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Summit

to Create a Cyber-Community to Advance Deaf and Hard-of-Hearing Individuals in STEM

DHH Cyber-Community

Summary Report

2008

The Summit was led by RIT and the University of Washington (UW) and supported by the National Science Foundation under Award No. OCI-0749253

Summit to Create a Cyber-Community to Advance Deaf and Hard-of-Hearing Individuals in STEM (DHH Cyber-Community)

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Introduction

Dr. T. Alan Hurwitz, NTID President and Vice President/Dean of RIT for NTID, Participated in the Summit as a Co-Facilitator of the Students in STEM Programs Group and Delivered Opening Remarks to Summit Gathering

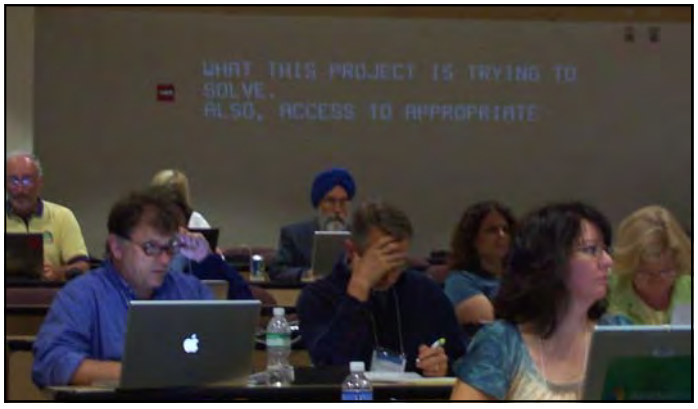
The Summit to Create a Cyber-Community to Advance Deaf and Hard-of-Hearing Individuals in Science, Technology, Engineering, and Mathematics (STEM) occurred on June 25-27, 2008 on the campus of Rochester Institute of Technology (RIT) in Rochester, New York. This Summit, led by RIT and University of Washington (UW), was supported by the National Science Foundation under Award No. OCI-0749253.

The goal of the Summit was to conduct a three-day conference with approximately 50 leaders in the field of support service provision for postsecondary deaf students in STEM programs. The primary outcome was to report on the current state of on-line remote interpreting and captioning, and identify the benefits and challenges associated with creating a multimedia cyberinfrastructure that would provide remote communication support for deaf and hard-of-hearing students in STEM mainstreamed classrooms. A cyberinfrastructure is a term used to describe a fast, secure system incorporating necessary hardware, software and cyber tools designed to support a specific domain. The expectation is that this report will help formulate future proposals related to the creation of a cyber-community to benefit deaf and hard-of-hearing individuals involved in STEM programs.

Project Background

The idea for this Summit transpired several years ago because there are an inadequate number of deaf and hard-of-hearing students enrolled in science, technology, engineering and mathematics programs.

Approximately 28 million individuals, 10 percent of the U.S. population, have significant hearing loss that interferes with their ability to carry out routine tasks or access information (Hitchen & Davis, 2002; Mitchell, 2006). Of these 28 million, it is estimated that 1 to 2 million use American Sign Language (Harrington, 2004). More than 300 of these men and women, who are mainstreamed in STEM programs at the baccalaureate level or higher, are enrolled at the National Technical Institute for the Deaf (NTID) at the Rochester Institute of Technology (RIT). However, the remaining STEM students who are deaf or hard of hearing, estimated at 400 (*College and Career Programs for Deaf Students*, 2001), are mainstreamed in more than 100 colleges and universities throughout the country.



Leaders in Support Service Provision for Postsecondary Deaf Students in STEM Programs Participate in Three-Day Summit

"It's the application of technology that is profoundly powerful, that changes lives, not the technology in isolation."

Introduction (con't.)

As deaf and hard-of-hearing students seek to prepare for careers in STEM fields through tertiary education, there is a growing need for skilled interpreters and captioners to interpret and caption at all course levels (beginner, intermediate, and advanced) in these four areas of study (NTID Annual Report, 2006). Deaf and hard-of-hearing students seeking degrees in STEM fields of study often do not have easy access to interpreters and captioners who are knowledgeable with the scientific terms and technical language used and needed in order for them to be successful. This need, coupled with recent successes related to emerging technologies and advancements (e.g., video relay services, video phones, video remote interpreting, teleconferencing technologies, etc.), have formed a confluence.

A multimedia cyberinfrastructure that supports deaf and hard-of-hearing students with appropriate remote interpretation and captioning has the potential of addressing this need. These services are referred to as **on-line remote interpreting and captioning in improved educational environments**.

"It was an interesting and thought-provoking two days and I hope it leads to some real movement in this area."

"It was a great event. I hope we can build on what we started."

Leaders from Across the Country Participate in Summit to Create a Cyber-Community to Advance Deaf and Hard-of-Hearing Individuals in STEM

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Plan of Execution

Forty-four leaders from across the country participated in the Summit based on their experience and/or level of expertise in one of the following six areas/stakeholder populations: educational, linguistic & sign language researchers and developers; coordinators of support services; STEM faculty; cyberinfrastructure specialists; educational captionists and interpreters; and STEM students. The number of participants in each group ranged between 5 and 9 members.

The Summit organizers, E. William Clymer and James J. DeCaro of RIT/NTID - PEN-International, Richard E. Ladner of the University of Washington, and Jorge L. Diaz-Herrera of the Rochester Institute of Technology, selected co-facilitators for each group approximately six months in advance of the Summit. The co-facilitators helped to formulate their respective groups and were responsible for preparing an outline or brief state-of-the-art working paper to set the context for the activities and outcomes expected from the Summit. The outline or brief working paper presented benefits and challenges associated with creating an on-line remote interpreting and captioning infrastructure specific to the stakeholder population in which they represented. The six constituency groups and corresponding group members are outlined below in brief.

1. Educational, Linguistic & Sign Language Researchers and Developers

Facilitator:	E. William Clymer	RIT/NTID, PEN-International
Group Members:	Anna Cavender	University of Washington
	Mark Henry	Eastman Kodak Company
	Joeann Humbert	Rochester Institute of Technology
	Marc Marschark	RIT/NTID
	Kent Robertson	The Shodor Education Foundation, Inc.
	Andrew Whitaker	University of Washington

2. Coordinators of Support Services

Facilitators:	Denise Kavin	RIT/NTID, PEN-International
	Marcia Kolvitz	PEPNet South
Group Members:	Barbara Keefe	PEPNet Northeast
	Chris Parker-Kennedy	California Polytechnic State University
	Naomi Sheneman	San Diego Community College District
	Tom Thompson	William R. Harper College

3. STEM Faculty

Facilitators:	Richard E. Ladner	University of Washington
	Caroline Solomon	Gallaudet University
Group Members:	Matt Huenerfauth	The City University of New York
	Catherine Beaton	Rochester Institute of Technology
	Joe Stanislow	RIT/NTID

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Plan of Execution (con't.)

4. Cyberinfrastructure Specialists

Facilitators:	Jorge L. Diaz-Herrera	Rochester Institute of Technology
	Gurcharan Khanna	Rochester Institute of Technology
Group Members:	Sharon Bryant	Job Placement Coordinator
	Jeremiah Parry-Hill	RIT/NTID
	Annuska Perkins	Microsoft
	George Tilson	TransCen
	Fred Videon	University of Washington
	Gregor von Laszewski	Rochester Institute of Technology

5. Educational Captioners & Interpreters

Facilitators:	Rico Peterson	Northeastern University
	Mike Stinson	RIT/NTID
Group Members:	Tom Apone	WGBH
	Shannon Aylesworth	University of Wisconsin
	Patricia Billies	PEPNet Northeast
	Tobias Cullins	University of Wisconsin
	Patricia Graves	Caption First
	Kim Kurz	Educational Consultant, Rochester NY
	Kip Webster	Rochester Institute of Technology

6. STEM Students

Facilitators:	Ellie Rosenfield	RIT/NTID
	T. Alan Hurwitz	RIT/NTID
Group Support:	Joshua Beal	RIT/NTID
Group Members:	Karen Alkoby	DePaul University
	Jessica DeWitt	University of Wisconsin
	David Fourney	Ryerson University
	Raja Kushalnagar	University of Houston
	Ron Painter	Stanford University
	Minoru Yoshida	Rochester Institute of Technology

The Summit agenda consisted of an introductory meeting on Wednesday, June 25, 2008 with group facilitators to review the Summit schedule, answer any outstanding questions, and address any unresolved technical issues in preparation for the two full-day working team meeting. On Thursday, June 26, 2008 after welcoming comments and introductions, each constituency group presented their outline or brief working paper, in panel format, to the entire Summit gathering. At the conclusion of each group presentation, the other Summit participants were invited to comment, ask questions, and/or add their personal experiences to the discussion. Participants were then instructed to break into their working groups to draft recommendations on the major issues and challenges associated with the development of a new on-line remote communication system specific to the group with which they were working. Again in a panel format, each constituency group presented their group recommendations, in sequence, to the entire Summit gathering on Friday, June 27, 2008. The participants were dismissed after all key points and recommendations for each group were appropriately captured.

Plan of Execution (con't.)

To ensure long term success of a cyberinfrastructure, each stakeholder population was asked to identify the benefits and challenges associated with creating a cyberinfrastructure to advance deaf and hard-of-hearing individuals in STEM programs. Each group presented and discussed at length, to the entire Summit gathering, the benefits, challenges and recommendations that specifically related to their stakeholder population. Interestingly, many similarities exist among the various constituency groups.

The following report provides an overview of current remote access services, and findings arranged by constituency group.



Summit Organizers, E. William Clymer, James J. DeCaro, Richard E. Ladner, and Jorge L. Diaz-Herrera, Deliver Opening Remarks to Summit Gathering

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Overview of Remote Access Services

There is a consensus that support services, in general, for deaf and hard-of-hearing students at mainstreamed universities are decreasing due to the lack of administrative support and the high costs associated with providing these kinds of services to just a "select few."

The following provides an overview of the various access services that are available and whether or not they are currently being offered remotely, and the use of remote services in various learning environments.

