Perspectives of Assistive Technology from Deaf Students at a Hearing University

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Abstract: The purpose of this study was to investigate the perspectives of Deaf students attending a large 'hearing' university regarding their use of assistive technology (AT). Individual, semi-structured interviews were conducted with nine participants and responses were videotaped and transcribed from sign language to English. A collective case study approach was used to analyze the data. Three primary categories concerning perspectives of AT emerged from the qualitative analysis: (a) self-reported use of assistive technology and overall benefits, (b) barriers to AT use, and (c) facilitators to AT use. Discussion centers on the struggle to balance the triad of information that deaf students encounter in the university classroom and offers recommendations to assist deaf students in 'hearing' classrooms at the university level.

Key Words: Assistive technology, Deaf students, Higher education, PowerPoint™

Authors Note

The researchers have acknowledged that participants in this study consider themselves as part of a cultural group and refer to themselves as 'Deaf.' We also recognize the American Psychological Association (APA; 2001) guidelines regarding person first language. However, to be sensitive to the expressed preference of study participants regarding terminology, the term 'Deaf' will be consistently used throughout the article.

AT and Legislation

The Individuals with Disabilities Education Improvement Act (IDEIA) of 2004 supported the role of assistive technology (AT) as an integral and necessary component of education for all students with disabilities, mandating that AT be 'considered' for all students when program plans are developed for children with disabilities [20 U.S.C. 1401 § 614(B)(v)]. Consequently, when a Deaf child enters the special education system at the age of three years, his or her individual education program (IEP) must document that AT services and devices have been considered and, if deemed necessary, a service plan for implementation and delivery has been developed and will be implemented.

The No Child Left Behind Act of 2001 (NCLB) has placed emphasis on the participation and success of all children--both with and without disabilities--in the academic curriculum. Thus, with IDEIA and NCLB in place, it would appear that a solid foundation was in place for the Deaf child to receive AT services in the public schools from early intervention through graduation from high school.

However, research has indicated that little guidance has been provided regarding how

AT is considered and how the process occurs for young children with disabilities (Mistreet, Lane, & Ruffino, 2005). While it is beyond the scope of this study to delve into the history of AT use with the Deaf, several studies have addressed this area of interest (e.g., Mackowiak, 1989; Stinson, Stuckless, Henderson, & Miller, 1988; Zazove et al., 2004). Conclusions from these studies indicate that the use of AT is increasing in the Deaf population and AT use is beginning at an early age. Ideally, Deaf students will graduate from the public schools with AT experiences that have prepared them for effective and successful university careers.

The Americans with Disabilities Act (ADA) and Section 504 of the Rehabilitation Act Amendments of 1973 continued the legislative support for an increasing number of individuals with disabilities to enter, learn, and graduate from institutions of higher education. Among those individuals with disabilities are an ever increasing number of Deaf students and students with hearing loss. Approximately 30,000 students in colleges and universities across the U.S. are Deaf (Kolvitz, Billies, Wilcox, & Rawlinson, 2003) and attend 'hearing universities.'

The term *hearing universities* was initially coined by Komersaroff (2005) to refer to universities dominated by students who are hearing. In these institutions, the hearing students experience equality that may not naturally be assured or assumed by peer Deaf students. Thus, IDEIA established the foundation for Deaf students to receive AT services at a young age and the ADA and Section 504 support the legal right to access AT support at universities by providing equal access to materials. Yet research to date has neglected to examine the perspectives of Deaf students themselves at these institutions—the ones who have directly benefited from legislation.

Technology and Deaf Students: Instructional or Assistive?

The IDEIA defined AT devices as "any item, piece of equipment or product system, whether acquired commercially or off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" [20 U.S.C. 1401 § 602(1)]. At a hearing university, accommodations are required for Deaf students to gain access to information that is readily available to hearing students. We acknowledge that technologies viewed as instructional for hearing students become assistive for the Deaf student. For example, if a professor is lecturing and using an instructional technology such as Microsoft® PowerPoint™, the Deaf student may rely heavily on the PowerPoint™ presentation to gain information not otherwise available to him/her. When that occurs, the instructional technology then becomes AT for that student because it improves the Deaf student's functional capabilities of receiving the information. Another illustration would be if a Deaf student were interacting with peers during a class activity and using text messaging to communicate with group members. The text messaging becomes AT because it allows the Deaf student to improve his functional capability of communication, since his or her speech may be unintelligible to peers due to deafness. Therefore, for the purposes of this paper and congruent with the perspectives of our participants, we will refer to AT as devices that our participants have identified as improving their functional capabilities and/or compensating for their hearing loss.

AT has been deemed as one of the "great equalizing forces in education and meaningful inclusion of students with disabilities both in terms of promoting access to the general curriculum and in facilitating the ability of students to demonstrate mastery of that

Table 1
Demographics of Participants

Name	Hearing Loss/Age of Onset	Speech Intelligibility	Communication Mode/Language During Interview	College Status	Age
Yvonne	Severe to profound/ Birth	Intelligible	Speech	Undergrad/ junior	Early 20s
Ken	Severe to profound/ Before 1 yr	Intelligible	MCE[a]	Undergrad/ senior	Late 20s
Henry	Profound/ 3 yrs	Intelligible	ASL[b]	Undergrad/ junior	Early 20s
Tony	Profound/ Birth	None	ASL	Undergrad/ sophomore	Early 20s
Keith	Profound/ Before 2 yrs	Limited	MCE	Undergrad/ senior	Early 20s
Karl	Profound/ Birth	None	ASL	Undergrad/ junior	Early 20s
Hayley	Profound/ Before 2 yrs	Intelligible	Speech	Undergrad/ junior	Mid 20s
Jennifer	Profound/ Birth	Intelligible	Speech	Graduate	Mid 30s
Botina	Severe/ Progressive/ Before 2 yrs	Intelligible	Speech	Undergrad/ junior	Early 20s

[a]MCE: Manully Coded English
[b]ASL: American Sign Language

knowledge" (Michaels & McDermott, 2003, p. 29). AT has great potential to assist Deaf students at hearing universities. However, the Deaf student at a hearing university must assume significant responsibility for the effective use of AT. While the ADA and Section 504 delineate the responsibilities of colleges and universities regarding the education of Deaf students, the Office of Civil Rights (OCR) has clearly stipulated that it is the student's responsibility to "notify the school of their disability, request academic adjustments, and provide any necessary evidence of a disability-related need for the requested adjustment" (Milani, 1996, p. 995). The Deaf student may not know or understand the various accommodations available, understand the effectiveness of accommodations, or have the knowledge and skills to ask for the appropriate accommodations that can vary across students, the curriculum, and faculty who deliver instruction. Additionally, students are often not exposed to various potentially advantageous technologies at the high school level and may be ignorant of technologies that might be useful.

