to be gathered. IRB approved the recruitment flyers, consent forms, and focus group scripts prior to use. The consent documents were written with the recognition that a portion of the study participants would have learned English as a second language and as a result, would have limited English proficiency. Since some participants were likely to have no English language literacy, and there is no written form of ASL, an interpreter or staff member fluent in ASL was always available to provide an ASL interpretation of the consent document (Meador & Zazove, 2005).

#### *Brainstorming of Assistive Devices*

The program faculty asked several of their community collaborators to review their ideas for a small collection of devices that the faculty and students thought might be both useful and feasible to develop. From that group, they were asked to select the two or three ideas that they perceived would most benefit people with hearing loss. The devices selected for exploration were a dialogue facilitator, an audio event detector, and a volume detector.

The first assistive listening device, the *Dialogue Facilitator*, would build upon the rapidly expanding field of voice recognition software. It converts the hearing user's speech into text, which the person with hearing loss can read on a computer screen and print out for immediate and later review. By including medical vocabulary, the dialogue facilitator could help deaf or hard-of-hearing patients communicate in a physician's office. It was envisioned that at the doctor's office, both the doctor and patient will sit near a computer. The physician will speak into a microphone, and the words that are said will be displayed on the computer screen. The patient can read from the computer screen to catch words or phrases that were missed. In the end, a full copy of the conversation can be printed out for the patient to keep. Such a device would be most helpful to people who are deaf or hard-of-hearing with relatively high literacy rates in the spoken language.

The second assistive listening device, the *Audio Event Detector*, would recognize and notify users of selected words, prompts, and sounds from the user's environment. Example sounds include the call of the user's name, an emergency alarm, a phone ring, and keywords for social activities, such as 'Bingo.' The user can program five to ten target sounds onto the device, which is designed to be small and wearable.

The third assistive listening device, the *Volume Detector*, would provide users who were hard-of-hearing with immediate feedback on the level of their vocal projections. People who suffer from hearing loss often have difficulties with modulating their own voice levels against the surrounding environment. This device simultaneously measures the level of surrounding noise and the level of the individual's speech. If a significant discrepancy is detected between these two levels, the device will notify the individual to either increase or decrease his or her volume level.

The Computer Science team members then began developing prototypes of these devices. The Cancer Center team members began recruiting potential participants for focus group discussions about the usefulness of those devices for people who are deaf or hard-of-hearing.

#### *Developing the Focus Groups*

*Eligibility requirements.* Eligibility requirements for study participation included: (a) self-identification as a person who is deaf or hard-of-hearing, (b) being at least 18 years of age, and (c) having the competency to understand and sign a consent document. Based on prior experience in conducting focus groups, the Cancer Center researchers anticipated that for every three people who said they would agree to attend a focus group, one could be expected to arrive.

*Recruitment of focus group participants.* The Cancer Center team members initiated a person-to-person recruitment strategy to populate the focus groups. Known members of the Deaf community were contacted using multiple communication strategies, including face-to-face conversations, emails, instant messaging, direct phone and calls through videophone, and posting of IRB-approved flyers at affinity organizations in San Diego (e.g., Deaf Community Services [DCS],

Association of Late Deafened Adults [ALDA], and the Hearing Loss Association of California). Additional recruitment was done through community venues that attracted people who are deaf or hard-of-hearing, such as ministries that provide accommodations for people who are deaf and hard-of-hearing and social gatherings (e.g., pizza nights, coffee nights, and health seminars that are specifically for people who are deaf and hard-of-hearing). Potential participants were given a copy of the IRB-approved flyer to help them retain the information they were given by the study recruiter, to serve as a reminder of the focus group schedule and location, and to share with others who might be interested (Merrell, Kinsella, Murphy, Philpin, & Ali, 2006). The recruiter explained that focus group participants would receive a \$15 gift card to a local grocery store chain in appreciation for their participation, as well as healthy refreshments at the focus group.