Types of Access Services Currently Available

- **Interpreting**
  Many universities across the nation, especially those that have programs for the deaf, have had onsite interpreting services available for many years. Some remote interpreting already is happening within a number of states, and even regionally among smaller institutions. There has been a lot of growth in this area commercially, on a not-for-profit basis; however, this growth is not yet widespread.

- **Captioning**

  Communication Access Real-Time Translation (CART) Communication Access Real-Time Translation (CART) services are almost exclusively conducted remotely; very few universities have a CART provider onsite. For the most part, remote CART services are readily available, even in rural areas.

  Non-Verbatim Meaning-Based Speech-to-Text Not many providers currently offer non-verbatim speech-to-text services like C-Print and Typewell. The lack of providers in this area will make the transition from live to remote services much more difficult. The group believes that organizations like Speech-to-Text Services Network (STSN) will help this area grow.

  Voice Recognition Technologies Voice recognition technologies services are not yet commonly used within the university setting. The group was only aware of a few select providers that even offer this kind of service remotely. They were in agreement that the quality of the captioning has been subpar to date, and mentioned the need to have someone onsite to make appropriate corrections.

- **Notetaking**
  Notetaking is typically a local, onsite service. The group was not convinced that there is a need/benefit to offer this service remotely when there are captioning and meaning-for-meaning services already available. The main concern relates to the quality of onsite service, because many of the notetakers are volunteers. Not all universities screen and train their notetakers. PEPNet offers free online notetaker training that may help address this concern.

Using Remote Services in Various Learning Environments

There are several different learning environments in which the use of remote services is critical in order to advance the educational experiences of the deaf and hard of hearing. Many universities are already using remote services in the traditional classroom, for e-learning, and within laboratory settings. However, remote access services are severely lacking in off-campus learning environments (e.g., field trips), study groups/tutoring situations, extra-curricular activities (e.g., clubs, organizations, sports teams), student internships, and business conferences.

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Benefits Associated with Creating a Cyberinfrastructure

The creation of a cyberinfrastructure that would allow remote communication support to deaf or hard-of-hearing individuals would provide new areas of research and development related to education, linguistics, and cognitive development. The results would be used to advance the educational experiences of deaf or hard-of-hearing individuals throughout the world.

Challenges Associated with Creating a Cyberinfrastructure

- **Matching the Student with the Technology**

  There is often the tendency to rush into using the latest technology when in fact it might not be appropriate for a specific student or educational setting. Meeting a student's individual needs has to be the top priority and this can be accomplished by first establishing educational goals. A critical step in achieving educational success is getting to know the student (e.g., language, background, education) and matching the appropriate technology to complement these characteristics. It is also important to recognize that the technology will differ for a particular student as the content or educational setting changes (e.g., small versus large classroom, formal versus informal setting). The software must allow the student the flexibility to change the layout of the screen (e.g., captioning, interpreting, visuals) to best meet his/her needs. However, a cyberinfrastructure may or may not be optimal for all students in all situations.

"What they might want or need in a smaller classroom might not be the same in a bigger setting. It's going to vary with student characteristics."

- **Preference versus Performance**

  Deaf and hard-of-hearing students prefer technologies with which they have experience. However, the technology that they are used to may not necessarily be the best technology available to facilitate their learning. Deaf and hard-of-hearing students need to be familiar, and have experience with, all of the different types of technology that is available to them. Ideally, these introductions should come during their early years of education (K-12). However, school districts often are bound by cost constraints and this may not always be a viable option. Minimally, every deaf and hard-of-hearing student should be given the opportunity to experience different technologies during their first year of postsecondary education. The process needs to be flexible, acknowledging that students may not always be successful during their trial and error phases. Support Services Coordinators agreed that there is a lack of awareness among deaf and hard-of-hearing students regarding the variety of support services that are available to them.

Group Members Representing Educational, Linguistic & Sign Language Researchers and Developers Lead Panel Discussion Regarding the Benefits and Challenges Associated with Creating a Cyberinfrastructure

"We need to find ways to communicate to deaf and hard-of-hearing consumers what services are available and then give them the opportunity to experiment with them during their first year."

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- **Elements of a Successful Business Model / Weighing Associated Costs** It is important to also consider how to make a cyberinfrastructure a sustainable, cost-efficient business so that universities can afford to offer the services of remote service providers to their deaf and hard-of-hearing students. Universities would incur a direct cost associated with using this service; compensation through a government program would not be an option. Group participants recognized that it may not be economically feasible to serve all the needs of all the students at all the different levels in all the different STEM programs.

> ***"With diversity being so high, and to make our intentions to develop an infrastructure viable economically, we may have to end up focusing on the center part of the distribution."***

- **Determining Best Practices to Guide Service Providers** The deaf and hard-of-hearing population is extremely diverse (e.g., prelingual, post-lingual, deaf parents, hearing parents, cochlear implants, etc.). Service providers often are confused on how to best deliver support services to individuals because this population has varying needs and preferences. The information/feedback that service providers receive from these students regarding their needs and preferences often is conflicting. For example, what is best -- real time text, live captioning, or remote captioning? In addition, there is not a significant amount of research to support the varying opinions. We need to learn how deaf and hard-of-hearing students best absorb and understand information. With regards to creating a cyberinfrastructure, it is important to understand what students already know about online services, their expectations, the service provider's role, the teacher's role, and the technician's role in providing this kind of service. It is also important to research how well the technology will work during group situations. Providing stakeholders with research-based assessments on the technology will be a critical component in terms of sustainability and longevity of a cyberinfrastructure.

> ***"As an online learning support person, I need guidance to know what's effective and what to offer students. There's a lot of opinions, but there isn't a lot of research-based, evaluation-based, practices that we can share with students."***

- **Measuring Success** Another critical component is how to accurately measure success of a cyberinfrastructure. Was it a good idea? Did it help students learn? Group members were quick to point out that neither test scores nor student surveys necessarily provide accurate or effective measures of success. A deaf or hard-of-hearing student might be successful in a class because he/she enjoyed the topic or the teacher, irrespective of the type of support services used. Identifying and assessing the tools currently being used to measure success would be a logical starting point. How do interpreters measure their success? Group members felt strongly that interpreters should be involved, as partners, in the evaluation process.

> ***"We want to be able to measure success. We want to say this was a good idea, a crumby idea...did they hate it? Did it help them learn?"***

> ***"It's fascinating to see that when the interpreters are involved in the research, as opposed to seeing it when it's over, they have a very different perspective. Involving interpreters as partners is essential to this whole effort."***

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- **Lack of Signs for STEM Programs**
  There are not enough signs to accurately identify all of the various and complex terms within STEM programs, so deaf and hard-of-hearing students often miss or misunderstand what is being taught. In addition, there are multiple signs for the same term or concept, which results in a lack of consistency/standards within these programs. In fact, these signs often are developed in isolation. It is also important to note that building a technical vocabulary is more complex than just assembling a dictionary of terms. Signs need to be developed for a particular situation and visualization must to be taken into consideration during development. Most group participants agreed that the development of signs should be a collaborative effort between the native users, interpreters, and professionals in STEM programs. The Student group suggested conducting an annual STEM sign development conference, that brings together the various stakeholder populations, to discuss and determine the best sign for a specific term or situation.

"Maybe a quarter of the signs for the terms that I need exist and often times there are multiple signs for one term."

Recommendations Associated with Creating a Cyberinfrastructure

- **Long Term Costs and Benefits of Technological Solutions**
  The Educational, Linguistic & Sign Language Researchers and Developers agreed that it is important to conduct research to measure the differences between the cost and benefits derived from the use of technology for both the instructional classroom application and other educational settings. Making incremental changes/improvements to existing technologies would be one way to get more return on investment.

- **Social and Literary Effects of Technologies**
  Research has shown that deaf and hard-of-hearing students have a greater preference for face-to-face communication and that classroom dynamics with a skilled instructor is a high priority, even if these have not been demonstrated to improve learning. The primary problem with online and distance learning is the lack of closeness/connection students have with instructors and other students when compared to the traditional classroom structure. Although there are many success stories of deaf students using captioning, there is no research/evidence to support these claims. This group recommended further research regarding the social and literary effects of technologies.

- **Effects of Cohort Differences and Technological Savvy**
  It is important to understand how/if deaf and hard-of-hearing students are capable of using technology, and whether they are able to stay current with all of the rapid changes. Assumptions are often made that young people are very sophisticated when it comes to technology, but is that always the case, especially when it comes to academic technology?

- **Advantages and Disadvantages of Synchronous versus Asynchronous Services**
  This group is interested in comparing the benefits of real-time delivery of services compared to archiving documentation and using support services after the classroom experience (e.g., downloading a captioned file for later review).

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- **Supporting Collaboration Within and Outside the Classroom**
  In a typical classroom, the exchange of information is usually between the deaf students and the instructor only. Researching methods/technologies that facilitate group dynamics with other students in and outside the classroom is essential to the educational experience of deaf and hard-of-hearing students.

- **Access Strategies that are Student versus Organizational Dependent**
  How do we appropriately support a deaf or hard-of-hearing student when an instructor is reluctant to accommodate and make basic changes in his/her teaching style (e.g., getting the instructor to not talk when writing on the white board, etc.)?

- **Terminology/Language for American Sign Language (ASL) and STEM**
  Developing the proper terminology/language for ASL and STEM has to be a priority. It was determined that many signs are developed in isolation, and as a result, not widely accepted. It was recommended by many group members to have various STEM stakeholder populations (e.g., native users of ASL in STEM programs, professionals, and interpreters) develop and determine appropriate signs for STEM terminology together at an annual conference type setting.

- **Interpreter/Captionist Training and Advancement in STEM**
  Appropriately training interpreters/captionists with STEM language/terminology is critical to the success of deaf and hard-of-hearing students enrolled in these programs. Providing interpreters/captionists with online training in these fields of study and/or requiring certification were a few recommended solutions.