Numerous research studies indicate that Deaf students are using a range of technologies with increased frequency and consistency, such as the Internet and email (Bowe, 2002); instant messaging ([IM]; Bowe, 2000); Real-Time Graphic Display ([RTGD]; Stinson et al, 1988); captioning (Ward, Wang, Paul, & Loeterman, 2007); and Teletype-writer ([TTY]; Power, Power, & Rehling, 2007). Such studies support the basic assumptions of the current investigation that: (a) use of AT is increasing, (b) use of AT is beginning at an early age, and (c) AT holds potential to equalize the university student experience at hearing universities. Yet, there has been no research that has examined the perspectives of Deaf students at a hearing university regarding their use of AT. Therefore, the purpose of this study is to investigate the perspectives of Deaf students regarding their use of AT while attending a hearing university. Specifically, the research questions that guided this study were: (a) What are the perspectives of students who are Deaf at a hearing university regarding use of AT? (b) What barriers to AT use at a hearing university are identified by students who are Deaf? and (c) What facilitators of AT use at a hearing university are identified by students who are Deaf?

Method

Qualitative methods were chosen for use in this study to allow researchers to thoroughly explore perspectives and gain insight into the feelings, emotions, and thought processes of the participants (Creswell, 2002; Strauss & Corbin, 1998). This study used a collective case study, which investigates more than one case to understand a phenomenon, population, or general condition (Stake, 2000). Miles and Huberman (1994) stated that investigating a number of cases, as opposed to a single case, will lead to better comprehension and better theorizing. Furthermore, collective case study allowed the researchers to examine processes and outcomes across many cases and to develop a deeper understanding through more powerful descriptions and explanations.

Participants

Convenience sampling was the method used for obtaining participants. Participants were 1 Hispanic and 8 Caucasian students who were Deaf at a large, Midwestern hearing university. Students were recruited by a faculty member in the Department of Special Education and/or an undergraduate student who was also Deaf (See Table 1 for participant demographics). Nine participants agreed to be interviewed and videotaped.

Setting

The setting was a large, Midwestern hearing university with a hearing student population of approximately 20,000 students and approximately 27 Deaf students. The university has an Office of Disability Concerns (ODC) that provides services to students with disabilities, including Deaf students. These services are primarily focused on determining appropriate accommodations for participation in the university curriculum and how to access accommodations. All Deaf students must initiate contact with the ODC and coordinate interpreter services, class schedules, and any other accommodations, such as note-takers, extended test time, or alternative test settings. Requests for copies of Microsoft® PowerPoint™ slides are made directly to individual faculty. No participants mentioned the ODC in their interviews, yet all participants who had interpreters did have some contact with the ODC.

Interviews

Interviews have been described as one of the most powerful ways to understand another's perspective (Fontana & Frey, 2000), and were the primary form of data collection. The interview questions were developed to address the research questions, and while each question was asked during each interview, the interviewer was given discretion to ask additional questions to probe or clarify issues that arose during the interview process when needed. Interviews were conducted by the primary researcher and the undergraduate student. Interviews consisted of two parts: (a) a written section which focused on obtaining demographics, and (b) a face-to-face interview that was videotaped [See Appendix A]. The face-to-face interview consisted of semi-structured interview questions. The mode of communication during the interview was determined by participant preference. The interviews lasted approximately 90 minutes, and occurred during the Fall semester. Communication modes and languages included American Sign Language (ASL), Manually Coded English (MCE), spoken English, or any combination. The primary researcher asked for clarification of responses as needed during the interview.

Each videotape was transcribed by the undergraduate student who was Deaf and a native signer. Four of the interviews were randomly chosen and transcribed by a hearing student who was a child of Deaf parents with native-like sign skills. This procedure was completed to assess reliability of the transcriptions from sign language to written English and reliability was 98%. Any discrepancies between the transcribers were noted, and the two transcribers met and reached consensus on discrepant words. For example, one transcriber translated a sign as ‘ongoing’ while the other transcriber translated the same sign as ‘continuous.’

Data Analysis

After completion of the interviews, the tapes were transcribed verbatim and the data were analyzed using a line-by-line multiple coding approach (Barbour, 2001). The nine interviews were divided among the research team members, which consisted of two faculty members from the Department of Special Education and two honors undergraduate students. Each team member analyzed all interviews. All four researchers then met frequently as a group to develop categories based on their individual line-by-line coding. Disagreements about categories were discussed, and categories were refined, expanded, and/or deleted as needed to reach concordance (Barbour). The constant comparative method by which researchers continually returned to the data for analysis was used as an overall methodological framework (Charmaz, 2000).

Confirmability

Several approaches were used to confirm the findings: triangulation, expert validation, respondent validation, and member checking. Triangulation is the process of corroborating evidence from different individuals, types of data, and different methods of data collection (Creswell, 2002). Nine different participant interviews were analyzed and common themes emerged across all participant interviews. The findings were then organized in graphic representation in the form of a concept map which is provided in Figure 1.

All interviews were read independently by an expert in the field of Deaf Education who has taught Deaf education and ASL, has native-like signing skills, and has served as an ASL interpreter. The expert validated the findings. Respondent validation was completed by reporting and requesting participant opinions of the findings. Member checking, the process of contacting participants and obtaining approval for the use of all their personal quotes, was used to further confirm the findings (Janesick, 2000). All participants confirmed the findings and gave their consent for the use of personal quotes.