The study recruiter also asked if potential participants would be willing to share the names and contact information of other people who might be interested in learning about the study (i.e., snowball sampling; Wasserman, Pattison, & Steinley, 2005). These methods of recruiting make it difficult to determine an accurate refusal rate since the denominator (those invited) is unknown. This is compounded by the fact that some people may have been willing to participate, but were unavailable during the times that the focus groups were scheduled.

*Preparations for conducting focus groups.* When researchers work with people outside of their own community or cultural group, it is essential that they seek guidance on how to cooperate with the group in a culturally competent manner (Munoz-Baell & Ruiz, 2000; Stebnicki & Coeling, 1999). Before conducting the first focus group, the research team held a three-hour practice session with two staff members from the Cancer Center

who were members of the Deaf community and had experience in conducting focus groups with people who are deaf and hard-of-hearing. Two hearing undergraduates were also part of this research team. They had been working on the Cancer Center's Deaf community cancer education program and had been trained in cultural sensitivity for the Deaf community. They assisted with the set-up of cameras and lighting for the recording of the focus groups.

Four interpreters were hired to provide additional advice on the optimal logistical configuration of the focus groups' participants and presenters. The practice session also gave the computer science graduate students their first opportunity to work with ASL interpreters. In addition, the practice session gave the students the chance to learn how best to employ their visual aids and helped them to learn the best way to pace and organize the presentation of their materials. The principle investigator (Sadler) for the Cancer Center's Deaf community cancer-related research projects assumed the role of overseeing the practice session and providing the doctoral students with additional immediate feedback on ways to improve the effectiveness of their presentations and their cultural competency.

Developing the optimal room configuration was a key logistical consideration during the practice session. The first goal was to provide optimal light without creating glare. The second goal was to provide strong enough lighting to enable participants to make accurate distinctions among the subtle differences in various signs and the rapid finger spelling of ASL. Lighting and video camera considerations had to take into account that all members of the focus group had to be in direct visual contact with each other to communicate in ASL. Placement of the cameras also influenced the room's configuration because it was essential to

produce quality video tapes that would capture not only the video of the interpreters' and participants' signing, but also the interactive aspects of the focus groups' dynamics. Since there were considerable costs incurred in conducting each focus group, and since the recording of the focus group was central to the success of the project, an extra video camera was always available in case one of the other two cameras malfunctioned.

Additional considerations involved keeping the expense of conducting the focus groups within the projected budget that was partially funded through the University's Chancellor's Interdisciplinary Collaboratories grants. (Note: These are small, innovation grants that are anticipated to promote interdisciplinary collaborations and yield the experience and data needed to secure subsequent funding.) When working with focus groups, the planned budget should allow for expected costs such as stipends and tuition remission for students, hourly wages for interpreters, recording equipment, participant incentives, and refreshments for the focus groups.

When calculating interpreters' cost, it is important to remember that for sessions that will last longer than 45 minutes, a second interpreter must also be hired so that the interpreters can relieve each other. This is not only essential for the well being of each interpreter, but also to avoid interpreter fatigue that will lead to diminished quality of communication. In the focus groups, a team of two interpreters is needed for translating the presenter's information into ASL and one additional pair of interpreters is needed for up to 10 members of the focus group so that their communications in ASL can be translated into English for the presenter's understanding. In addition, for people who are hard-of-hearing and do not sign, a real-time captionist must be available to convert the spoken words into written format. Again, depending on the duration and the size of the

focus group, more than one person may be required.

A final consideration that can increase the quality of the focus groups is the pre-event preparation of the interpreters. Providing a written summary of the content of the presentation planned, a glossary of technical terms, and time for the interpreter to ask questions of the presenter can significantly improve the quality of the interpreter's transmission of the information.

*Protocol for Focus Groups*

All three, two-hour-long focus groups were scheduled to be conducted at the Moores UCSD Cancer Center because it was a familiar location to most participants due to the Center's long-term educational collaboration with people who are deaf and hard-of-hearing. Each focus group was designated for a particular group of people in order to better

address the needs of that group; the first two focus groups were planned primarily for deaf individuals, and the last one was intended primarily for people who were hard-of-hearing.

