AccessComputing

Pathways to Success for Students with Invisible Disabilities

Proceedings of an *AccessComputing* Capacity Building Institute at Landmark College

April 8–9, 2013

Supported by National Science Foundation

Pathways to Success for Students with Invisible Disabilities

Proceedings of an *AccessComputing* Capacity Building Institute at Landmark College

Multiple activities to increase the participation of students with disabilities, including veterans, in computing and information technology (IT) postsecondary education and career fields are coordinated by the Alliance for Access to Computing Careers (*AccessComputing*). *AccessComputing* is led by the Department of Computer Science and Engineering and the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington (UW) and is funded by the Computer and Information Science and Education (CISE) program of the National Science Foundation (#CNS-1042260).

This publication shares the proceedings of Pathways to Success for Students with Invisible Disabilities, an *AccessComputing*-sponsored CBI that was held at Landmark College on April 8–9, 2013. The content may be useful for people who

- participated in the CBI.
- are on the local project teams of *AccessComputing* institutional partners.
- want guidance for conducting a CBI at their institution, in their region, or at a national or international forum.
- seek to increase their understanding of issues surrounding the participation of students, including veterans, with invisible disabilities in computing and IT studies and careers.
- are motivated to engage in an electronic community to discuss these issues.

- would like to access resources to help them make their campus courses, services, and activities more welcoming and accessible to students with invisible disabilities.
- have promising practices to share with others.

About *AccessComputing*

AccessComputing works to increase the participation of people with disabilities in computing and IT fields. *AccessComputing* institutional and organizational partners apply evidence-based practices to

- increase the number of students with disabilities successfully pursuing degrees and careers in computing fields.
- increase the capacity of postsecondary computing departments to fully include students with disabilities in computing courses and programs.
- create a nationwide resource to help students with disabilities pursue computing fields.
- help computing educators and employers, professional organizations, and other stakeholders develop more inclusive programs and share effective practices nationwide.

AccessComputing institutional partners are Auburn University, Carnegie Mellon, City University of New York (Queen's College), Clemson University, Gallaudet University, Georgia Institute of Technology, Landmark College, New Mexico State University, North Carolina State University, Portland State University, Rochester Institute of Technology, Southern Illinois University Edwardsville, Towson University, University of Colorado Boulder, University of Maryland Baltimore County, University of Rochester, and Washington State University.

AccessComputing organizational partners are Advancing Robotics Technology for Societal Impact (ARTSI); the Alliance for Students with Disabilities in Science, Technology, Engineering, and Mathematics (*AccessSTEM*); Caribbean Computing Center for Excellence (CCCE); Center for Minorities and People with Disabilities in Information Technology (CMD IT); Commonwealth Alliance for Information Technology Education (CAITE); Computing Alliance of Hispanic Serving Institutions (CAHSI); East Alliance for Students with Disabilities in STEM; Empowering Leadership Alliance (ELA); Georgia Computes; Into the Loop; National Center for Women & Information Technology (NCWIT); National Girls Collaborative Project (NGCP); Reaching the Pinnacle (RTP); STARS Alliance; Virtual Alliance for Deaf and Hard of Hearing in STEM; Expanding Computing Education Pathways (ECEP), and Institute for African American Mentoring in Computing Sciences (iAAMCS).

AccessComputing collaborates with project partners by

- conducting CBIs focused on increasing the participation of students with disabilities in computing and IT academic programs and careers.
- sharing the results of the CBIs with other institutions and individuals who serve students with disabilities.
- providing an electronic forum to continue discussion of issues for students, including veterans, with disabilities and increase services and supports for these students.
- extending resources to other programs and promising practices via an online searchable Knowledge Base.