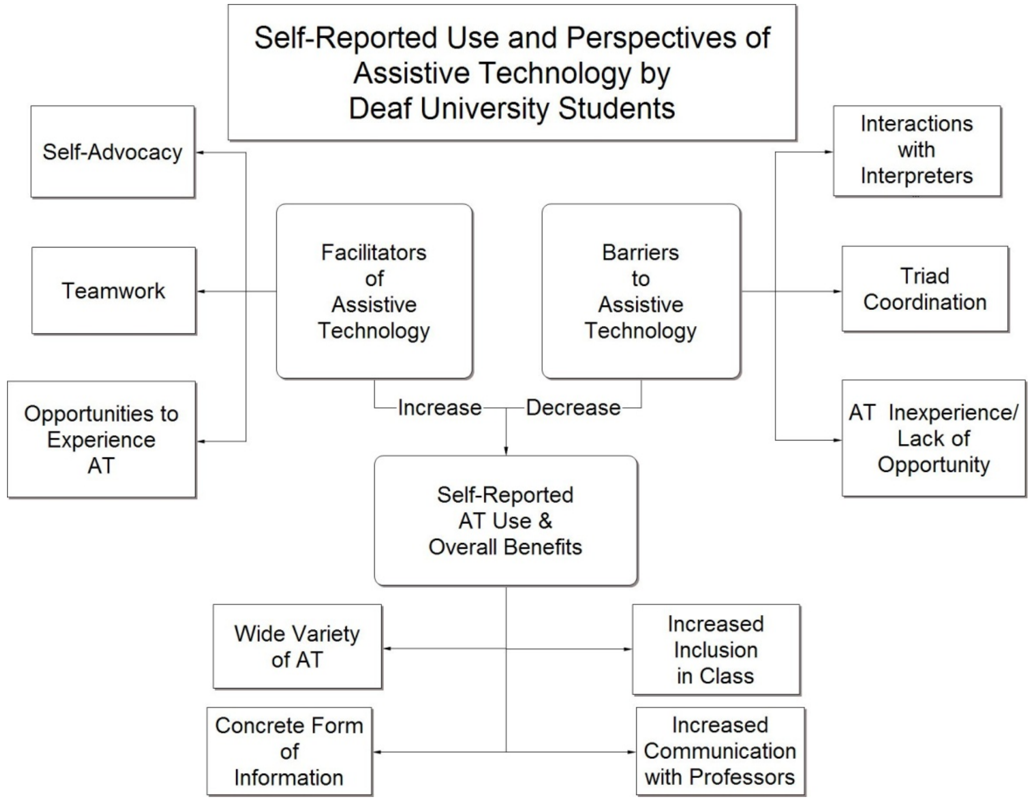
Self-Reported Use and Perspectives of Assistive Technology by Deaf University Students
Self-Advocacy
Teamwork
Opportunities to Experience AT
Facilitators of Assistive Technology
Barriers to Assistive Technology
Interactions with Interpreters
Triad Coordination
AT Inexperience/ Lack of Opportunity
Increase
Decrease
Self-Reported AT Use & Overall Benefits
Wide Variety of AT
Concrete Form of Information
Increased Inclusion in Class
Increased Communication with Professors

Figure 1. Themes of AT use by students who are Deaf at a hearing university.

Findings

Analysis of the data yielded three primary categories concerning perspectives of AT: (a) self-reported use of AT and overall benefits, (b) barriers to AT use, and (c) facilitators to AT use. Within each of these categories several subcategories emerged. The findings are organized by categories, and a discussion of the categories and the corresponding subcategories is presented.

Self-Reported Use of AT and Overall Benefits

Students spoke of the AT they personally used and the overall benefits of AT. Numerous AT tools were mentioned by participants (see Table 2).

There was a wide variety of AT use among participants, yet, the use was not homogenous. Instead, individual students spoke of preferences for certain AT. Across the university community one of the most commonly used assistive technologies in classrooms was PowerPoint™, which appeared to offer a comfort level for both student and professor. For the student who was Deaf, however, PowerPoint™ was not a panacea and presented its own complications which are discussed under the section *Barriers to Assistive Technology Use.*

Another type of AT that participants spoke of frequently was the Sidekick®, a mobile communication device that allows the user to receive and send IM and email. This AT was used primarily for social purposes as Henry explained,

> I pick up girls, meet girls. I use my Sidekick®, ask for their screen name. It's kind of funny, different, my hearing friends have to ask for phone

Table 2
Assistive Technology Used by Participants

Technology	Description	*N* Participants Using Technology
Captel™	A telephone that displays real-time captions of the current conversation.	1
Cell Phones/ Pagers	A long range, portable electronic device used for mobile communication.	4
Closed Captioning	Commonly known as subtitles. As the video plays, text captions are displayed that transcribe (although not always verbatim) speech and often other relevant sound.	5
Computers	A device capable of performing a series of arithmetic or logical operations.	8
E-mail	Short for *electronic mail.* A method of composing, sending, storing, and receiving messages over electronic communication systems.	6
FM Systems	Devices that transmit the teacher's voice directly to the student at a consistent level, ensuring that the teacher's voice is heard above the level of background noise.	6
Hearing Aids	Device used in some forms of deafness to amplify sound before it reaches the auditory organs.	8
Instant Messenger	A form of real-time communication between two or more people based on typed text. The text is conveyed via computers connected over a network such as the Internet.	5
Internet	An association of computer networks with common standards which enable messages to be sent from any host on one network to any host on any other.	6
Interpreters	A person who facilitates dialogue between parties who use different languages.	7
LCD Projectors	A video projector for displaying video, images, or computer data on a screen or other flat surface. It is the modern equivalent of the slide projector or overhead projector.	4
Mallard™	A web-based system used for quizzing.	1
Overhead Projectors	A display system that is used to display images to an audience.	7
PowerPoint™	A presentation program developed by Microsoft® for its Microsoft Office computer system.	8
Real Time Captioning	Simultaneously converts the spoken word into printed format using computer-aided translation, which appears on a large screen for anyone to view.	5
Sidekick®	A mobile communication device that allows the user to receive and send IM and email.	5

Table 2. (Continued)
Assistive Technology Used by Participants

Technology	Description	*N* Participants Using Technology
SmartBoard™	A large, touch-controlled screen that works with a projector and computer. The projector throws the computer's desktop image onto the interactive whiteboard.	1
Text Relay	Text characters are carried over the same Real-Time Transport Protocol (RTP) stream as voice.	2
TTY	A now largely obsolete electro-mechanical typewriter which can be used to communicate typed messages from point to point. These teletypewriters are still in use by the deaf for typed communications over the telephone.	5
TVs	A widely used telecommunication system for broadcasting and receiving moving pictures and sound over a distance.	2
Video Relay	A telecommunication service that allows deaf, hard of hearing and speech-disabled individuals to communicate over the phone with hearing people in real-time, using a sign language interpreter.	4
Videos	The part of the television signal which carries the picture information.	5
Voice Recognition Software	Software that converts a speech signal to a sequence of words in the form of digital data by means of an algorithm implanted through the computer program.	1
WebCT	Computer software program used in many colleges to access grades, assignments, and/or post messages.	7

> paper, I just give them my Sidekick®. And, if it's dark, I use the Sidekick®'s backlight. I use it to hook up with my friends, what's going on tonight.