The students were told to exactly follow the IRB-approved focus group protocol, which included individually greeting and welcoming the participants as they arrived and inviting them to partake in the refreshments. Once all expected participants had arrived, the students were to give a formal introduction of the entire research team and fully explain the goals of the focus group. They would then take the participants through the full IRB-approved consenting process with documents in written English and presented in ASL. Video release consent forms were also included to ask for participants' permission for the video tapes to be used for research, training, and presentations at scientific and

**Table 1**  
**Focus Group Discussion Guide**

**Device 1: Volume Detector**

- Will this device be useful for people who are deaf or hard-of-hearing?
- Would you use a device like this? In what situations??
- How would you like to wear it? Attached like a pager? In a pocket? Other?
- How would this device notify you? Vibrations? Lights? Other?
- What else? How can it best serve you?

**Device 2: Dialogue Facilitator**

- Will this device be useful for people who are Deaf or hard-of-hearing? How would it be useful for you?
- Is there anything about this device that you would like to modify?
- Will this device be useful in other scenarios besides a doctor's office?
- How important is it to you that this device is mobile? How small would this device have to be?
- How often do you visit the doctor? What is usually the format of these visits?
- Do you ever have trouble communicating with your doctor? Do you communicate with your doctor using an interpreter?

**Device 3: Sound Detector**

- Will this device be useful for people who are deaf or hard-of-hearing? How would it be useful for you?
- Is there anything about this device that you would like to modify?
- What are some useful sounds or words that you would program onto this device?
- How would you like to wear this device?
- How would you like this device to alert you?
- Which of the three devices presented would you be most interested in using?

educational conferences.

The computer science student was to remind the participants of her name and then give a thorough explanation of the device being presented. She would then lead the focus group discussion about the device with the help of a Cancer Center staff member who was deaf and proficient in ASL. Table 1 lists the questions that were to be used for each device to guide the discussions throughout the focus groups. The questions were developed by the computer science students and project faculty and approved by IRB. They focused on gaining an understanding of how the potential end-user might employ the device, how the prototype of the originally conceived device should be modified to make it more user friendly, and whether there were other potential uses for the device that had not been identified. As the focus groups were approaching completion, the computer science students were to ask the participants if they would like to be notified if any of the devices reached the point of readiness for (beta) testing. Finally, to further strengthen the students' and focus group members' comfort working across language and culture barriers, the computer science students were to encourage the focus group participants to stay a little longer for social exchange and refreshments after the focus group.

#### *Field Notes and Transcription*

During the practice session, the placement of an audio tape was also tested along with the best position for the undergraduate students to sit when they were gathering field notes. The undergrads needed to be unobtrusive recorders of key observations and also able to periodically check to assure the proper functioning of the video and audio recording equipment. The audio tape recording was made because it is easier to transcribe from an audio tape than a video tape, and these audiotapes served as a back-up strategy in case

the video equipment failed or parts of the videotaped discussion were inaudible. A back up audio recording device is, therefore, also a wise investment.

The transcription of the audio tape would be done as soon as possible after each focus group. That transcription would then be compared with the dialogue on the video tape as a double check for accuracy. The relevant transcription of the focus groups would then be coded into thematic clusters, the frequency data would be determined, and conclusions would be developed.

#### *Participants*

The participants ranged in age from 24 to 75 yrs (see Table 2). For females, the average age of the participants was 53; for males, 43. The group included 12 deaf participants and three hard-of-hearing participants (one did not answer the question) and had diverse modes of communication. One of the group members had completed high school, 11 had attended some college, and four had completed college or beyond. While the participants' ethnic diversity was not representative of the region's racial/ethnic characteristics, it was the need to assure a diversity of hearing-related characteristics that primarily drove the recruitment efforts in the area of attaining sample diversity.