- **Enhanced Captioning**
  Enhanced captioning was also recommended to improve communications. Research shows that text displayed in all caps is difficult to read; however, captioning often is displayed in this format. In addition, it is difficult for captionists to display many of the visuals shown in class such as graphs and formulas.

- **Communicating Access Needs with Organizations that Develop Technology**
  Researchers are interested in knowing how to best share access needs, with organizations that develop technology, to ensure products/services incorporate features that benefit disabled individuals. There is the need to be at the table at the appropriate time to communicate access needs to product developers and design specialists. Although, who are the best people to represent the deaf and hard-of-hearing community in this situation?

Group Members Representing Educational, Linguistic & Sign Language Researchers and Developers Participate in Breakout Meeting to Develop Recommendations

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Coordinators of Support Services

When the participants of the Coordinators of Support Services group began preparing for their participation in the Summit, they soon realized that there was a gap in the literature with regard to technology and how it directly applies to the deaf and hard of hearing. As a result, the group conducted a brief survey with service coordinators representing various institutions from across the nation to better understand their experiences. The link to the survey was posted on several websites relating to disability services, and a total of 30 surveys were completed. The survey addressed successful practices for using remote services for access, associated barriers, and recommended solutions. The following information reflects both the survey results and opinions of the group participants.

Benefits Associated with Creating a Cyberinfrastructure

- **Rural Schools Access to Interpreting and Captioning**
  Being able to tap into a cyberinfrastructure would be a great benefit to schools, particularly those located in rural areas where local field service providers are lacking and often non-existent.

> ***"We have a great deal of difficulty finding field service providers in rural areas. There are no interpreting or real-time captioning services nearby."***

- **24/7 Access**
  Another benefit would be the ability to get closer to 24/7 access. Deaf and hard-of-hearing individuals would no longer be dependent on the schedules of interpreters who have limited availability. A larger pool of service providers would allow for more flexibility.

Challenges Associated with Creating a Cyberinfrastructure

- **Identifying and Locating Remote Service Providers** There is no central location for finding information about remote services. The resources are available, but it takes time and effort to pull all the different pieces together. It can be a very overwhelming experience, particularly for coordinators of support services who are new to the industry. A central website and/or warehouse that lists, and possibly rates, the various providers by service type, location, and cost would be ideal.

Group Members Representing Coordinators of Support Services Lead Panel Discussion Regarding the Benefits and Challenges Associated with Creating a Cyberinfrastructure

- **Retaining Service Providers**
  In the past, universities have had difficulty finding local service providers, so they often found themselves training their own people to fill the void. Many of these individuals would leave after a great deal of time and money had been invested in them; there was just not enough work to keep them working full-time. Using a remote service provider, or offering full-time employment by sharing services with other institutions, are viable solutions.

> ***"There are resources, but they are very scattered. So as we were doing our research on remote services, it was like a puzzle that we had to put together to make sense of everything that was out there."***

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Coordinators of Support Services (con't.)

- **Effectively Interpreting Terminology, Diagrams and Graphs for STEM Students**

  It is very difficult to effectively capture and appropriately interpret advanced terminology, diagrams, pictures, tables and graphs remotely, particularly within STEM programs. An in-class notetaker would have to supplement the remote interpreting and/or captioning services. Another option would be to identify and utilize software programs, but these programs would have to be compatible with the captioning software.

> ***"Sometimes there is a need for an in-class notetaker to fill in pictures, diagrams, and tables that are added because captions often cannot capture that."***

- **Gaining Support of Faculty/Administration**

  Not all faculty members are willing to provide support services in their classroom. The reasons for denying services are usually issues relating to copyrights and/or intellectual property regarding the materials being captioned remotely. Many teachers do not want their materials distributed outside the university. Lack of administration support usually stems from the costs associated with providing various support services for just a few select students. All of the equipment, software, and services that are necessary to provide appropriate access support can be extremely expensive.

  Provide teachers with assurances that their material will be protected. Perhaps limit the time in which captioned material can be accessed. Market to administration and faculty how support services can benefit all students, not just the deaf and hard of hearing.

> ***"You have to consider academic freedom. Teachers do not want things to be outside the university. So if the captionist is in the classroom, that's fine because they can see that it is not going to be sold outside. But if it is remote, these teachers don't know where it's going to go. They don't know where it is!"***

> ***"On my campus, for example, the chancellor and the president want to have the board meetings available as webcasts. We are also talking about being a global university. So providing captioning is one way to make things that are audio, or with film, more accessible to the rest of the world, and if benefits us too. It's a win/win situation."***

- **Gaining Support of Technical Staff**

  Gaining the support of technical staff at universities to help set up and support remote services can be extremely difficult. They often have many other demands that they feel take priority. They also may not understand the importance of supporting this kind of service. Some of the higher end service providers will in fact provide their own technical support people at no extra cost; however, not all universities are willing to work directly with a third party vendor. It is often the support service coordinator's responsibility to be the contact person between the IT department and an outside vendor. There is the need to advocate to university officials that it would be most effective and productive to have technicians representing service providers and university technicians work directly together.

> ***"I have to remind technical staff repeatedly to help with our remote services."***

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Coordinators of Support Services (con't.)

- **Qualified Interpreters**
  It can be quite difficult to find qualified interpreters, especially for STEM programs. What is the best way to evaluate interpreters? What criteria should be used? Should interpreters be certified in STEM?

- **Prioritizing / Handling Last-Minute Requests**
  Another significant challenge support service coordinators encounter relates to prioritizing and handling last-minute requests. This group suggested the need to develop a priority system/schedule to determine who receives services first. This system would need to take into consideration numerous variables such as whether a service provider is on site or the extra time that is needed to set up technology for a remote service situation. In addition, last-minute requests, which often are unavoidable (e.g., study groups, special events, mandatory department meetings, etc.), tend to cost significantly more. The system has to be able to appropriately handle and facilitate such requests; providing advance notice isn't always an option. Establishing a working guide, that includes various scenarios, will help support service coordinators prioritize support service requests. In addition, departments need to negotiate with service providers by identifying their own terms, conditions, and requirements. For example, build last-minute requests into the terms of agreement so there are no additional costs.

- **Hardware and Software Compatibility**
  Hardware and software compatibility issues continue to be an ongoing problem. Some deaf and hard-of-hearing students use Polycom Videoconference software, while others use a PC or Mac platform. It is very difficult to find software that is universal and able to accommodate everyone. Universal design has to be a top priority.

- **Bandwidth/Strength of Connection**
  The quality of audio and video suffers significantly when a university is not able to supply sufficient bandwidth. The obvious answer is to increase bandwidth; however, many universities do not have the budget/resources to do so. If a connection is lost during the class, event, or activity, the student is suddenly out of contact. Universities have to decide how they are going to support services, and there needs to be a back-up plan in place when technical difficulties occur. A hard line to an ethernet connection would be one solution.

Denise Kavin and Marcia Kolvitz, Co-Facilitators of the Coordinators of Support Services Group, Discuss Group Finding

"At our college, we have a priority system to determine who gets the service first. If it's a remote situation, they need more time in advance. If we have somebody on campus, it's easier to send them."

"Some students use Polycoms, some students prefer laptops. Some software like e/pop and Polycom are not compatible with Macs. It's difficult to find software that's going to accommodate everyone."

"One issue is bandwidth. If it's full, the video quality suffers. If we ask for more bandwidth, we are told that we don't have the budget for that. If there is a bad connection, that can be lost. There were one or two days where we didn't have connections."

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Coordinators of Support Services (con't.)

- **Mobility**
  It can be extremely challenging to move the equipment needed to support remote services from location to location (e.g., classroom, laboratory, etc.), especially if there are time constraints. A good example is when a deaf or hard-of-hearing individual attends a conference and is going from one lecture to another.

"I think it is difficult when we have a lot of equipment that we have to move around in lab settings or other kinds of settings. There's a need to have the connection made, and then the connection cut, and then moved to another location. Mobility is often challenging."

- **Helping Universities Support Deaf Students**
  The reality is that many universities across the nation have yet to enroll a deaf student. Even the disability specialists at these universities do not fully understand the needs of disabled students. The challenge is identifying universities that are enrolling a deaf student for the first time and providing the support service coordinators, disability specialists, and faculty members with the proper training to appropriately support this student. Developing a database to track deaf and hard-of-hearing high school graduates seeking higher education would begin to address this challenge.

"Our job is not only to help process the accommodation request and make the most accessible environment for students, but in many cases we also are trying to help the faculty understand how to work with their very first deaf student."

- **Identifying Future Trends in Technology**
  It is extremely important to be aware of future trends in technology in order to plan appropriately for access and support services in the future. It is also important to look outside the education industry to better understand technology trends as a whole.

"I have found it important, and even Necessary, to get out of my own field, and so I've been going to just some general technology conferences to see where things are going. Because what we see is what we know, but we don't know what the technology is going to be in five or 10 years."

- **Over Accommodating / Justifying Costs**
  The Support Services Coordinators group discussed the possibility of over accommodating students. Is it appropriate to provide just one service, or is it required to provide both captioning and interpreting? How do you justify spending the money on all of those resources for one student? In what cases is the expense justified? In what situations?

  The Support Services Coordinators group also recognized the fact that service providers charge anywhere between $50 and $100 an hour for their services. The costs are not standardized, making planning and budgeting that much more of a challenge, especially for the smaller universities that have limited resources. This group also examined the costs associated with purchasing the hardware and software that is needed to provide remote services (e.g., web cams, microphones, etc.). These are all cost variables that need to be taken into consideration before providing remote services.

Group Members Representing Coordinators of Support Services Group Participate in Breakout Meeting to Develop Recommendations

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Coordinators of Support Services (con't.)

Recommendations Associated with Creating a Cyberinfrastructure

- **Establishment of Service Hubs**
  The Coordinators of Support Services group recommended setting up service hubs within each state or region in an effort to share resources, providing smaller schools, and those schools located in rural areas, the opportunity to provide remote services. This group suggested seeking federal and/or state funding to support the establishment of these regional programs/service hubs. It would make the most sense to select colleges that already have established programs for deaf and hard-of-hearing students to be service hubs. These service hubs may, in fact, encourage standardization of pay and practices.

