Deaf STEM Community Alliance: Establishing a model virtual academic community

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Abstract— This presentation describes the incremental and iterative development of the Deaf STEM Community Alliance's virtual academic community, the Deaf and Hard of Hearing Virtual Academic Community (DHHVAC). The DHHVAC components address three critical barriers to the success of students who are deaf or hard-of-hearing: student preparation, socialization, and access to media.

Index Terms— Deaf and hard-of-hearing; online learning; communities of practice

I. Introduction

The educational needs of students who are deaf or hard of hearing (D/HH) are often overlooked, especially for those students who are preparing for science, technology, engineering, and mathematics (STEM) careers [1]-[2]. Educational marginalization creates a "participation gap" for students who are D/HH because their modes of communication and learning styles are different from their hearing peers [3]-[4].

Hearing loss may be invisible to the general public, but it poses significant barriers for students specializing in STEM fields. Specialists in postsecondary education for students who are D/HH identify several critical barriers for these STEM students including: student preparation, socialization issues and media access [5]- [6]. The Deaf STEM Community Alliance [7] was created to address these issues. The Alliance involves students and professionals from Rochester Institute of Technology/National Technical Institute for the Deaf (RIT/NTID) (Rochester, NY), Camden County College (Blackwood, NJ), and Cornell University (Ithaca, NY). This presentation describes components and activities of the Deaf STEM Community Alliance's virtual academic community, the Deaf and Hard of Hearing Virtual Academic Community (DHHVAC).

Paper presented the RIT Effective Access Technology Conference, June 17-18, 2014, Rochester, NY. This project is supported by a grant from the National Science Foundation, (HRD-1127955).

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Project Rationale

Student preparation

Students who are D/HH receive limited exposure to quality STEM education in elementary and secondary school as their education often emphasizes speech, literacy and language skills but much less attention to STEM [5]-[6]; [8]-[9]. Walter [10] also notes that, D/HH students perform more poorly than their hearing peers on average on standardized assessments for reading comprehension, science, social studies, and math. Weak skills and inadequate exposure contribute to poor preparation for the rigorous demands of STEM education at the postsecondary level. Consequently, postsecondary tutors provide support for skill building and academic success [11]-[13]. Educators of D/HH students and D/HH students themselves often embrace new technologies [14], but there is a paucity of scholarship relating to remote tutoring with D/HH students [15]-[16]. In a recent study at RIT/NTID, one tutor offered students both in-person tutoring and remote (online) tutoring for her writing course. Of her 22 students, 14 participated in tutoring — five in in-person tutoring and nine via remote tutoring. The tutor noted that without the online tutoring option, she would typically have about five of the 22 students receiving in-person tutoring [16]. Bryant's [16] study suggests that students may not always take advantage of

traditional tutoring services, but may be more receptive to tutoring alternatives.

Students who are D/HH have diverse learning and communication needs [17]. In general education, it is common to rely on digital resources for personalized learning opportunities, including digital libraries, remote tutoring, and remote collaboration opportunities [18]. According to Wolf [19], essential elements of personalized learning include: (a) flexible, anytime/everywhere learning; (b) redefinition and expansion of the role of a teacher; and, (c) student-driven learning. The Deaf STEM Community Alliance addresses these issues of personalized learning by providing resources responsive to students' needs.

Socialization

Lack of community and a need for role models are two socialization issues confronting D/HH students in STEM. Similar to other students with disabilities (SWDs), many D/HH students in STEM programs feel rejected and isolated, frequently being the only deaf person in class [20]-[21]. They want to connect with their hearing peers and with other D/HH students in STEM programs throughout the world [22]. Computer-mediated communication connects people separated by time and space who might not otherwise meet. The Internet provides a medium with the potential to build and sustain human relationships over great distances, especially for SWDs [23]-[25].

D/HH students may have difficulty envisioning a STEM career without role models [5]-[6];[9]. Walter [10] found that overall, 17.9 percent of persons who are hearing are employed in STEM occupations versus 15.5 percent of workers who are D/HH and the types of STEM jobs in which persons who are hearing and D/HH are employed differ. Without exposure and significant interaction with D/HH professionals who have successfully completed postsecondary STEM programs and entered STEM professions, students' aspirations will be negatively affected. These role models could serve as excellent mentors.