### **Results**

#### *Impact of the Practice Session on Data Gathering in the Focus Groups*

Comparing the students' experiences in the practice focus group session to the consistent and high quality results of the three focus group sessions, there could be no doubt of the demonstrable benefits that were gained from the single practice session. The room configuration was changed multiple times during the practice session to address issues

**Table 2**  
**Focus Group Participant Demographics (n=16)**

Category	Total
<i>Gender</i>	
Male	10
Female	6
<i>Race/Ethnicity</i>	
Black/African American	1
White/Caucasian	15
<i>Age</i>	
18-30	4
31-40	2
41-50	2
51-60	4
61+	4
<i>Identity†</i>	
Prelingually deafened (Became deaf before speech acquisition)	12
Postlingually deafened (Became deaf after speech acquisition)	0
Late deafened	0
Hard-of-Hearing	3
<i>Primary Mode of Communication‡</i>	
ASL	13
Pidgin Sign English (PSE)	2
Sign Exact English (SEE)	0
Total Communication (sign, speech, lip-read, etc.)	3
Oral	2
Cued Speech (hand movement paired with visual signs that represent phonetics)	0

†One participant did not answer this question.  
‡Some participants chose two primary modes of communication

related to (a) achieving optimal lighting; (b) filming to include all participants; (c) ensuring clear audio pick-up; (d) maintaining direct visual access among all parties involved in the focus groups; (e) providing interpreter accommodations; and (f) seeing the presenter, interpreter, and slides simultaneously.

Following the practice session, the three focus group sessions preceded extremely smoothly, the recordings were of sufficient clarity and entirely audible, and the data gathered was of very high quality and directly addressed the students' information needs. Figure 1 presents the final room configuration used for all three focus groups and is the one which would be selected for all future focus groups of comparable size.

### *Students' Acquisition of Cultural Competency*

The reading materials combined with the practice session were sufficient to help the students gain an appropriate level of cultural competency in their presentations and interactions with the members of the focus groups. Following each focus group session, the participants: (a) volunteered comments expressing their appreciation of the students' clear efforts to be deaf-friendly; (b) expressed excitement about the devices; (c) stayed after the focus groups to talk to the individual presenters and staff members; (d) volunteered to participate in future focus groups; and (e) unanimously agreed to be notified of the overall progress of the study, as well as future opportunities to participate in research.

The computer science students gained valuable experience working with the

interpreters and an appreciation of the importance of taking the time to learn culturally competent ways to work with people who are deaf and hard-of-hearing. By having a highly interactive practice session, the doctoral students were able to hone their skills as they received real-time feedback from their computer and behavioral science faculty,

deaf team members, and interpreters. By giving the students suggestions throughout their presentation, the students had the opportunity to practice each lesson learned during the remainder of their presentation, thus reinforcing the lessons. At the end of each presentation, the students received a written summary of the key points they would