- **Development of Websites/Databases to Support Remote Services**
  This group recommended creating a centralized website that provides an overview of remote access services including current technologies (e.g., Pepnet.org, stsn.org). This website would also include a database of remote service providers, an interactive database that shows interpreter/captioner availability by specialty, and an online library of STEM terminology, phrases, and diagrams.

- **Development of Remote Service Materials**
  In an effort to eliminate some fear and resistance in adopting remote technologies, the Coordinators of Support Services group suggested providing universities with appropriate information regarding remote technology. Some examples of documents that would be helpful to directors of support services (DSS), technicians, administrators, faculty and students include a one-page overview/tip sheet describing remote services, guidelines on establishing and providing remote access services at the postsecondary level, corresponding policies and procedures to help coordinators manage and prioritize requests, and technical requirements (e.g., bandwidth, hardware, etc.).

- **Technology Equipment**
  Utilizing service hubs as equipment loan centers so deaf and hard-of-hearing individuals are able to appropriately pilot/test equipment was also recommended. The people using the equipment must be the people who test the equipment. In addition, it is always difficult to find funding. Providing a list of funding resources or making sure that programs that we seek funding for are connected to equipment was suggested. In order to keep current with emerging technologies, it would be ideal to set up a group of technical support people to serve as technical advisors.

- **Remote Service Training**
  The group also recommended providing online training for faculty and students regarding remote access services. Creating virtual forums with organizations such as AHEAD, RID, STSN, and PEPNet would help support remote access services and subsequent online training initiatives.

- **Certification of Interpreters in STEM**
  The Coordinators of Support Services would like to make a recommendation to RID or NAD to consider certifying interpreters in the STEM fields. This would help address the challenge of assessing skill sets and matching interpreters to the most appropriate environment.

- **Cost Effectiveness Study**
  A study comparing the cost of providing remote versus onsite access services was also recommended. The results of the research would help universities determine what options they would be able to offer their deaf and hard-of-hearing students.

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

STEM Faculty

In order to provide deaf and hard-of-hearing students with all of the support service options that are available, there must be support from faculty. However, there are challenges associated with having a deaf or hard-of-hearing student in the classroom. Faculty members would have to change their teaching styles in order to accommodate these students, and some instructors are resistant to change.

Benefits Associated with Creating a Cyberinfrastructure

- **Improving Educational Experiences for Deaf or Hard-of-Hearing Students**
  One of the primary benefits of a cyberinfrastructure would be the ability to provide deaf or hard-of-hearing students with interpreters and captioners who have advanced knowledge within a specific area of study (e.g., STEM programs). Being able to appropriately interpret and caption scientific terms and technical language will significantly improve the educational experiences of deaf and hard-of-hearing students.

- **Keeping Students Interested and Engaged**
  There is often resistance by faculty members to have a disabled student in their classroom because they would then have to modify their behavior to appropriately accommodate the student's needs. However, many instructors are already modifying their behavior by incorporating current or popular technologies into their classroom/curriculum in an effort to keep students interested and engaged (e.g., PowerPoint presentations, YouTube, etc.). A few extra adjustments (e.g., captioning YouTube videos) would keep deaf and hard-of-hearing students engaged as well. Faculty members who are already employing some of the latest technologies may be more receptive to allowing remote communications into their classroom.

- **Maximize Learning**
  Faculty members, especially those who are encountering a deaf or hard-of-hearing student in their classroom for the first time, need to be educated about deaf people and how to best teach to deaf or hard-of-hearing students in order to maximize learning. Many of the recommended strategies will also help hearing students. For example, faculty members are instructed to regularly pause to allow interpreters and/or captioners to catch up and also to provide deaf or hard-of-hearing students the opportunity to ask a question or make a comment before going on to the next topic area. The hearing students who are taking notes usually appreciate this extra time to catch up as well. Remote communication technology will help all students be more engaged, thus maximizing their learning potential.

Group Members Representing STEM Faculty
Lead Panel Discussion Regarding Benefits and Challenges
Associated with Creating a Cyberinfrastructure

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Challenges Faced by Deaf and Hard-of-Hearing Students in Mainstream Classrooms

Understanding the many challenges that deaf and hard-of-hearing students face in mainstream classrooms is the first step in providing adequate support. Some of these challenges include the following.

- **Visual Dispersion**
  There are too many resources deaf or hard-of-hearing students have to look at simultaneously in the classroom (e.g., PowerPoint, captioning, interpreter, etc.). As a result, the student could easily miss or misinterpret what is being taught.

- **Access to Appropriate Accommodation**
  It is important to make sure the class size is not too large, that the interpreter is qualified to interpret the subject matter, and that the technology is appropriately in place. Also, there should be a back-up plan in case any technical difficulties occur.

- **Barriers to Classroom Participation**
  Determining how questions are to be asked in the classroom is key to participation for students who are deaf or hard of hearing. A deaf student may be interested in asking a question or adding to the discussion, but missed the opportunity because of interpreter delay.

"Sometimes a student will wave his/her hand to participate, and have missed his/her opportunity. So often that causes the student to shrink back and not be active in participating."

- **Barriers to After-Class Activities**
  There are also communication barriers outside of the classroom regarding participation in study groups, lab activities, group projects, and hallway conversations. How will the deaf student communicate with other students and/or faculty in settings outside the classroom?

"I've seen many faculty where their conversations happen in the hallway. So with a deaf student, the faculty member is restricted to just hello. They can't accommodate outside the classroom."

Changes in Teaching Style Due to Presence of Deaf Students in Classroom

Instructors may have to change their teaching styles due to the presence of a deaf student in their classroom. The key is providing faculty members with the knowledge to appropriately plan and accommodate for these changes.

- **Provide Training Materials/Resources**
  Provide instructors with written materials, resources and strategies on how to effectively teach deaf and hard-of-hearing students. The instructors who have never experienced a deaf or hard-of-hearing student in their classroom will have a better idea of what to expect and how to better accommodate. Not to mention, these teaching strategies benefit all students. However, this training needs to occur on time. This training should not occur during orientation as many instructors may not encounter their first deaf or hard-of-hearing student until three or five years later. ClassAct is a good, online, teaching resource.

"One thing we have to do is make possible the changes in teaching style by providing training materials as resources. Include deaf friendly strategies, and we find that those strategies tend to benefit all students."

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- **Universal Design in Teaching**
  It is important to make sure that instructors design curriculum that is suitable for all students.

"What is good for the deaf student is good for all students."

- **Style Adjustments in Minor Lecture Setting**
  A few adjustments in teaching style have to be made in a minor lecture setting. The interpreters and/or captioners have to be placed where they can hear the instructor and be seen by the deaf and hard-of-hearing students. Other important adjustments include: making sure people are taking turns when talking/discussing, eliminating any visible obstructions, and not speaking when writing on the board. Successfully managing the classroom will eliminate communication chaos and confusion (e.g., people talking over each other).

"And, my favorite is, 'No talking when you are actually doing the writing.' Write and then turn around and talk."

- **Communication Outside of Classroom**
  It is important to be cognizant that deaf and hard-of-hearing students would not be able to communicate or hear what is being said in settings outside of the classroom (e.g., field trips, laboratories, etc.).

Richard Ladner
Co-Facilitator of STEM Faculty Group

- **Expectations of Deaf and Hard-of-Hearing Students** Some instructors have the tendency to lower the bar, expecting less of deaf students because they cannot hear or write as well as their hearing peers, therefore concluding that they are not as intelligent. However, if the expectations are known, the instructors can modify their teaching so that deaf and hard-of-hearing students are successful and can, in fact, compete at the same level as their hearing peers.

Changes in Teaching Style Due to Remote Accommodation

Instructors also may have to change their teaching styles to accommodate remote assistive technology. It is important that these faculty members understand the following issues in advance so that they are able to appropriately plan, accommodate, and become comfortable with the changes.

- **Arrive Early to Test Technology**
  It is important to have someone responsible for testing the technology (e.g., AV equipment, microphones, cameras, laptops, etc.) before every class or event. The person responsible for testing should be someone knowledgeable with the equipment. In addition, he/she needs to be on site to resolve any technical difficulties in a timely manner. Often times, the qualified individual is a student, and faculty members need to be able to accept advice from students in these situations.

  The other factor to take into consideration is that not all universities have the facilities to support services. Faculty members may need to change their room to accommodate the technology, and some instructors may be reluctant to do so.

"What if a microphone stopped working? What does the professor do? Is the situation irremediable? Does the professor just keep going?"

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

STEM Faculty (con't.)

- **Self Advocacy**
  Deaf and hard-of-hearing students have to be taught to be their own advocates, especially when there is a breakdown in technology/communication. Instructors could help by encouraging class participation and communication between teacher and student.

> ***"We talked about how deaf students often become invisible in the classroom. There is a responsibility of the student to speak up if communication is breaking down. It has to be a two-way street."***

- **Standing Before Speaking / Identifying Self**
  It is also very important that every person who is interested in speaking, whether it is to ask a question or add to the discussion, stands and identifies themselves before speaking. This practice is important for both interpreting and captioning purposes.

> ***"We need to have a repetition of questions. In a classroom, we might only have one microphone which means that if a student has a question, the instructor will need to repeat what it was that the student asked, as opposed to running around the auditorium or the classroom with a microphone."***

- **Repeating Questions Asked from Audience**
  If there is only one microphone in the classroom, the instructor must repeat the questions that are being asked by students/ audience members, so the questions are properly relayed to the deaf and hard-of-hearing students.

- **Captioning Videos**
  As a result of YouTube's popularity, many instructors are now assigning homework projects that incorporate music, video, and animation. Although media programs such as YouTube, QuickTime, and Media Player include a captioning feature, the captioning process is quite difficult. In addition, how is a deaf or hard-of-hearing student supposed to complete a homework assignment that includes a portion relating specifically to audio? How is a deaf or hard-of-hearing student going to hear the project demonstration conducted by their hearing peers? These factors need to be considered before assigning these types of media projects.