Other students reported using the Sidekick® during group work within the classroom to communicate with hearing peers. Botina stated,

> Well, for my hearing friends, I just use the instant messenger and email. In class and also when I have a group meeting, you know if we can't get an interpreter right away, we'll just IM or email back and forth.

Participants appeared to have favorites within the AT domain. Some participants talked positively about video relay systems, while others indicated negative feelings regarding them. Keith spoke positively about communicating with faculty through TTY: "When I started college, they didn't have a really good online relay system. Now they've improved, that's improved. With relay I can call my professors to talk about issues in the classroom."

Negative comments about relay systems focused on technological problems, operational capabilities of professors, and language concerns. Henry explained his concern about the level of language with relay systems: "Before email, professors used a relay system and that uses a really high level of language. You can miscommunicate easily, so screw it." Keith expressed concern about understanding professors' operational capabilities, or lack of, when operating the relay system: "Mostly, the only problem I have is professors who do not know how to use the relay system, not technology. It's not the professors' fault."

One of the benefits of AT use in the classrooms was identified as providing a concrete form of information. Auditory information or signed information is transient. Written or visual information is non-transient, and participants spoke of the benefit of having a non-transient form of information during class lectures. All participants identified PowerPoint™ presentations as the primary instructional technology professors used to provide the visual information that assisted hearing students. Once again, the Deaf students perceived this commonly used technology as assistive when it offered them compensation for their lack of auditory input. Hayley exemplifies this when she spoke of the benefit of having visual information: "I depend on reading a lot. When I read things it makes more sense to me than when someone is talking or signing. I'd rather just read." Similarly, Yvonne spoke of the benefit of PowerPoint™: "It [PowerPoint™] helps with guiding me with homework and assignments, lectures in class. It's a guide for me to understand what the teacher is talking about."

Additionally, when visual information was provided the participants spoke of less reliance on interpreters, a feeling of greater independence, an increase in the ability to remember the information, and more time to process the information. Karl spoke of using technology and an interpreter:

> I get help from my interpreter, but if like, there is technology then I can see at the same time with other hearing people. It's a lot easier and more efficient, like if [a professor] talk, and look at the overhead, and I can't hear, so I try to look at everything with an interpreter, it's hard. It's better now with the overhead and technology, with the PowerPoint™ helps me do better.

Similarly, Keith described the benefit of using Mallard™:

> Well, sometimes professors do have what they call the Mallard™ System, where I can read notes or take quizzes to help me understand things in class. You log in with university ID, and then you have for, whatever class, you have like lessons where you take quizzes, or email with professors, …with Mallard™, my old university didn't use it, but now this one does. So it helps me because I can take quizzes many times on my own time, not follow restricted time.

AT was also identified as greatly increasing the communication between professor and student. Very few students had professors that were fluent in sign language. Thus, their primary means of communicating with the professors was technology, specifically in the form of email, IM, WebPages, and other Internet services such as WebCT (a computer software program used in many colleges to access grades purchased by Blackboard®; see http://www.blackboard.com/us/index.bbb) assignments, and/or post messages. Botina described how technology has affected interactions with professors using technology: "It's [communication with faculty] improved a lot with PowerPoint™. And they are just more knowledgeable. They know how to do the PowerPoint™ and they're not scared of new technology. They communicate more, and they're willing to accommodate you more."

Participants spoke of *more* communication between themselves and their professors when technology was utilized. Hayley described her interaction with faculty as,

> Well, I think technology helps faculty and students communicate a lot easier. Because I always bring PowerPoint™, with all the information, I feel that we [students] look at information, when s/he's talking. I feel like raising my hand and saying 'I agree' with that section point of discussion on the presentation or I feel, 'I disagree' with that. I think it helps with communication [with faculty]. No communication barriers because of that [technology].

Ken who describes himself as "a little behind in technology skills" illustrated the benefit of email when communicating with faculty:

> When you talk with faculty without using email, say you'd have to go back and forth to the building, go up, go down, oh you forgot to say something, go back up to talk with the teacher again. With email, it's right there. You can send, back, send, back. Respond. That really helps a lot. For me.

One of the perspectives that emerged regarding overall AT use was that the use of AT in the classroom does not benefit only the students with hearing loss. Participants recognized that the use of AT, such as PowerPoint™, benefited the entire class. Ken addressed this issue:

> Well I feel that not only do the teachers and technology support me, but they support everyone else as well. Maybe the teachers talk, talk, talk, and I think I'm the only one who can't understand what the teacher is saying, but that's not true. Hearing students have difficulties as well, and they would rather have PowerPoint™, papers, hard copies, and overhead projectors, showing what the teacher's talking about. I feel that teachers are not only doing PowerPoint™ for students with needs, but everyone has needs. Especially, I'm sure the hearings. Same way.

Additionally, participants spoke of how AT made them feel more included. AT use did not set them apart, but facilitated their inclusion into the classroom since all students were benefiting from the use of the technology. Tony stated that, "The technology helps me become more comfortable with the classroom, with the teacher, with the students, and makes me comfortable enough to speak for myself, share my opinion". Hayley expressed similar views,

> It [technology] improves a lot for me. Compared to high school where we didn't have a lot of technology, and we didn't use it all the time. But here, when you come to this university, you use it all the time. I've improved so much, because I'm so visual, most of my information is from looking at PowerPoint™, looking at different visuals. It's helped me participate more, communicate my opinions more.

In summary, participants reported a wide variability of AT use and highly individualized preferences for certain AT. PowerPoint™ was the most common form of AT used in the classroom, and the Sidekick® was the most common form of AT for social purposes. Participants identified AT use as overwhelmingly positive, assisting communication with professors and hearing peers, and facilitating inclusion into the classroom and university community. However, difficulties with technology use did emerge.

Barriers to AT Use

Barriers identified by the participants that impeded their use of AT had little to do with the functioning of technology. Rather, identified barriers were either interactions with sign language interpreters *and* technology or difficulties coordinating information from the professor, the interpreter, and the AT. All this information formed a complex triad, during class, which required skill to coordinate, energy to process, and collaboration to use effectively.