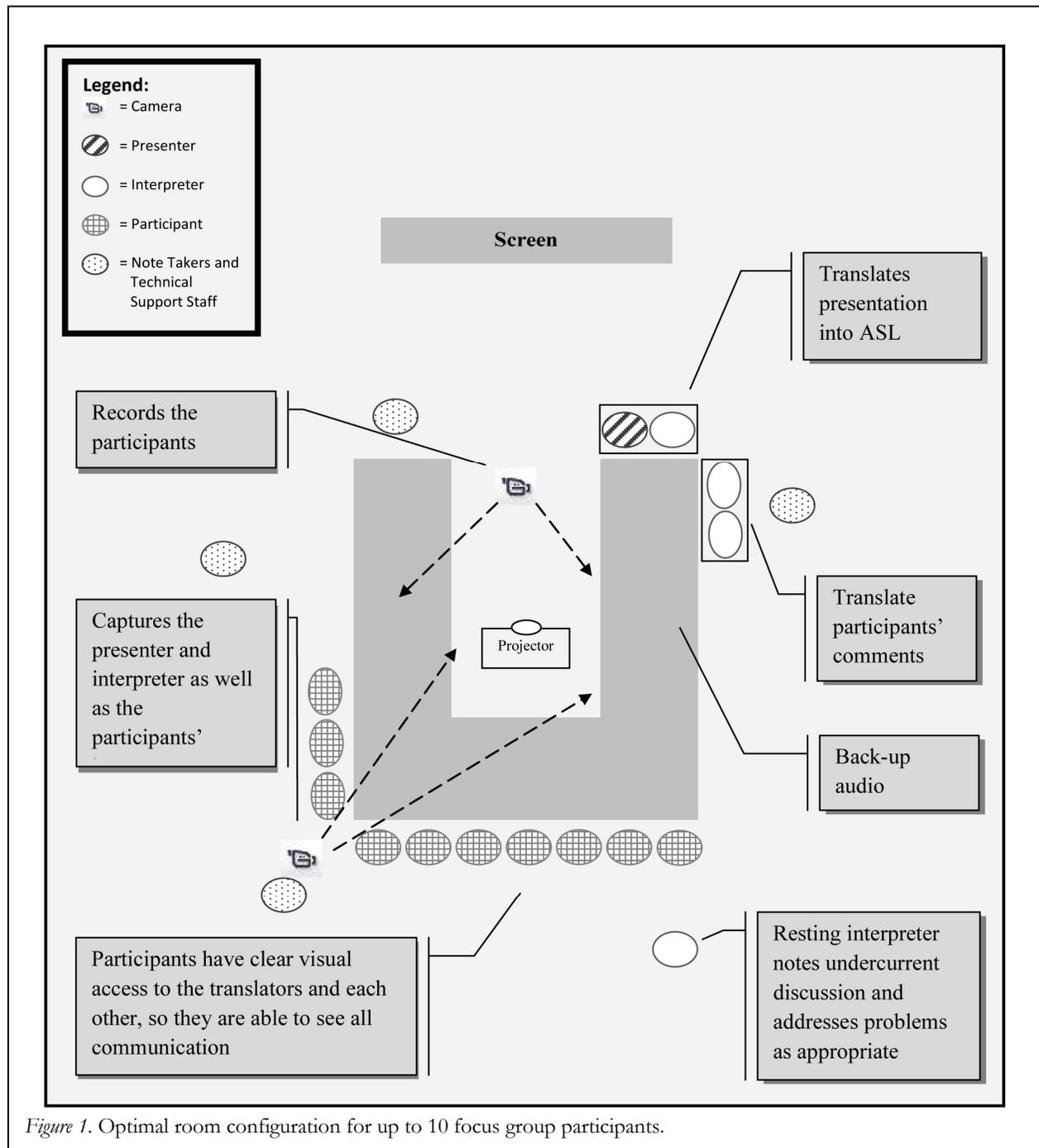


Figure 1. Optimal room configuration for up to 10 focus group participants.

**Table 3**  
**Culturally Competent Techniques for Conducting Focus Groups with People Who Are Deaf or Hard-of-Hearing**

- 
- Present visual information sequentially with oral presentation to allow participants to follow along.
  - Recognize the difference between Deaf and hard-of-hearing subgroups, and how this may affect their application of devices.
- Allow participants the opportunity to read the presenter's lips by avoiding the following:*
- Turning face away from audience.
  - Talking behind hands.
  - Talking while the participants' attention is diverted (eating food, taking a break, etc.).
- Display competency working with interpreters, including:*
- Giving eye contact to the participant, rather than the interpreter.
  - Allowing time for the interpreter to translate, by speaking slowly or pausing between statements.
  - Using more common and less technical terms.
  - Taking breaks to allow interpreters to rest.
  - Bringing the group to order by waving arms or flicking lights on and off.
  - Providing visual components that are easily accessed:
    - Using a PowerPoint™ presentation with diagrams and pictures to illustrate the physical devices.
    - Incorporating key terms, and avoid unnecessary details.
    - Accommodating color-blind participants, by avoiding red and green colors.
    - Choosing fonts that are easier to read, rather than those that are more aesthetically appealing.
- 

need to practice and remember to do correctly during the actual focus groups.