> ***"I know that we've provided remote services in interpreting and captioning, and often the faculty member didn't seem to understand the importance of that prep material. It is extremely important in a remote situation especially, when you don't have a visual cue of what's happening in the classroom."***

- **Providing Service Providers with Material in Advance**
  In a remote situation, it is extremely important for instructors to provide service providers with course materials in advance. This will allow the service providers time to adequately prepare, ultimately improving the quality of the interpreting/captioning.

> ***"Professors are really concerned about archiving every single tape of every single course. They do not want it to go on forever. At our school, the instructors negotiated with the unions to have the material available for as long as the course was offered and then it would be erased."***

- **Copyrights / Intellectual Property**
  Although the Copyright Act involves explicit exemptions for blind and deaf individuals who read copyright protected material, faculty members need assurances that their material will be protected. Similar to other groups, STEM faculty suggested limiting the amount of time course material can be accessed. Group members felt that this would be an important factor in building a cyberinfrastructure and receiving faculty support.

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Recommendations Associated with Creating a Cyberinfrastructure

- **Need for Faculty Members to Adjust Teaching Style**
  The main recommendation from the STEM faculty group is recognition that faculty members need to adjust their teaching styles in order to accommodate deaf and hard-of-hearing students in their classroom. However, the utilization of assistive technology should minimize these adjustments. Also, a mechanism needs to be in place to determine whether faculty members are making the recommended adjustments and that the changes/new processes are successful.

- **Create a Faculty Website**
  The STEM faculty group also recommended the creation of a website designed specifically for faculty members who have a deaf or hard-of-hearing student enrolled in their classroom, possibly for the first time. The website would include advisement materials on what to expect, examples of best practices and universal teaching designs, an online class tutorial, legal responsibilities, and a faculty forum where they can post questions. This group felt that PEPNet would be a logical host for this type of website.

  Examples of web resources include:

  - PEPNet
    http://www.pepnet.org
  - RIT Class Act
    http://www.rit.edu/~classact
  - Queen's University Deaf Academics & Interpreters
    http://biology.queensu.ca/%7Equdai/index.html
  - University of British Columbia Faculty & Staff Disability Resources
    http://www.students.ubc.ca/facultystaff/disability.cfm?page-students
  - University of Washington DO-IT
    http://www.washington.edu/doit

- **Use of Technology Agreement**
  Provide faculty members who have a deaf or hard-of-hearing student in their classroom with an agreement form that explains the process and identifies the persons who are responsible for the various tasks associated with providing access technology. The tasks include setting up technology and planning how to handle technical failures. The set up plan should incorporate different educational settings such as classroom, laboratory, and field.

- **Part-Time Faculty**
  It is important to make sure that part-time faculty, temporary faculty and teaching assistants have access to the materials/resources associated with providing support services to students who are deaf or hard of hearing. All faculty and staff members need to understand their responsibility associated with providing a classroom that is accessible to all students.

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- **Intellectual Property**
  An agreement needs to be made between the university and faculty members concerning captioned materials (e.g., transcriptions, video streams). The agreement should outline who has access to the material, how long the material will be archived, and when the material will be destroyed.

- **Educational Research**
  Providing faculty members with evidence-based research on the effectiveness of adjusting teaching styles to accommodate deaf and hard-of-hearing students will assist in the faculty buy-in process. A cyberinfrastructure should be designed to collect and track data automatically.

- **Mobility**
  A cyberinfrastructure must also be able to support access outside of the traditional classroom. It is critical that deaf and hard-of-hearing individuals are able to receive remote services on field trips, at conferences, in laboratories and demonstration classrooms, at the workplace, in team meetings, and during one-on-one tutoring sessions.

- **National Interpreter/Captioner Database**
  It would be ideal to have a national interpreter and captioner database to find the best qualified provider for a specific area of study. This database needs to be accessible to the public. To address problems associated with managing this type of database, the STEM faculty group recommended charging a fee to providers similar to the yellow pages, or having service providers post and update their own interpreters/captioners qualifications and availability.

- **Interpreter/Captioner Certification**
  The STEM faculty group members recommended certification for both interpreters and captioners in STEM fields.

Group Members Representing STEM Faculty
Participate in Breakout Meeting to Develop Recommendations

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Cyberinfrastructure Specialists

Cyberinfrastructure is a term coined by The National Science Foundation several years ago to call attention to the infrastructure needed for the 21st century economy. A cyberinfrastructure is a fast, secure system incorporating necessary hardware, software and cyber tools designed to support a specific domain. Deaf and hard-of-hearing students in STEM Programs is an example of a specific domain. A cyberinfrastructure is built through the support of not only the cyber community, but experts in the specific field of study; a collaborative effort of identifying specific requirements and trying to map the requirements to existing technologies. The cyberinfrastructure specialists provided a state-of-the-art perspective regarding the applicability of a cyberinfrastructure to support remote interpreting and captioning within a postsecondary STEM environment.

Examples of Existing Technologies

The following information identifies existing technologies that can help support deaf and hard-of-hearing students.

- **RIT Collaboration Grid**
  The objective of this project is to connect people together that are at a distance in an effort to unify the RIT community on and off campus. The project connects 12 different places within RIT (colleges, library, student union, president's house, etc.) utilizing real time, interactive, high quality video and audio.

- **Conference XP**
  Conference XP is high quality video conferencing software that is built on a platform allowing for real time collaboration. In other words, the software allows those knowledgeable, like programmers/developers, to easily add new functionalities (e.g., captioning stream, etc.). Accessibility and archiving are the key features of Conference XP.

- **Adobe Connect Captioning**
  Adobe Connect Captioning is a product used to facilitate online web meetings. The screen layout is segmented into three windows referred to as pods, and the layout and positioning of the pods are determined by the instructor.

- **Microsoft Office Live Meeting**
  Microsoft Office Live Meeting is a product used to facilitate online meetings. Similar to Adobe Connect, Microsoft Office Live Meeting has different windows where you can see the presenter, the text captions, and PowerPoint presentation or other visuals. Microsoft Office Live Meeting also allows for shared desk space, which enables two students to work together on the same document using their own computers. In addition, Microsoft is working on other projects that help to create captions with any and all videos, adaptive technology that works with any and all input devices, and technology that adjusts display size (e.g., whole office wall versus hand held, etc.).

- **IBM Hosted Transcription Service**
  IBM Hosted Transcription Service is an off-line transcription service that allows information to be transcribed using any combination or modality that is most convenient to the user. For example, a user would be able to submit visual or audio media to the website and the video or audio would be processed in the output form of choice. The user is also able to change the visual appearance/layout of the form.

"Each of these multimedia conferencing tools have all these neato features, but none of them are quite exactly what we want.

In Adobe Connect, it's not individual, it's not flexible in the sense that everybody sees the same view. You can't have different students with different views, and we've been talking about the diversity of students and how crazy important that is.

In Conference XP, you set up this whole infrastructure, but a student cannot really come into the classroom, set up their laptop and they are good to go.

EPOP has similar problems with cost. It's like each of these programs are so close."

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Settings Where Technology is Needed to Support Deaf and Hard-of-Hearing Individuals

The following information identifies the settings where technology is needed to help support deaf and hard-of-hearing individuals.

- **Academic Setting**
  The future definition of an academic setting is anywhere, anytime education; meaning that teaching does not just take place in the classroom. There are field trips, laboratory assignments, and study groups where deaf and hard-of-hearing students need technology to support their learning.

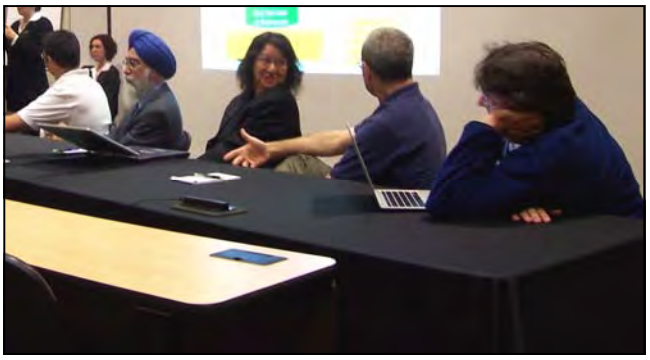
"We came up with this slogan that represents the classroom of the future, 'anywhere, anytime education.'"

- **Workplace Setting**
  There are workplace settings where deaf and hard-of-hearing individuals need to be supported. At RIT, there is an internship program that every student must participate in. Often research cannot be conveyed in a typical lecture room setting. There are also ad hoc department meetings and lunch meetings where the location may not have static infrastructures.

"I'm actually a researcher that does super computing research, and much of the research I'm doing cannot be communicated in a classroom setting."

Benefits Associated with Creating a Cyberinfrastructure

Services within the cyberinfrastructure framework to support deaf and hard-of-hearing students would include the following.



Group Members Representing Cyberinfrastructure Specialists Lead Panel Discussion Regarding Existing Technologies, Benefits, and Challenges Associated with Creating a Cyberinfrastructure

- **Develop Approaches, Methods, and Techniques** Developing approaches, methods, and techniques will enable information to be exchanged among sets of users, for discovering sets of users who could benefit from the exchange of information, and for studying how such exchanges affect those involved.

- **Support Workshops**
  Three is a need to support workshops with particular user communities to test different methods and technologies to analyze the effectiveness of the cybertools.

- **Provide System (and inter-system) Integration, Operation, and Administration**

- **Supplement Existing Facilities**
  Supplementing existing national and regional facilities will enable optimal and productive use of them.

- **Ensure Effective Design**
  Effective design of the environments will be achieved through direct participation by users in their development.

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Recommendations Associated with Creating a Cyberinfrastructure

- **Create an Experimental Platform and Testbed**

  The Cyberinfrastructure Specialists recommended creating an experimental platform and testbed to allow people throughout the nation and the world to experiment, conduct research, and build new tools and applications to be used to support deaf and hard-of-hearing STEM students, faculty and other stakeholder populations. The experimental platform would be a combination of open source and proprietary building blocks. The steps associated with creating an experimental platform/testbed include: requirements gathering, design process, and challenges.