Accessible media

A common complaint expressed by Foster's [5] and Walter's [6] focus groups was that STEM courses often incorporate uncaptioned media. Uncaptioned videos are inaccessible to D/HH students, and in-class interpreters or captionists find it difficult to interpret or caption quickly enough to capture information presented in the videos [26]-[30]. Furthermore, Lang & Steely [14] suggest that web-based content needs to address such factors as reading ability, student engagement, and visual reinforcement of content to be appropriate for D/HH learners.

Cyberinfrastructures and Communities of Practice

The National Science Foundation (NSF), U.S. Department of Education, and others have made substantial investments to create resources supporting STEM learning. Resources are housed in many different domains, including free-standing software packages, YouTube videos, websites for various projects, and thus not always easy to locate [31]-[33]. Cyberinfrastructures consolidate diverse resources, ensuring the preservation of these resources for the future [31]-[32].

Cyberinfrastructures can impact knowledge and information sharing by creating *communities of practice* (CoPs) [34]-[36]. CoPs have emerged in which groups of individuals unite online to share their knowledge and to generate new understanding within their realm of common interest.

Description of the Project

The DHHVAC is using an engineering-based construct of model building. According to this construct, model building incorporates both iterative and incremental steps to facilitate a functioning prototype [37]. The Deaf STEM Community Alliance is developing an Internet-based cyberinfrastructure/CoP to support postsecondary students who are D/HH. The platform provides activities designed to address barriers to student preparation, socialization, and accessible media that often confront D/HH learners. The goal of the Deaf STEM Community Alliance is to establish a model for a Virtual Academic Community (VAC) to increase graduation rates of D/HH STEM majors in postsecondary education in the long term.

Methods

Participants

Students. Since February, 2012, the project has enrolled 30 students who are STEM majors. Of the 30 students, 26 attend RIT, 3 attend Camden County College, and one attends Cornell University.

Tutors. Fourteen individuals have provided tutoring, including five tutors who are themselves D/HH. Two tutors were graduate students in an RIT-sponsored Master's program in Education of the Deaf, one was an upperclassman at Cornell, and one was a professional civil engineer working as an adjunct for RIT, living out of state. The remaining tutors were RIT/NTID faculty whose primary job was to provide face-to-face tutoring to students.

Mentors. Mentors are all D/HH individuals who are employed in STEM-related fields. Nine mentors have been enrolled in the project, including an accountant, an air quality engineer, an architect, two biologists, a building engineer, a civil engineer, a computer software engineer, and a public health professional.

Staff. Eight staff members participate in the DHHVAC. Six are associated with RIT and one each at Camden and Cornell. Staff include D/HH undergraduate and graduate students as well as faculty and disability service staff. Staff members built the project website, regularly participate in DHHVAC discussions, recruit participants, collect data, prepare reports and conduct presentations.

Materials

Hardware. Everyday activities associated with the DHHVAC use any type of computer or mobile device with Internet access. For remote tutoring and mentoring sessions and intercampus staff meetings, participants use standard desktop or laptop computers and Chromebooks with webcams that are either external to or built into the computer.

Software. Considerations for the appropriate platform included accessibility, administration options, collaboration and variety of features, cost, user interface (UI) ease, operating system (OS) compatibility, and user analytics tools.

The DHHVAC infrastructure includes six main components: email accounts; Google+ Hangouts; Google+ private community; Google+ public community; a YouTube channel; and, a project website: http://www.dhhvac.org. These features work in concert to facilitate DHHVAC activities.

In circumstances where speech-to-text captioning is required, the project uses C-Print® Lite, a web-based version of the C-Print application that has been developed at RIT [38].

Procedures

Recruitment. **Partner schools** at Camden County College and Cornell University were recruited based on information from a needs assessment of colleges and universities around the country that serve D/HH students in STEM majors. Once the project was initiated, **tutors** were the first participants recruited. STEM department chairs identify potential tutors from among the faculty who provide face-to-face tutoring as part of their normal workload. Nominated faculty members receive personal e-mail invitations to participate. **Students** from RIT are nominated by tutors. Each tutor is asked to invite one or two students whom they think would be willing to try on-line tutoring. At partner schools, partner school liaisons in the disability services offices recruit participants. **Mentors** are recruited by recommendation from university administration or through personal contacts. Following their recommendation, mentors complete an application including a background check before they are allowed to join the DHHVAC.