Participants needed and readily acknowledged the benefit of having interpreters. Henry and Keith contended that they relied on interpreters in class. Henry described his reliance on his interpreter, "I don't really use technology in classes. I'm an old school student; all I really need is my interpreter, although once in awhile if I forget to write things down I will use my Sidekick®." It should be noted that subsequent responses reflected that Henry used email to communicate with professors and fellow students. He also reflected positively about PowerPoint™ use during class. Keith also stated that he "used interpreters, but that's not really technology" in response to the question about technology in the classroom. Keith also discussed the Mallard™ system, captioned movies, PowerPoint™, email, and online relay systems to communicate with professors and peers.

Other participants identified difficulties when interpreters intermittently failed to convey the full content of what was happening in class. Participants reported knowing that the sign language interpreter was not interpreting all the professor was saying. When this occurred participants became anxious that they were missing important information. They expressed concern that they could not stop and ask their interpreter because class was continuing to move, and if they halted their interpreter, they were going to miss even more information.

Jennifer described her frustration with coordinating technology, specifically PowerPoint™, during class:

> Well, I find PowerPoint™ a little annoying for me. I don't like it because it is hard to watch the interpreter and then look at the PowerPoint™. When working with my interpreter, we have agreed that if it's a paragraph on the PowerPoint™, and the teacher is just reading, all she has to do is point and tell me to read. I'm noticing, recently, what's happening is that the interpreter is telling me to read one sentence. She says, read it, then I'm waiting, but oftentimes the speaker goes on. But technology isn't always helpful. Sometimes it causes more distractions for me.

Botina also expressed difficulties with PowerPoint™, "Sometimes I can't see the interpreter and everything on the PowerPoint™ [at the same time] so then the teacher says it in a different way." Students were frustrated at times by the presence of three types of stimuli coming at them at once: signing by their interpreter, professor speaking, and visual information, usually in the form of PowerPoint™. Participants overwhelmingly reported that coordinating this triad of information was a challenging feat.

Facilitators of AT Use

During participant interviews several themes emerged that were categorized as facilitators. These facilitators were common among participants, appeared to assist the student with classroom performance, or assisted the student with communication within the classroom. It should be noted that not all students benefited from the facilitators to the same degree.

One of the facilitators, self-advocacy, was mentioned frequently as a behavior that students either engaged in or should be engaging in to increase competency and use of AT. Self-advocacy took various forms. Some students talked with their professors on the first day of class, informing them of their disability and requesting the use of AT, such as PowerPoint™, that would aid them in comprehending lectures. One student, Ken, reported giving the professor options as to what specific accommodations would meet his needs.

> I would go to the teacher and ask the teacher if the teacher could adapt, develop PowerPoint™s, online work that repeats what we're going to discuss. Maybe at the same time, I ask if there are any volunteers, student note-takers for me, document any information.

Other students recognized the need to self-advocate but talked about their reluctance to do so. Students who did self-advocate reported positive results, as exemplified when a professor either switched to PowerPoint™ or gave the student hard copies of lecture notes.

Another facilitator of technology use was teamwork. This is especially important when the student was trying to coordinate a triad of information: professor lecture, interpreter signing, and reading PowerPoint™ slides. Jennifer admitted that she has difficulties coordinating this triad of information during class and needs to address this issue with her interpreter. "I need to let the interpreter know," Jennifer stated, "that if it's just a sentence, then go ahead and sign it. But if it's a paragraph, then give me enough time to read it." Teamwork became a facilitator when students expressed their needs regarding the triad of information to their interpreters.

Botina contrasted her experience in high school when teamwork was not facilitating comprehension to her experience at the university where the technology appears to have facilitated teamwork.

> Well, like in high school they never had handouts or PowerPoint™s, so I would always be like lost because of the group. And I'm like 'Wait, I was looking at the interpreter'. And I don't know what is going on in the group, and it was overwhelming. They were moving so right away and talking so fast, and the interpreter was just off, and I miss. Now, with the PowerPoint™ and the handouts, the group is more focused and helping me more, and it slows down the interpreter also.

Consequently, teamwork was identified as a facilitator when the student, professor, and interpreter all understood the student's technological needs and the benefits, as well as the limitations of AT.

As described in the section of self-reported AT use, students had a wide variance in the types of AT they used and preferred. One student expressed her delight and fascination with an interactive whiteboard technology, specifically, the SmartBoard™. Hayley spoke of the benefit of using a Smartboard™ in one of her classes.

> I think it helps instructors to focus on the subject. Focus on the presentation. It provides something you can use for presentations. Teachers can add to the discussions from the group and put it on the Smartboard™. It makes it easier for me to see what other people are saying. It's very fluid. It helps things go nicely.

Hayley had the Smart Board™ available in one of her classes and used it frequently for class presentations, attending to and comprehending class discussion, and presenting her own work. She specifically mentioned that the SmartBoard™ helped her express her opinions and participate in discussions. Obviously, she had to be aware of the AT, desire to learn about the technology, and successfully experience it to benefit from it. Smartboard™ technology is not common at her university and is costly. When she was given the opportunity to learn and use this AT, she did not hesitate. One does not know if she will have the opportunity to continue to use this AT upon graduation, but she is aware of it and is now proficient in its use.

In summary, facilitators of technology included self-advocacy on the part of the participants; teamwork among professors, students, and interpreters; and the opportunity to learn about new technologies.

Discussion

The discussion is organized by the three themes that emerged from the data analysis: self-reported use of AT and overall benefits, barriers to AT use, and facilitators of AT use.

Self-Reported Use of AT and Overall Benefits

Literature focused on the use of AT by individuals who are Deaf has reflected both increased use (Bowe, 2002), a wide range of AT applications (Zazove et al., 2004), and substantial benefits of AT for a community that is Deaf (Weiserbs, 2000). Findings of this study confirmed these results with regard to students who were Deaf at a hearing university.

However, one of the unique perspectives of AT that student participants emphasized was the use of AT for socialization purposes. This is encouraging since research has suggested that students who are Deaf and students who are hearing do not socialize well together (Antia & Kreimeyer, 1996). Technology, though, may be a modality to connect students who are Deaf with students who are hearing. Weiserbs (2000) found that AT has a positive influence on the relationship between students who are Deaf with their hearing peers. In this study, many participants spoke of their use of the Sidekick® for sending emails and IM and for communicating in social settings. More generally, social networking technologies are used by the hearing population for socialization purposes (e.g., MySpace® and Facebook©). Given that the hearing population has embraced such technologies, the use of social networking tools by Deaf students would facilitate socialization within the broader university community.