  Requirements Gathering Investigate how technology can assist problem diagnosis and resolution, and identify short- and long-term deployment. Identify what can be done now versus what may be possible in 5-10 years. Short-term activities would include documenting and improving the use case scenarios; explaining "Everywhere, Anytime Education" paradigm; using existing commodity technologies and providing demonstrations; developing guidelines for deployment; and using social computing tools to automate the discovery of groups of users. The long-term activities may include: building a scalable server-based host environment; building a client base that interfaces with the hosting service; hiring permanent staff; and building a community of practice.

  Design Process User involvement is the most important component of the design process. The process should also include a diversity of scenarios and on-the-fly modification; user interface "smart" customization; and just-in-time and just-in-case practices.

  Challenges Platform independence is a challenge associated with creating a cyberinfrastructure. Ownership of the project, which group would govern the creation of standards; ISO, W3C or a forum that ensures the needs of the end user are represented in the requirements and standards. Who owns/controls the solution? Who owns, and who is allowed to access and for how long, the content/intellectual property that are archived/delivered by the system? How to deliver content to disparate devices (e.g., computers, cell phones) that have both different bandwidth and user interface concerns? Accounting for technology failures, and creating back-up plans for archive failures and when real time delivery systems fail, are all challenges that need to be addressed.

Group Members Representing Cyberinfrastructure Specialists Participate in Breakout Meeting to Develop Recommendations

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Educational Captionists & Interpreters

Captionists and interpreters have many similar concerns, issues and situations related to providing remote services to deaf and hard-of-hearing students.

Benefits Associated with Creating a Cyberinfrastructure

- **On-Demand Services**
  Being able to provide on-demand remote access services will make a significant difference in the lives of deaf and hard-of-hearing individuals around the world. The process to find and schedule an interpreter and arrange set up is still very cumbersome.

"Right now, getting access is still difficult for the deaf or hard-of-hearing person. Being able to easily make a request for service and then get that service almost on demand in a forum that is useful….I think it would be a huge difference in the lives of deaf and hard-of-hearing people."

- **Coverage During a Variety of Times**
  Deaf and hard-of-hearing individuals need access services during different times of the day; not just during the daylight hours. Remote access services would allow access at any time.

- **Variety of Places**
  Remote access would address the need for services outside of the classroom (e.g., laboratory, field trip, conference, business environment).

Group Members Representing Educational Captioners & Interpreters Lead Panel Discussion Regarding the Benefits and Challenges Associated with Creating a Cyberinfrastructure

- **Support of Group Communications**
  Through remote access, deaf and hard-of-hearing individuals would be able to participate fully in group situations whether it be study groups, business or team meetings, or social settings.

- **Choice of Services**
  Deaf and hard-of-hearing individuals would be able to choose the type of service that best meets their needs, and also be able to have multiple services on their screen at one time, if they so choose. Having the ability to customize their screen (e.g., make captioning larger, change font size, background color) to best meet their individual needs is key to successful learning. A good example is a current research project at the University of Washington called ClassInFocus (http://dhhcybercommunity.cs.washington.edu/projects/).

- **Easy Access to Captioned/Interpreted Materials** Another benefit associated with creating a cyberinfrastructure is that it would allow easy access to the captioned/interpreted materials. These materials would not only be accessible to deaf or hard-of-hearing students, but to all students, improving the learning experiences and providing a win/win situation overall.

"Institutions of higher education need to recognize that we're not talking about a small, very loud special interest group, but we're talking about ameliorating the learning circumstances for many students. Once that is recognized, we'll have a much better chance at success."

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Challenges/Needs in Providing Captioning and Interpreting

The challenges captionists and interpreters encounter when providing services have been divided into four categories: technical/logical, communicative/linguistic, pedagogical, and other. The other category addresses challenges specific to both captioning and interpreting.

- **Technical/Logical**

  Remote services need sufficient flexibility to support different settings (e.g., education, work, and community). Support services also need to be available in non-traditional learning settings such as field trips. A primary concern involves being disconnected and attempting to re-establish the connection. It is imperative that there is a back-up plan in place to account for technical difficulties. Another concern is the lag time between speaker and provider when using wireless Internet connection or cell phone. Other challenges include supporting online or distance learning, changing the microphone when there is more than one speaker and only one microphone, excess background noise, and technology training for both students and teachers. Group participants explained that the technology training does not have to be in-depth, just acknowledging whose responsibility it is, for example, to change the battery on the microphone every Monday.

"It is important to make sure there is training for students and teachers, because it is really important for the success of remote CART and captioning to be provided. It could be as simple as changing a battery on a microphone. These are not major things that we have to involve the entire IT department on."

Mike Stinson and Rico Peterson, Co-Facilitators of the Educational Interpreters & Captioning Group, Prepare Group Findings

- **Communicative/Linguistic**

  Two-way communication between teacher or student and provider is desirable for clarification purposes. The provider does not typically see figures, charts, graphs, etc., which affects comprehension of the material for both the provider and student. In addition, the provider is not always aware of the technical jargon and acronyms used within advanced courses. It is imperative that the curriculum/course material be sent to providers in advance.

"Interpreters are information junkies. We learn to depend on every bit of available information in order to make the best translation. When we are in a remote location, we don't have access to some of the tools that we've become very dependent on and I think it will be very interesting to see how training of interpreters in the future changes to accommodate that.

Not only does the quality of the interpretation suffer, but the stress level of the interpreter increases. Some materials suggest that people working in remote locations need to work much shorter shifts because after 15 or 20 minutes, they're pretty fried."

- **Pedagogical**

  Environmental issues have to be taken into consideration (e.g., dark rooms, the need for privacy in an examination/operating room, etc.). There is a need to develop a comprehensive clearinghouse/scheduling system that lists all types of providers by specialty that can be easily accessed by deaf and hard-of-hearing users. The challenge will be to get all of these providers to work together. There was also the suggestion of sharing resources among institutions on a more widespread basis. Classroom

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

management is a significant concern. The instructor must make sure each person identifies himself before speaking and that people do not talk over one another. The instructor may also need to manage the placement of the microphone to make sure students have the opportunity to make their comments and participate fully in class. The placement of the camera is critical as well. Remote interpreters need to be able to see the PowerPoint, the classroom and the instructor, so they are able to read all the social dynamics.

- **Other Challenges**

Captioning While many of the same challenges exist between captioning and interpreting, there are some challenges/needs that are specific to only captioning. These challenges include the need to have captioned materials available immediately, to provide real-time captioning in Braille, the need to show subject-specific symbols, signs, and terms, for the user to have a choice regarding layout of captioned material, having the ability to provide captioning in a multimedia environment, having the ability to show multiple drafts of texts, and the stigma felt by users for being in need of captioning services.

Interpreting Similarly, there are challenges/needs that are specific only to interpreting. The primary challenge involves the quality of interpreters/interpreter training.

Other challenges include access issues involving Deaf-Blind consumers and the need for remote tactile and close-visual interpreting, and changes in state and federal legislation with regards to Video Relay Services (VRS).

"Students coming out of interpreting programs typically have marginal fluency and typically do not have the best literacy, and what it is that needs to come out is not at all real clear just yet."

"There is a good deal of pressure being brought to bear on interpreter education programs, or I.E.P.'s by industry, specifically the video relay industry, to include video relay training in their curriculum."

Recommendations Associated with Creating a Cyberinfrastructure

- **On-Demand National Agency/Clearinghouse for Providing Captioning/Interpreting**
Similar to other groups, Educational Captionists and Interpreters recommended creating a national clearinghouse that provides information on remote service providers, including the qualifications of captionists and interpreters. This also would be an area where instructors could post their documents in advance, so interpreters/captionists would be better prepared and able to provide better service.

- **Funding to Support Certification Training for Interpreting/Captioning**
This group acknowledged the importance of formal training of interpreters/captioners in order to provide quality services for deaf and hard-of-hearing students in STEM programs. They recommended approaching government and/or private agencies in order to fund certification training, or providing certification through universities such as Gallaudet or NTID.

- **Need for Varying Display Options**
A standard laptop may not always be the best display option for remote technology outside the classroom. The functionality has to work across different platforms (e.g., PC, Mac, PDA, etc.). It is also important for the user to be able to have control with regards to layout, color, font, size, etc. Users should have the ability to make the interpreter larger on the screen if they so choose.

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Educational Captionists & Interpreters (con't.)

- **Multiple Audio and Video Input for Service Providers in the Classroom** The quality of video and audio input provided to the remote service provider is critical. Wide angle perspectives provide much more information than single, fixed angle cameras. In addition, multiple microphones in the classroom allows for improved audio service.

"It is part of their job to be information junkies. They need as much information as possible regarding the classroom dynamics and material. If I, as an interpreter, could have anything I want, I would want to see on my display the PowerPoint, the classroom, the instructor, and the deaf student."

- **Possibility of Wedding Captioning and Interpreting**
Group members who represent educational interpreters explained that captioning can be very helpful to them as well. Providing remote interpreters with captioning would improve their service overall.

- **Evaluations**
Evaluation must be a part of any provision of services. There is the standard evaluation that measures quality of service and also a more thorough evaluation that measures the benefits associated with using technology.

Group Members Representing Educational Captioners & Interpreters Participate in Breakout Meeting to Develop Recommendations

- **Cross-disciplinary STEM Software**
There is a need to have cross-disciplinary STEM software in order to appropriately caption formulas, mathematical symbols, etc. Although the software exists to display formulas and mathematical symbols, it is not compatible with captioning software.

- **Technologies for Students with Multiple Disabilities**
It is necessary to adapt technology to best fit individuals' needs, which includes students with multiple disabilities. A deaf vision-impaired student may need to increase the font size or change the background of captioning.

"This also goes back to the idea of having technology compatible with a screen reader for individuals who need Braille display; a refreshable Braille display with their captioning."

- **Different Platforms Accommodating Support Service of Choice**
Group participants would like to see the availability of various kinds of support (e.g., CART, C-Print, etc.) being fitted into different platforms (e.g., Adobe Connect, NetMeeting, Wimba, Elluminate Live!).