Table 3 includes examples of the lessons students learned about cultural competency during the practice focus group session. For example, they learned that one culturally acceptable way of gaining attention from an audience of deaf and hard-of-hearing people is to flick the room's lights off and on quickly. Another example they learned is that they must first explain the visual aid they will be showing to the audience. Then they show the audience the visual aid without further accompanying conversation. Finally, they recapture the audience's attention by entering into the audience's visual field and signaling the start of conversation before actually initiating the conversation. Students learned that additional graphics and hands-on exhibits would increase the accuracy and speed the transmission of information to their focus group participants.

They also learned the value of adding slides with keywords and pictures as a visual supplement to the presentation. Equally important, students learned that their slides should only include colors that are accessible to people who are color blind to assure optimal accuracy of the transmitted information (Cole, 2004). As a result of the practice focus group session, each student developed a more detailed slide presentation that better forecasted the order of the topics to be presented and enhanced the ease of understanding the complex information being shared. Giving this depth of attention to the cultural competency of the students' presentations coincidentally disclosed other ways to enhance the students' likelihood of research success. The focus group setting is an unfamiliar one for most computer science students. This practice session made it easy for the Moores behavioral science staff and faculty to identify ways to help the students employ the social skills that are routinely used to put participants at ease in focus groups (see Table 4).

**Table 4**  
**General Interpersonal and Presentation Skills**

- Personally greet participants upon arrival.
- Help participants get comfortable and access amenities.
- Gain the attention of the entire audience before beginning the presentation.
- Begin the presentation with a thorough introduction and overview.
- To reduce disruptions, have the participants collect all refreshments and bring them to the table before the session begins
- Allow participants to retrieve more refreshments between breaks in the presentation to assure their comfort.
- Elicit feedback from the participants frequently.
- Elicit responses from participants in random order.
- Bring relevant sidebar discussion into mainstream discussion.

*Evaluation of Budget Projections*

The practice session was also useful in helping the faculty assess if they had correctly projected the funds that would be required to conduct the three focus groups planned or whether adjustments would be needed to the budget or methodology. Since the faculty members were preparing subsequent research proposals, this practice session also gave them a more accurate assessment of the actual costs of conducting focus groups with people who are deaf or hard-of-hearing. Table 5 illustrates the approximate budget for a two-hour focus

group for up to 10 participants.

A total of four interpreters were used for the two focus groups with participants who were deaf (two oral and two signers). Two interpreters (one oral and one signer more English-language geared) were sufficient for the hard-of-hearing focus groups. None of the participants indicated a need for a real-time captionist to provide simultaneous transcription of the focus group dialogue. Hence, this cost is not included in the budget, but should be a consideration when planning budget expenses for focus groups with people

**Table 5**  
**Estimated Costs for One Two-Hour Focus Group of 10 Participants**

Item	Price/Unit	Qty.	Total
<i>One-Time Costs</i>			
LCD Projector	\$1000	1	\$1000
Cameras	\$ 600	3	\$1800
Light Kit	\$ 100	2	\$ 200
Audio Recorder	\$ 35	1-2	\$ 35 - \$70
<i>Total Start-Up Costs</i>			\$3,035 - \$3,070
<i>Per-Session Costs</i>			
Video Tapes	\$4	6	\$24
Audio Tapes + batteries	\$5	1	\$5
Interpreters (costs vary by city)	\$130/2 hour minimum	4	\$520 for 2 hours
Participant Incentives	\$15 - \$100	10	\$150 - \$1,000
Healthy Refreshments	\$8 per person	20	\$160
<i>Total Per-Session Costs</i>			\$859 - \$1,709