Using the same technology in the classroom with all students was identified as a facilitator of inclusion for students who were Deaf. For example, the use of PowerPoint™ in the classroom provides students who are Deaf with an easily accessible AT tool that was used by all. Students identified PowerPoint™ as technology that allows them to focus on lectures and participate in the classroom, while also facilitating their inclusion in activities. Inclusiveness is important for *all* students, yet students who are Deaf can have feelings of isolation in the classroom setting (Keating & Mirus, 2003). However, in this study, use of PowerPoint™ gave participants a feeling of being included.

In university classrooms, PowerPoint™ is a commonly used presentation technology. Some colleges and universities actually require instructors to use visual supports in the classroom (Hardin, 2007), and PowerPoint™ should be viewed as a necessary accommodation for many Deaf and hard of hearing students, while recognizing its benefits as a powerful instructional technology for typical students.

Barriers to Assistive Technology Use

Participants in the current study identified several barriers to AT use. Concerns included (a) difficulties coordinating the AT during class; (b) inexperience with the AT itself; and (c) the challenge of successfully managing the triad of information from the PowerPoint™, professor, and interpreter during class. Inefficiency of AT was also addressed focusing primarily on older technologies, such as TTYs and telephone relays.

Apprehension regarding the efficiency of AT could be alleviated by providing a technology specialist who is trained in both maintenance and curricula integration of tools that malfunction intermittently. Universities typically have technology personnel available for commonly used technologies (e.g., computers), but providing personnel who are specifically trained in technologies used by students who are Deaf will benefit both students and faculty. Technical support challenges are not unique to faculty and students at hearing universities. Lack of support for AT at all educational levels has previously been documented as a barrier to AT use (e.g., Beukelman & Mirenda, 1998; Carey & Sale, 1994; Copley & Ziviani, 2004; Riemer-Reiss & Wacker, 2000). Participant concerns about lack of familiarity with AT and infrequent usage is consistent with previous studies that focused on AT use in the public schools (Derer, Polsgrove, & Reith, 1996; Lesar, 1998; Parette, 1997; Scott, 1997). Previous literature has strongly recommended involving faculty and students in the AT planning processes, whether for a single device or an entire AT program (Carey & Sale, 1994; Copley & Ziviani, 2004; Riemer-Reiss & Wacker, 2000; Todis & Walker, 1993). This recommendation is relevant to the current study in that AT planning for a classroom or entire program needs to involve all stakeholders: faculty, students who are Deaf, technology specialists, *and* interpreters.

Literature concerning the relationship between students who are Deaf and interpreters also stresses teamwork (Luckner & Muir, 2001). Interpreters facilitate communication between students who are Deaf and their hearing teachers and hearing peers (Antia & Kreimeyer, 2001), and interpreters play important roles in the success of students who are Deaf (Luckner & Muir). Therefore, professors are encouraged to be aware of the importance of the interpreter and the interpreter's part in his/her lecture. Lectures with PowerPoint™ slides are appealing to students, but when using slides in classes that have a student who is Deaf with an interpreter, college professors should be sensitive to the needs of students who must watch the PowerPoint™ presentation, the interpreter, and the college professor. Continuous feedback between student and professor is needed since the coordination of the triad of information is no small feat for the college student who is Deaf.

Facilitators to Assistive Technology Use

Identified facilitators were self-advocacy, the use of the interpreter, and AT experience. Several participants explained their role as a self-advocate for technology use. Self-advocacy is related to self-determination and unfortunately data from the National Longitudinal Transition Study (Cameto, Marder, Wagner, & Cardoso, 2003) indicate that too few people with disabilities become self-sufficient citizens and do not fare nearly as well as their nondisabled peers after schooling (Chadsey & Shelden, 2002; deFur, 2003; Nuehring & Sitlington, 2003). Individuals who are Deaf are also in this category.

Cawthon (2001) found that students who are Deaf need to be taught how to self-advocate. Essentially, the goal of the educational process is to teach all students to become self-determined adults. However, educational systems often fail to educate students with disabilities in the area of self-determination (Wehmeyer & Schalock, 2001). Students who are Deaf must serve as their own advocates with both instructors and interpreters. Preferences regarding AT, access to instructor notes, and coordination of the triad of information should be explicitly expressed at both the beginning of the semester and throughout. In addition, effective teamwork will be facilitated if the student who is Deaf also recognizes and expresses positive feedback.

Little research has focused on self-determination skills of college students who are Deaf at a hearing university; however, self-determination must be present at some level or these students would not be receiving a college education. Hopefully, at some point in the educational experience, they have learned to self-advocate. Opportunities abound at the primary, middle, and secondary school levels for students to engage and learn self-determination skills such as self-advocacy. For example, student-led IEP meetings or student-led parent teacher conferences can provide students with opportunities to learn and gain experience in self-advocacy beginning in the early grades (Boardman, Argüelles, Vaughn, Hughes, & Klingner, 2005).

Advocacy role models in the student's family have been shown to be positive influences on the development of self-advocacy (e.g., Grigal, Neubert, Moon, & Graham, 2003; Stoner, Angell, House, & Goins 2006). Opportunities to self-advocate for specific uses of AT would benefit students who are Deaf when approaching faculty to request specific AT use. When students in this study self-advocated effectively with faculty, the benefit was two-fold. Not only did the student get the needed AT, but the faculty member was able to plan and provide for AT in the classroom.

Teamwork associated with AT is a vital and necessary component for effective use. Team collaboration is widely acknowledged as best practice and mandated by IDEIA to most effectively identify, secure, and implement AT (Beigel, 2000; Downing, 2005; Lahm & Nickels, 1999; Locke & Mirenda, 1992). Students who have completed high school and are enrolled at universities are not covered by the benefits of the IDEIA, but may certainly take advantage of establishing and working with a team of stakeholders who are willing to facilitate their academic success. Teams should include the student who is Deaf, the interpreter in the classroom, the professor, the office of disability concerns, and the student's advisor. If all these team members would consult and plan for effective AT use, the student as well as the faculty would benefit.