- **All-Way Communication Between Student, Teacher, and Service Provider**
All-way communication access needs to exist between student and teacher, between student and service provider, and between teacher and service provider. Back-up plans need to be in place in case the main channel of communication breaks down.

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Students in STEM Programs

The student group consisted of both graduate and undergraduate deaf and hard-of-hearing students in STEM programs representing various institutions across the United States.

Benefits Associated with Creating a Cyberinfrastructure

- **Online Database and Centralized Repository for Signs in STEM Language**
  A cyberinfrastructure would provide people the opportunity to post all of their ideas, concepts, and definitions for signs in one place. This type of database would be helpful to not only deaf and hard-of-hearing students, but faculty members and service providers as well.

> ***"I've taken four years of chemistry, and I go into a new state, and I see no interpreters that have knowledge of chemistry at my level, or no knowledge of chemistry period. There are no resources or contacts. I remember in my first year I spent a lot of time and did a lot of work and negotiation around training and working with interpreters to develop signs."***

- **Teaching Tools for Educators**
  A cyberinfrastructure would also be a good tool for deaf educators, as it requires specific and detailed communications with interpreters. Service providers need to be able to understand what the instructor is saying in order to accurately interpret the material.

- **Accessibility Guidelines for Content Development**
  A cyberinfrastructure would have the flexibility to meet deaf and hard-of-hearing students' needs (i.e., captioning, interpreting, etc.) and varying course levels (beginner, intermediate, and advanced).

- **Best Practices for STEM Relating to RROC and VRI Personnel**
  This also may help initiate certification for interpreters/captioners in STEM programs, which the STEM student group felt would be ideal.

Group Members Representing Students in STEM Programs Lead Panel Discussion Regarding the Benefits and Challenges Associated with Creating a Cyberinfrastructure

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Challenges Faced by Deaf and Hard-of-Hearing Students in STEM Programs

The student group identified several challenges that they face on a day-to-day basis.

- **Respect and Recognize Diversity**
  One of the most important challenges that deaf and hard-of-hearing students face is the lack of respect and recognition they receive with regard to their diverse communication needs and preferences. Some students prefer ASL, while others prefer an oral or written interpretation. There is a wide scope of preferences and students should be able to choose the communication/ interpreting method that best meets their needs.

> ***"You can't put deaf students in a box and expect all the individuals to conform because we have a diverse range of needs."***

- **Cost of Technology and Service Provision**
  The student group, however, recognized cost as being a significant factor in providing students with these choices, particularly within universities that have limited resources. The student group found that these service options may be available in a formal classroom setting, but, in most cases, not available in an informal setting such as in a laboratory or on a field trip.

> ***"There's a cost to implement the technology. For example, some universities may not have policies on the kind of technologies that are used, while other schools may have a laptop that is passed out for everyone to share. So, there's no stereotype or stereotypical system. If you are in a lecture hall, maybe technology could solve a problem, but suppose you are in a lab, or on a field trip. What happens in those situations when remote interpreting and captioning is unavailable?"***

- **Availability of Technology Due to Marketplace Demand** There are not enough providers available who offer captioning and interpreting services to meet the increased demand. Government regulations have been a significant contributor to this increase in demand.

> ***"There's competition for limited resources. With CART, government, and corporate, everyone wants CART services, but there are limited resources and there's a limited number of CART, captionists, and interpreters. It takes time for supply to catch up with demand."***

- **Educating the Provider**
  Students explained that it often is better to keep the same captionist or interpreter for an entire year or semester. Providers are not usually trained in a specific area, so STEM students have to take the time to teach the provider the various terminology and vocabulary associated with their field of study. This especially holds true for the deaf and hard-of-hearing students taking advanced STEM courses. This process is similar to on-the-job training. This "training" period also allows the provider the opportunity to become familiar with the student's specific learning style.

> ***"We do a lot of educating (providers) in the first week or two weeks of using a new provider. It's kind of like on-the-job training."***

- **Advantages and Disadvantages of Access Technologies** Video Relay Services (VRS), Video Relay Interpreting (VRI), and Real Time Remote Online Captioning (RTROC) are all Internet-based and dependent on a signal, wifi or wireless set up. The dif-

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ference between VRS and VRI is that the Federal Communications Commission (FCC) has mandated VRS to provide communication services to people who are deaf and hard-of-hearing outside of the educational classroom, including teleconferencing capabilities. VRI, on the other hand, is able to facilitate a conversation between two people in the same room, or within a classroom setting, through a remote interpreter; however, it is not mandated by the FCC nor is RTROC. All three access tools provide quality services in a remote setting, especially benefiting deaf and hard-of-hearing students attending universities located in a rural setting. The disadvantages of using VRS and VRI is that there is limited participation. A microphone needs to be passed from speaker to speaker. Another disadvantage with VRI is that there is no opportunity to work with an interpreter in advance. If a student needed to conduct a presentation, it would have to be done on an ad hoc basis.

"We haven't found the real solution, but what we have to do is to start to think outside the box. That means we need future advances of new technology. We should dream the impossible dream. Create new technology, signing avatars, a hologram of an interpreter."

Automatic Speech Recognition (ASR) is designed to provide direct access to captioning without requiring a third-party captionist. The primary problem with this technology is that the person who is going to wear the microphone must spend 1-2 hours of training so that the computer appropriately recognizes his/her voice. Realistically, an instructor is not likely to do this for one student. FM technology is very outdated and assumes the instructor does all the talking. The deaf or hard-of-hearing students miss any and all discussions held by other students. The student group suggested that technology such as instant messaging, email, and Vlog should be used to supplement the weaknesses of the other technologies until new and better technology is developed.

Ellie Rosenfield, Co-Facilitator, and Joshua Beal, Group Support, Assist the Student Group with their Findings

Recommendations Associated with Creating a Cyberinfrastructure

- **Empower Students**
  The STEM student group recommended the need for STEM students to be empowered in order to be successful. They need to know how to make a request for services. They need to know how to find a qualified interpreter or service provider in a specific STEM field, and they need to be more aware and knowledgeable of the law and how to advocate for themselves.

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- **Develop Social Networking Opportunities for Both Live and Virtual Contact** Many deaf and hard-of-hearing students in STEM programs throughout the country feel isolated. The STEM student group recommended providing an annual workshop or retreat for both deaf faculty and students where they can meet/network, hold discussions and collaborate — fostering a love for their field of study. It is also important to set up an online cyber-community for deaf and hard-of-hearing students in the STEM field. The development of a support network would help eliminate isolation and also provide the opportunity for people to come together to share thoughts, ideas, and resources.

> ***"It's important to develop some kind of support network. It could be Internet-based, community-based, kind of like a social networking tool. The concept would be deafacademic.org where all over the world people in the STEM fields could come together and support one another."***

- **Focus on STEM Vocabulary and Discourse**
  As several other groups mentioned, there is a need to develop proper terminology/language for ASL and STEM. The STEM student group recommended supporting ASL STEM forum development; similar to a current research project at the University of Washington called ASL-STEM Forum (http://dhhcybercommunity.cs.washington.edu/projects/). Various STEM stakeholder populations (e.g., interpreters, captioners, students, faculty) would be encouraged to participate. This group also agreed that interpreter training and STEM certification should be a priority.

- **Shared Access to Deaf-Friendly STEM Instructors Across Universities**
  Another recommendation to help eliminate isolation is allowing deaf and hard-of-hearing students to take a course at another university that has deaf-friendly instructors who sign, such as NTID, California State University Northridge (CSUN), and Gallaudet. This would especially benefit those students in their first few years of postsecondary education.

- **Virtual Tutorial Support/Provision**
  This group also discussed the need to provide virtual tutoring support through a video phone in order to maintain direct communication between the deaf student and tutor.

Minoru Yoshida, Representing Students in STEM Programs, Takes his Turn at Presenting Group Recommendations

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Conclusions

Each of the six stakeholder populations represented at the Summit carefully considered the potential benefits and challenges associated with the application of remote service provision and formulated recommendations for future research, development and evaluation of cyberinfrastructure solutions. These findings can be used by educators, service providers and developers as a catalyst and guide for future implementation of a cyberinfrastructure to advance deaf and hard-of-hearing students in STEM programs.

The six stakeholder populations represented at the Summit included: educational, linguistic & sign language researchers and developers; coordinators of support services; STEM faculty; cyberinfrastructure specialists; educational captionists and interpreters; and STEM students. There were many similarities among the groups regarding the benefits, challenges and recommendations associated with creating a cyberinfrastructure. Any differences among the groups are specifically noted. The following summary provides an overview of the findings representing all six stakeholder populations.

Benefits Associated with Creating a Cyberinfrastructure

- **Ability to Choose and Customize Service(s) to Best Meet Students' Diverse Needs**
  The constituency groups agreed that students, in order to be successful, need to be able to choose the technology/services that best meets their individual needs, and a cyberinfrastructure would provide students with different service options. The software would also allow the student the flexibility to customize the layout of the screen (e.g., make captioning larger, change font size, background color) to best meet his/her preferences and/or individual learning style.

- **Teaching Tools/Strategies for Educators**
  A cyberinfrastructure would provide educators, especially those that encounter deaf and hard-of-hearing students on occasion, with appropriate training. This training would provide educators with the teaching tools and strategies necessary to effectively teach deaf and hard-of-hearing students. Educators would gain a better idea of what to expect and how to better accommodate these students, in order to maximize learning potential for all students in the classroom.

- **On-Demand Services / Rural Schools Access to Interpreting and Captioning**
  Creating a cyberinfrastructure would bring deaf and hard-of-hearing students closer to 24/7 access. They would no longer be dependent on the schedules of interpreters/captioners who have limited availability. A larger pool of service providers would allow for more flexibility. A cyberinfrastructure would also allow deaf and hard-of-hearing students attending smaller schools, or schools located in rural areas, access to interpreting and captioning services.