**Table 6**  
**Insights Gained from Focus Groups**

Theme Area	Focus Group Advice and Changes Recommended
<i>General (across all three devices)</i>	<ul style="list-style-type: none"> <li>• Integrate devices with already owned gadgets, such as a PDAs, cell phones, or laptops</li> <li>• Need to be financially feasible.</li> </ul>
<i>Device 1: Volume Detector</i>	<p><i>Advice:</i></p> <ul style="list-style-type: none"> <li>• Needs to be small and portable.</li> <li>• More suitable to the hard-of-hearing community, because Deaf community does not typically use their voice.</li> <li>• Should have options for signal of volume, such as blinking lights and vibrations.</li> </ul> <p><i>Changes Recommended:</i></p> <ul style="list-style-type: none"> <li>• Add variation in intensity of signal to denote degrees of volume.</li> </ul>
<i>Device 2: Dialogue Facilitator</i>	<p><i>Advice:</i></p> <ul style="list-style-type: none"> <li>• Technology should not be a replacement for human interpreters; instead, it should supplement interpreting or be an alternative option.</li> <li>• Institutions (i.e. doctors and hospitals) should not control the use of this device; rather, the patients should be able to own this device and use it at their own discretion.</li> <li>• The device should be portable.</li> <li>• There are other scenarios (besides the doctor's office) where the device would be useful, including at school, court, or a restaurant.</li> <li>• To interact back with the doctor, people preferred to type.</li> </ul> <p><i>Changes Recommended:</i></p> <ul style="list-style-type: none"> <li>• Make the screen very large so that the patient can more easily see the doctor and the screen at the same time.</li> </ul>
<i>Device 3: Sound Detector</i>	<p><i>Advice:</i></p> <ul style="list-style-type: none"> <li>• It should be easy for the user to record new 'events' that he or she wants to detect.</li> <li>• Must be small enough that the user can carry it around effortlessly.</li> </ul> <p><i>Changes Recommended:</i></p> <ul style="list-style-type: none"> <li>• Add an indicator to tell how close a certain sound is, perhaps a light that flashes at greater frequency when the sound is closer.</li> <li>• Add a timestamp to record when a certain sound occurs.</li> <li>• Add an indicator to show directionality of the origin of the sound.</li> <li>• Have the ability to record certain sounds so that they can be replayed to hearing friends to ask exactly what that sound was.</li> </ul>

who are hard-of-hearing or deaf.

While it was possible to attract participants with the \$15 gift card incentive, this low amount was insufficient to attract participants quickly. It is also likely that the people who

did participate were more attracted to the novelty of the experience, the chance to socialize with other deaf or hard-of-hearing people, or the opportunity to do a community service than the incentive and this may have biased the sample to attract a more affluent

group of participants. Given the amount of time ultimately requested of the participants, an incentive in the range of \$50 to \$100 would have been more appropriate.

#### *Insights Gained Related to Device Development from the Focus Groups*

The audio and visual recordings were successfully transcribed, coded, clustered, and interpreted into meaningful findings. All three focus groups' participants expressed unique needs for, and applications of, the three identified devices. The participants were insightful regarding the physical design, overall concept, and commercial markets for the devices, both identifying and nullifying ideas within these areas. The research team found several common themes that were identified throughout all of the focus groups. See Table 6 for examples of the identified themes, advice, and changes recommended by focus group participants.

Most importantly, these insights would have been difficult to derive without the input from the focus group participants. The three sessions provided achieved consensus on several key points, while also producing several new insights and ideas. Had fewer focus groups been held, important information would have been missed. Since the three focus groups never reached the point where new information was not provided, the additional focus groups scheduled for the next stage of developmental feedback will likely yield further new ideas.

The audio portion of the recording allowed for good transcription of the interpreters' oral translations. While the visual recordings were not of the highest quality, they were sufficient to supplement the audio recordings, to observe interactions and dynamics among the focus group participants, and to permit the participants' signs to be deciphered and the overall messages to be understood. Better

lighting, however, would have ensured better accuracy and better teaching materials.