When PowerPoint™ presentations are used by faculty in the classroom, the team should include the instructor, the student, and the interpreter. This seems to be especially important when the triad of information is coordinated. The team should discuss the use of PowerPoint™ during the instructor's lecture (read the slide verbatim or add information as students read); the interpreter's role (interpret the PowerPoint™ slide as professor reads or just point directing the student to read); and the student's self-advocacy (express when having difficulty with watching all three: interpreter, professor, and PowerPoint™). Decisions could be negotiated according to individual preferences regarding when to sign, how long to allow the student to read slides without interruption, and how to inform the student that the instructor is providing new information not on the slides.

Limitations

While this study utilized responsible qualitative research methodologies, there are several limitations that might influence the validity of the findings. The first limitation of this study is related to generalizability of the findings which is inherent in qualitative research. The findings are based only on the perspectives of nine Deaf students at a large hearing university in one Midwestern state. A sample using more universities in a larger geographic region would have enhanced the generalizability of the findings.

Similarly, since the study was conducted at only one university, Deaf students from other universities may have different experiences with AT. Similarly, faculty from other universities may have had more or less experience with Deaf students, which could have resulted in different outcomes related to perceived barriers and facilitators to use of AT in university classrooms. Therefore, caution must be exercised not to generalize the experiences, perspectives, and responses of the participants to all Deaf students at hearing universities.

References

Americans with Disabilities Act, 42 U.S.C. §§ 12101 *et seq*. (1990)

American Psychological Association. (2001). *Publication manual of the American Psychological Association* (5th ed.). Washington, DC: Author.

Antia, S. D., & Kreimeyer, K. H. (1996). Social interactions and acceptance of deaf or hard-of-hearing children and their peers: A comparison of social-skills and familiarity-based interventions. *Volta Review, 98*, 157-180.

Antia, S. D., & Kreimeyer, K. H. (2001). The role of interpreters in inclusive classrooms. *American Annals of the Deaf, 146*, 355-365.

Barbour, R. S. (2001). Checklists for improving rigor in qualitative research: A case of the tail wagging the dog? *British Medical Journal, 322*, 1115-1118.

Beigel, A. R. (2000). Assistive technology assessment: More than the device. *Intervention in School & Clinic, 35*, 237-244.

Beukelman, D., & Mirenda, P. (1998). *Augmentative and alternative communication: Management of severe communication disorders in children and adults* (2nd ed.). Baltimore: Brookes.

Boardman, A. G., Argüelles, M. E., Vaughn, S., Hughes, M. T., & Klingner, J. (2005). Special education teachers' views of research-based practices. *Journal of Special Education, 39*, 168-180,

Bowe, F. G. (2000). *Broadband and Americans with disabilities*. Silver Spring, MD: National Association of the Deaf. Retrieved September 26, 2008, from http://www.newmilleniumresearchorg./disability.pdf.

Bowe, F. G. (2002). Deaf and hard of hearing Americans' instant messaging and e-mail use: A national survey. *American Annals of the Deaf, 147*(4), 6-10.

Cameto, R., Marder, C., Wagner, M., & Cardoso, D. (2003). Youth employment. In *NTLS2 Data Report: Reports from the National Longitudinal Transition Study, 2*(2). Retrieved September 26, 2008, from http://www.ncset.org/publications/viewdesc.asp?id=1310

Carey, D. M., & Sale, P. (1994). Practical considerations in the use of technology to facilitate the inclusion of students with severe disabilities. *Technology and Disability 3*, 77-86.

Cawthon, S. W. (2001). Teaching strategies in inclusive classrooms with deaf students. *Journal of Deaf Studies and Deaf Education, 6*, 212-225.

Chadsey, J., & Shelden, D. (2002). Social life. In K. Storey, P. Bates, & D. Hunter (Eds.), *The road ahead: Transition to adult life for persons with disabilities* (pp. 137-156). St Augustine, FL: Training Resource Network.

Charmaz, K. (2000). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 509-536). Thousand Oaks, CA: Sage.

Copley, J., & Ziviani, J. (2004). Barriers to the use of assistive technology for children with multiple disabilities. *Occupational Therapy International, 11*, 229-243.

Creswell, J. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Merrill Prentice Hall.

deFur, S. H. (2003). IEP transition planning: From compliance to quality. *Exceptionality, 11*, 115-128.

Derer, K., Posgrove, L., & Reith, H. (1996). Survey of assistive technology applications in schools and recommendations for practice. *Journal of Special Education Technology, 8*, 62-80.

Downing, J. (2005). *Teaching communication skills to children with severe disabilities*, Baltimore: Brookes.

Fontana, F., & Frey, J. (2000). The interview: From structured questions to negotiated text. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 645-672). Thousand Oaks, CA: Sage.

Grigal, M., Neubert, D. A., Moon, M. S., & Graham, S. (2003). Self-determination for students with disabilities: Views of parents and teachers. *Exceptional Children, 70*, 97-112.

Hardin, E. E. (2007). Presentation software in the college classroom: Don't forget the instructor. *Teaching Psychology, 34*(1), 53-57.

Individuals with Disabilities Education Improvement Act, 20 U.S.C. §§ 1400 *et seq.* (2004)

Janesick, V. (2000). The choreography of qualitative research design. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 379-399). Thousand Oaks, CA: Sage.

Keating, E., & Mirus, G. (2003). Examining interactions across language modalities: Deaf children and hearing peers at school. *Anthropology & Educational Quarterly*, *34*, 115-135.

Kolvitz, M., Billies, P., Wilcox, D., & Rawlinson, S. (2003, July). *A showcase of services and resources for students who are deaf or hard of hearing.* Symposium conducted at the meeting of the Ahead: Association on Higher Education and Disability, Dallas, TX.

Komesaroff, L. (2005). Category politics: Deaf students inclusion in the 'hearing university.' *International Journal of Inclusive Education, 9,* 389-403.

Lahm, E. A., & Nickels, B. L. (1999). Assistive technology competencies for special educators. *Teaching Exceptional Children, 32*(1), 56-64.

Lesar, S. (1998). Use of assistive technology with young children with disabilities: Current status and training needs. *Journal of Early Intervention, 21*, 146-159.

Locke, P., & Mirenda, P. (1992). Roles and responsibilities of special education teachers serving on teams delivering AAC services. *Augmentative and Alternative Communication, 6*, 38-49.

Luckner, J. L., & Muir, S. (2001). Successful students who are deaf in general education settings. *American Annals of the Deaf, 146*, 435-446.

Mackowiak, K. (1989). Deaf college students and computers: The beneficial effect of experience on attitudes. *Journal of Educational Technology Systems, 17*, 219-229.