- **Interpreters/Captioners Qualified in STEM**
  A cyberinfrastructure would provide information about STEM programs (e.g., terminology, language, ASL signs) that would be helpful to service providers in order to better prepare and more accurately interpret curriculum materials at all course levels (beginner, intermediate, and advanced). Many of the Summit participants felt that a cyberinfrastructure would also help initiate certification for interpreters/captioners in STEM programs, thus eliminating the need for students to train the service providers themselves.

- **Centralized Repository for Signs in STEM Language**
  Another benefit associated with creating a cyberinfrastructure would be a centralized repository for signs in STEM language. People would be able to post all of their ideas, concepts, and definitions for signs in one place, eliminating the development of signs in isolation.

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Conclusions (con't.)

- **Anywhere, Anytime Education / Mobility**
  The creation of a cyberinfrastructure would allow deaf and hard-of-hearing students access to services outside of the traditional classroom (e.g., laboratory, field trip, study group, conference, internship). Remote access also would allow deaf and hard-of-hearing students to participate fully in group discussions.

- **Easy Access to Captioned/Interpreted Materials**
  Another benefit associated with creating a cyberinfrastructure is that it would allow for easy access to captioned/interpreted materials. These materials could be accessible to both deaf and hearing students, thus improving the learning experiences for all students. In addition, educators are instructed to submit materials to service providers in advance for preparation purposes. A cyberinfrastructure would allow for a centralized site for these submissions, streamlining the process for educators.

- **Research Opportunities and Data Gathering**
  A cyberinfrastructure would provide many new areas of research and development regarding education, linguistics, and cognitive development. The research findings would benefit all of the stakeholder populations, and a cyberinfrastructure would be able to collect and track much of this data automatically.

Challenges Associated with Creating a Cyberinfrastructure

Understanding the challenges identified by each of the stakeholder populations will help ensure the long term success of a cyberinfrastructure. As previously stated, many of the constituency groups identified similar challenges associated with creating a cyberinfrastructure.

- **Matching Students with Appropriate Technology**
  A critical step in achieving educational success is getting to know each individual student and recognizing his/her diverse background (e.g., language, education, culture) and matching the appropriate technology to complement these characteristics. However, the technology will differ by student as the content and educational setting changes (e.g., small versus large classroom, formal versus informal setting). In addition, the technology that the student prefers or is used to using, may not be the technology that best meets his/her educational needs. Students need to be made aware of, and have the ability to experiment with, all the different types of technologies that are available to them before they reach the postsecondary education level.

- **Determining Best Practices / Developing a Working Guide**
  The first step in developing a working guide for stakeholders providing assistance to deaf and hard-of-hearing students, is to determine best practices through research-based assessments. The current research regarding service preference is often conflicting. It is critical for stakeholders to know for example, how deaf and hard-of-hearing students best absorb information. Educators need to know how to effectively teach deaf and hard-of-hearing students; the rolls of teachers, students, technicians, and service providers need to be clearly defined; and coordinators need to know how to prioritize requests. Research-based assessments may be the best way to gain support of educators, administrators, and technicians.

- **Identifying and Retaining Qualified Remote Service Providers**
  There is no central location for finding information about remote service providers, let alone by specialty. The resources are available, but it takes considerable time to pull all of the information together. The student group mentioned that they often have to take time to teach the provider the various terminology and vocabulary specific to their field of study. For this reason, they prefer to keep the same captionist or interpreter for an entire year or semester.

This material is based upon work supported by the National Science Foundation under Award No. OCI-0749253.

Conclusions (con't.)

- **Lack of Signs for STEM Programs**
  There are not enough signs available to accurately identify all of the various and complex terms within STEM programs. As a result, deaf and hard-of-hearing students often miss or misunderstand what is being taught. In addition, there are multiple, and often outdated, signs for the same term or concept, which results in a lack of consistency/standards within these programs.

- **Quality of Service / Technical Difficulties**
  Hardware and software compatibility issues continue to be a problem. Students are using different platforms and the necessary software is not universal. Also, the quality of audio and video suffers significantly when a university is not able to supply sufficient bandwidth (strength and speed of connection), or if there is only one microphone or one single angled camera. If a connection is lost, the student is suddenly out of contact. Backup plans need to always be in place.

- **Mobility / Lack of Equipment**
  Access outside of the classroom is extremely important; however, it can be challenging to have to move equipment needed to support remote services between locations, especially if there are time constraints.

- **Identifying Universities Enrolling Deaf Student for First Time**
  In order to provide sufficient training and support to coordinators of support services and educators, universities that have enrolled a deaf or hard-of-hearing student for the first time need to be appropriately identified. Confidentiality issues may pose an extra challenge.

- **Copyrights / Intellectual Property**
  Many educators do not want their materials distributed outside of the university. When material is captioned remotely, faculty members have no idea where their information is going or who is accessing it. Educators need assurances that their material is protected.

- **Cost Effective Business Model**
  In order for the cyberinfrastructure to sustain and be successful, a cost-effective business model must be adopted. It may not be economically feasible to serve the needs of all deaf and hard-of-hearing students at all levels in all the different STEM programs.

- **Measuring Success**
  With any new idea/concept comes the challenge of how to accurately and effectively measure its success. Summit participants were quick to point out that neither test scores nor student surveys necessarily provide accurate measures of success. The student may have enjoyed the topic or teacher, irrespective of the type of support services used.

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Conclusions (con't.)

Recommendations Associated with Creating a Cyberinfrastructure

Summit participants were charged with formulating recommendations on how to proceed with the development of a cyberinfrastructure designed to advance deaf and hard-of-hearing individuals in STEM programs. Again, there were many similarities among the stakeholder populations, and any differences in responses are appropriately identified.

- **Self Advocacy / Empowerment**
  Many of the groups, particularly the student group, felt strongly that deaf and hard-of-hearing students need to be empowered and taught how to be their own advocate. Participants discussed the need for deaf and hard-of-hearing students to be more knowledgeable about the law, to know where to go and how to request services, and to immediately speak up when technical failures occur.

- **Mobility**
  A cyberinfrastructure must be able to support access outside the traditional classroom, as a great deal of learning happens on field trips, in laboratories, at conferences, during study groups or one-on-one tutoring sessions, and in the workplace.

- **Remote Service Training Forum for Educators and Students**
  Both educators and deaf and hard-of-hearing students need to be provided with the opportunity to become familiar, and experienced, with all of the different kinds of remote support options that are available. A site/forum that outlines all of the options that are available would address this need.

- **Online Training for Interpreters/Captioners in STEM**
  Many constituency groups recommended implementing an online training program for interpreters and captioners to become more knowledgeable with specific STEM language and terminology. These participants felt this would be the first step towards interpreters/captioners becoming certified in STEM programs.

- **Communicating Access Needs to Organizations that Develop Technology**
  Summit participants recognized the need to communicate access needs to organizations that develop technology in order to ensure that they incorporate features that benefit the disabled. The stakeholders that should represent the deaf and hard-of-hearing community "at these tables" has yet to be determined.

- **Centralized Service Provider Database / Clearinghouse**
  All of the groups were in agreement that a centralized database/scheduling system needs to be developed listing all of the remote service providers by specialty, their qualifications, and availability. This database would be accessible by all stakeholder populations providing on-demand services twenty-four hours a day, seven days a week.

- **Enhanced Captioning**
  Participants representing the educational, linguistic & sign language research and developers, and educational captionists and interpreters recommended enhanced captioning to improve communications. Captioning should have the capability to display all visuals, such as graphs and formulas, and the student should be able to have the captioned material appear in the format that best meets his/her needs (e.g., lower case text versus all caps). In addition, captioned materials should be immediately available for downloading and able to provide real-time captioning in Braille.

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Conclusions (con't.)

- **Centralized Repository for Signs in STEM Language / ASL STEM Forum**
  An online database and centralized repository for signs in STEM language for stakeholders to post their ideas, concepts, and definitions for signs in one place was recommended by several groups, particularly the student group. This type of forum would allow stakeholders the opportunity to discuss and come to an agreement on a specific sign that best meets a particular need. Students would also favor the development of a social networking system, both live and virtual, for deaf and hard-of-hearing students in STEM to help combat the feeling of isolation.

- **Working Guide to Deliver Remote Services**
  Summit participants recommended developing a working guide to help assist in the implementation and delivery of remote access service for deaf and hard-of-hearing students in STEM. This guide would include information such as a brief description of remote services, options that are currently available, guidelines for establishing and providing remote access services at the postsecondary level, policies and procedures to help coordinators manage and prioritize requests, examples of backup plans to accommodate any technical failures, and technical requirements (e.g., bandwidth, hardware, software, etc.).

- **Multiple Audio and Video Input Devices / All-Way Communication**
  In order for remote service providers to provide quality interpreting/captioning, the environment must be equipped with multiple audio and video input devices. Wide angle perspectives provide the remote interpreters with a lot more information than a single, fixed angle camera, and multiple microphones improve audio service significantly. It is also important that the equipment allows all-way communication between the student, teacher, and provider.

- **Service Hubs**
  Coordinators of support services recommended establishing service hubs within each state or region in an effort to share resources, providing smaller schools and those schools located in rural areas, the opportunity to access remote services. These service hubs could also serve as equipment loan centers.

- **Copyrights / Intellectual Property Agreement**
  In an effort to gain the support of faculty members to allow remote access services in their classrooms, Summit participants recommended developing a copyrights/intellectual property agreement. The agreement would outline who has access to the material and how long it can be accessed.

- **Areas of Research and Development**
  Summit participants were in agreement that research studies need to be conducted regarding the effects of a cyberinfrastructure. Recommended research topics included: cost versus benefits; social and literary effects of remote technology; probability that deaf and hard-of-hearing students will utilize and stay current with changing technology; benefits of real-time remote services versus downloading archived materials post class/discussion; and effectiveness of adjusting teaching styles to accommodate deaf and hard-of-hearing students.

- **Measuring Success through Ongoing Evaluation**
  Evaluation is a critical component of any provision of service. A standard evaluation process must be in place every time a service is provided and a more thorough evaluation to measure the overall benefits and challenges associated with the creation of a cyberinfrastructure. These measurements need to be automatically built into the system.

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