#### *Outcomes and Benefits*

This study has been successful in meeting our goal of teaching doctoral students how to overcome language and cultural barriers in order to engage the anticipated end users of their discoveries in meaningful discussions. Computer science students learned to communicate with, and reach out to, people from different cultural backgrounds. The students created an environment in which deaf and hard-of-hearing participants felt comfortable and where their collaboration was genuinely appreciated. The participants' understanding of the material and acceptance of the research team was demonstrated by the overwhelming amount of feedback given and the sincere interest shown for helping the students to develop their devices. The students now have the confidence needed to work with people across communication, language, and cultural barriers. They also have learned the value of finding people who can help them make a good first impression through cultural competency, how to create bridges to overcome interpersonal barriers, and the value of good prior planning. The insights they gained from the focus group session expanded the students' awareness of the value of collaborating with the presumed end-users of their devices to gain insights that will better focus their work.

Throughout the course of this study, the research team has accumulated valuable experiences for working with people who are deaf or hard-of-hearing in a focus group setting. The most important recommendations include the following.

1. *Contact leaders who advocate on behalf of people who are deaf and hard-of-hearing. They are a valuable resource for recruitment, knowledge about the*

people to be served, and interpreting needs and services. Having the support of a community leader for a scientist's research can be essential in acquiring the trust of other individuals who have had limited experience with research. For this study, the majority of contacts established were gained through DCS, which has peer associations nationwide.

2. *Become familiar with the people to be served and their culture.* This knowledge allowed this study's researchers to establish better communication and trust with their study participants who were deaf or heard of hearing as well as future collaboration opportunities.
3. *Use professional interpreters when attempting to communicate in the absence of a common language.* For many deaf people, ASL is their primary language. Local advocacy organizations can put researchers in contact with interpreting services and advise the researcher on determining the appropriate level of interpreting expertise to request, so that the interpreters' skills will match the interpreting needs.
4. *Recognize that people who are deaf and hard-of-hearing rely upon more than one form of communication.* It is appropriate to inquire which methods should be provided to accommodate each person best. Since interpreters must be scheduled at least a week in advance, it is essential to inquire about participants' preferred mode of communication well before their arrival at the focus group. This is a critical step since clear communication is federally mandated for the consenting process.
5. *Value a practice session.* In our study, this was the most valuable resource for planning the room layout, interpreter accommodations, positions of recording equipment, and the budget.

The practice session also provided the students' with exposure to real life examples of language and cultural considerations before the students gave their presentations.

6. *Invest in good video and audio recording devices.* A high quality audio recording and a high-resolution camera make clear transcriptions possible, a particularly important concern when the fine hand and finger movements of ASL must be understood. Having a person take field notes can also enrich the interpretation of the transcription.
7. *Have a deaf or hard of hearing person assist with focus group facilitation.* This will help participants feel more comfortable and be more willing to share their ideas and opinions.
8. *Recognize the many characteristics among people who are deaf or hard-of-hearing.* Such characteristics can create diverse communication accommodation needs, as well as diverse opinions. One option is to group together participants with like accommodation needs to facilitate intra-group communication. Alternatively, since people with different hearing challenges might think of different applications for the same device, bringing people with diverse characteristics together is likely to expand the ideas raised for discussion. Having more diversity within this study's focus groups allowed participants to gain insights from each other, as one group recognized a value in an aspect of a device that the others had not considered.

## Conclusion

Teaching tomorrow's computer science researchers how to work across communication, language, and cultural barriers to reach the intended end-users of

their discoveries enriches students' learning, while helping them to create devices that will better serve their end-users. When the intended end-user is a person who is deaf or hard-of-hearing, special accommodations must be considered. This study demonstrates the value of collaborating with intended end-users and prior preparation for doing so. It offers specific strategies that all researchers who seek to improve the well-being and quality of life of people who are deaf or hard-of-hearing can employ.

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