Michaels, C. A., & McDermott, J. (2003).

Assistive technology integration in special education teacher preparation: Program coordinators' perceptions of current attainment and importance. *Journal of Special Education Technology, 18*(3), 29-44.

Milani, A. A. (1996). Disabled students in higher education: Administrative and judicial enforcement of disability law. *Journal of College and University Law, 22*, 989-1043.

Miles, M., & Huberman, A. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage.

Mistreet, S. G., Lane, S. J., & Ruffino, A. G. (2005). Growing and learning through technology: Birth to five. In D. Edyburn, K. Higgins, & R. Boone (Eds.), *Handbook of special education technology research and practice* (pp. 273-307). Whitefish Bay, WI: Knowledge by Design.

No Child Left Behind Act, 20 U.S.C. §§ 6301 *et seq*. (2001)

Nuehring, M. L., & Sitlington, P. L. (2003). Transition as a vehicle: Moving from high school to an adult vocational service provider. *Journal of Disability Policy Studies, 14*, 23-35.

Parette, H. (1997). Assistive technology devices and services. *Education and Training in Mental Retardation and Developmental Disabilities, 32*, 267-280.

Power, D., Power, M. R., & Rehling, B. (2007). German deaf people using text communication: Short message service, TTY, relay services, fax, and e-mail. *American Annals of the Deaf, 152*, 291-301.

Rehabilitation Act Amendments, 29 U.S.C. §§ 701 *et seq*. (1973)

Riemer-Reiss, M. L., & Wacker, R. R. (2000). Factors associated with assistive technology discontinuance among individuals with disabilities. *Journal of Rehabilitation, 66*(3), 44-50.

Scott, S. B. (1997). Comparison of service delivery models influencing teachers' use of assistive technology for students with severe disabilities. *Occupational Therapy in Health Care, 11*(1), 61-74.

Stake, R. (2000). Case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 435-454). Thousand Oaks, CA: Sage.

Stinson, M., Stuckless, E. R., Henderson, J., & Miller, L. (1988). Perceptions of hearing-impaired college students toward real-time speech to print: RTGD and other educational support services. *The Volta Review, 90*, 339-348.

Stoner, J. B., Angell, M. E., House, J. J., & Goins, K. (2006). Self-determination: Hearing the voices of adults with physical disabilities. *Physical Disabilities: Education and Related Services, 41*(2), 3-35.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage.

Todis, B., & Walker, H. M. (1993). User perspectives on assistive technology in educational settings. *Focus on Exceptional Children, 26*(3), 1-16.

Ward, P., Wang, Y., Paul, P., & Loeterman, M. (2007). Near-verbatim captioning versus edited captioning for students who are deaf or hard of hearing: A preliminary investigation of effects on comparison. *American Annals of the Deaf, 152*, 20-28.

Wehmeyer, M. L., & Schalock, R. L. (2001). Self-determination and quality of life: Implications for special education services and supports. *Focus on Exceptional Children, 33*, 1-16.

Weiserbs, B. (2000). Social and academic integration using e-mail between children with and without hearing impairments. *Computers in the Schools, 16*, 29-44.

Zazove, P., Meador, H. E., Derry, H. A., Gorenflo, D. W., Burdick, S. W., & Saunders, E. W. (2004). Deaf persons and computer use. *American Annals of the Deaf, 148*, 376-384.

Appendix A

Interview Questionnaire for Deafed.net Research Project

Please answer as many questions as you can. You may skip questions you feel uncomfortable answering, or do not apply to you. Some questions may have several answers that apply to you. You are not limited to one choice.

Demographic Information

Please answer the following written questions.

1. What is your gender?
    a. Male
    b. Female
2. How old are you?
    a. 16-19
    b. 20-29
    c. 30-39
    d. 40-49
    e. 50+
3. What is your nationality?
    a. Caucasian
    b. African American
    c. Hispanic
    d. Native American
    e. Asian
    f. Pacific Islander
    g. Other
    h. Not Available
4. What is your hearing status?
    a. Deaf
    b. Hard of Hearing
    c. Other
5. What is the cause of your hearing loss?
    a. Genetic
    b. Childhood disease
    c. Trauma
    d. Age-related
    e. Unknown
    f. Other
6. Check all of the answers that describe where you were educated from 3 years-to high school graduation.
    a. Residential School
    b. Self-Contained class with a deaf educator in a public school program
    c. Integrated/Mainstreamed into general/regular education classes with an interpreter
    d. Integrated/Mainstreamed into general/regular education classes without an interpreter
    e. Other
7. Which of these describes your *primary* place of education?
    a. Residential School
    b. Self-Contained class with a deaf educator in a public school program
    c. Integrated/Mainstreamed into general/regular education classes with an interpreter
    d. Integrated/Mainstreamed into general/regular education classes without an interpreter
    e. Other

Real World Applications of Technology

8. Which of the following internet technologies do you use?
    a. Email
    b. Chat Rooms
    c. Instant Messaging
    d. Blogs
    e. Listservs
    f. Web Boards
    g. Usenet
    h. Text Relay
    i. Video Relay
9. Of the internet technologies that you use, how often do you use them and what benefits (if any) do they provide you?
10. Which of the following portable communication devices do you use?
    A. Blackberry
    B. RIM
    C. Sidekick
    D. PDA
    E. O-Go
    F. Cell Phones
    G. Other
11. When using portable communication devices, which programs do you use frequently?
    a. Email
    b. Instant Messaging Programs
    c. Relay
    d. SMS/Text Messaging
    e. Internet
12. Of all the portable communication devices you use, what benefits do they provide you?

Technology in the Classroom

13. Please describe how you use technology in your classes.

14. What technologies do instructors/professors/ lab assistants/teacher assistants use in your classes/labs?
15. How does technology facilitate communication between you and your hearing peers?
16. How has technology assisted your integration into the college classroom?
17. How has technology improved or changed your communication with college faculty?
18. How has technology improved your understanding of class lectures?
19. How has technology improved your understanding of material in labs, study groups, etc.?
20. If you don't utilize an interpreter what, if any, technology do you use to acquire information from lectures, from professors, and from peers?
21. What, if any, assistive listening devices do you use?
22. If you could design an assistive listening device, what would you incorporate and why?
23. How can technology improve lecture comprehension?
24. How has classroom technology changed since you were a child?
25. Have you improved or changed your assistive listening devices since you were a child?
26. What classroom struggles do you have that technology could make easier?