Orientation. During year one, the consent and orientation session for participants was a 60-90 min in-person session that included a project team researcher, the Virtual Academic Community (VAC) Manager, the tutor, and the student(s). Information from these sessions was used to create a step-by-step email protocol for participants at remote sites. The online orientation includes links to six brief videos that are posted on the DHHVAC YouTube channel. The videos are signed in American Sign Language, and are captioned.

DHHVAC Activities. Activities that engage DHHVAC members include remote tutoring, remote mentoring, and social media opportunities.

Results

Model Building

This project is using an incremental and iterative approach to build the virtual academic community [37]. Following an incremental model means that components are developed sequentially,

according to needs of the project. Components have been developed in the following incremental order: public website, synchronous remote tutoring, socialization activities in the private community.

The iterative approach implies continuous improvements in development based on updates or changes in software, feedback from project participants and requirements of the project. For example, the website which is hosted on an RIT server, was created in Drupal 6, and subsequently reworked when Drupal 7 was adopted at RIT. Another example of iterative process is demonstrated by our email system. The project collects data on user activity. Project participants initially received project-specific email accounts with an @gmail domain name, however it was difficult to track user activity. In order to better track user activities, we created a Google educational enterprise account with @dhhvac.org domain that allowed us to achieve our data collection objectives.

Student Preparation

Remote tutoring is the key activity associated with student preparation in the DHHVAC. Tutors and their students participate in both remote synchronous and asynchronous tutoring sessions. Tutoring has been provided in a variety STEM courses including: Biochemistry, Calculus, Circuit Theory, Computer Science, Differential Equations, Endocrinology, Engineering, and Physics.

Synchronous tutoring. Since the start of tutoring activities in February 2012, 109 synchronous remote tutoring sessions have occurred. Tutoring sessions lasted, on average, 61 minutes, the range between 15 - 120 minutes. Tutoring sessions occurred one to three times per week, depending on student needs.

For initial sessions, students used computers in a campus learning center, while the tutors were in their offices. As tutor/tutee pairs became more comfortable with the technology, they ventured to other locations, such as the library, dorm room, or home. The VAC Manager provides technical assistance during the tutoring sessions and through email. Technical assistance required depends on participants' technical expertise and comfort level with the Google applications.

Students and tutors have been solicited for their reactions to synchronous remote tutoring. Students' favorable responses included comments about the permanence of the text, "*The ability to save everything that was said for future reference"* and the convenience of this type of tutoring, *"When I don't have the time or methods to go to see a tutor, it is much easier to do it remotely and only work for a short time."*

Tutors made similar comments regarding the convenience of the program, for example: "*I found it convenient to chat and to use the Google Docs to try and communicate with the video. Also it was great to be able to be able to tutor from home!"* and, "*It makes it easier to meet with students who have a limited time window (esp. since my office it so far from their classes)."*

Asynchronous tutoring. Tutors and students often use asynchronous methods such as email and document sharing when their schedules conflict, or if the students only have a few questions. The project staff considered the use of asynchronous tutoring as an unexpected consequence. A more detailed description of the uses and benefits of asynchronous tutoring can be found in [39].

Socialization

The primary mode of socialization for the DHHVAC is the Google+ Private Community page. This is the platform for sharing information about STEM information, work & scholarship opportunities, etc. Since its launch in late January 2013, the community has logged over 400 posts, nearly 700 comments, and over 1000 "+1s."

Accessibility

Providing accessible information is achieved through several means for the DHHVAC. Within the Google+ private community, video posts are screened to assure that captions are available. Project products such as videos housed on YouTube are typically signed and captioned. The project website includes accessible resources such as STEM-ASL dictionaries and tutorials. The website was designed to be accessible to those with hearing, vision, and mobility challenges.

Discussion and Conclusions

The Deaf STEM Community Alliance has created a virtual academic community using incremental and iterative model building. Components of the community are designed to address critical barriers that confront postsecondary students who are D/HH in STEM fields. To the best of our knowledge, this is a novel activity for postsecondary STEM students who are D/HH.

Preliminary data from the project suggest that participants are embracing the DHHVAC. As the project continues, additional modifications will be made to address the needs of participants. Lessons learned by this CoP will be applied to other CoPs that have their own reasons for uniting in the online world.

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