Contents

About the CBI

The Pathways to Success for Students with Invisible Disabilities CBI took place in Putney, Vermont. Landmark College Institute for Research and Training and *AccessComputing* worked together to organize the event. Its overall purpose was to promote cross-campus collaboration to increase the number of students with learning disabilities, attention deficit hyperactivity disorder (ADHD), and autism spectrum disorders (ASD) successfully pursuing higher degrees and careers in computing fields. Taking place at an *AccessComputing* institutional partner school, attendees included postsecondary faculty, disability service providers, and instructional technology personnel. Featured speakers included *AccessComputing* PI Richard Ladner and Co-PI Sheryl Burgstahler.

Participants in this two-day event included postsecondary faculty, disability service providers, and instructional technology personnel from multiple colleges and universities as well as guest speakers who presented on relevant topics. The CBI provided a forum for discussing recruitment and access challenges, sharing successful practices, developing collaborations, and identifying systemic change initiatives for increasing the participation of students with learning disabilities, ADHD, and ASD in computing fields. There were seven specific goals of this CBI:

- to increase their understanding of the profiles of students with disabilities
- to expand their collective knowledge of best practices for students with invisible disabilities (learning disabilities, ADHD, and/or autism spectrum disorders), including strategies for applying universal design (UD) principles to instruction
- to form collaborations with each other to address common access challenges and share successful practices
- to coordinate their efforts to develop strategies for increasing the success of students with invisible disabilities and the capacity of their institutions to serve these students

- to learn about Landmark College's comprehensive approach to addressing the access needs of students with invisible disabilities
- to discuss evidence-based practices to increase the numbers of students with invisible disabilities moving through critical junctures during their undergraduate tenure to successfully pursue higher degrees and careers in computing fields
- to create a strategic plan or task list(s) that incorporates the best practices to improve accessibility options at attendees' own campuses

Speakers and panelists were also CBI participants. Many had disabilities and/or were practitioners with direct experience in serving students with disabilities. Broad issues that were discussed included

- universal design of instruction (UDI);
- the future of accessibility;
- assistive technology and accessible web design; and
- best practices for students with learning disabilities, ADHD, and/or ASD.

In this CBI

- all participants contributed to its success;
- experts in all topic areas were in the audience; and
- although some predetermined professional development was presented, new content was delivered as the meeting unfolded and participant interests were expressed and expertise was made known.

The CBI was comprised of individual presentations and group discussion. Individual presentations included information about universal design, profiles of invisible disabilities, accessibility, and assistive technology. The group discussion offered participants an opportunity to disability support services, faculty, and information technology personnel can work together to support students with invisible disabilities.

The agenda for the CBI and summaries of the presentations are provided on the following pages.

CBI Agenda

Monday, April 8

8:30 – 9:00 a.m.	**Registration**
9:00 – 10:00 a.m.	**Welcome**: Manju Banerjee
10:00 – 11:00 a.m.	**Keynote Speaker**: Sheryl Burgstahler Universal Design in Education
11:00 – 11:15 a.m.	**Break**
11:15 a.m. – 12:00 p.m.	**Overview of Profiles of Invisible Disabilities**: Manju Banerjee, Linda Hecker, Ibrahim Dahlstrom-Hakki, and Sapna Prasad Current Trends in Invisible Disabilities
12:00 – 12:30 p.m.	**Landmark College Student Panel**
12:30 – 1:30 p.m.	**Working Lunch** Small group discussions with Landmark College students
1:40 – 3:15 p.m.	**Working Group Report and Discussions**

3:30 – 4:15 p.m.	**Landmark College Faculty Panel** Best Practices: Self-Advocacy Michelle Bower, Geoff Burgess, Frank Kluken, Anita Long, and Melissa Wetherby
4:15 – 4:30 p.m.	**Day 1 Closing Remarks, Preview of Tomorrow's Topics, Evaluation**

Tuesday, April 9

8:30 – 9:00 a.m.	**Registration**
9:00 – 10:00 a.m.	**Keynote Speaker**: Richard Ladner Accessibility: Past, Present, and Future
10:00 – 10:15 a.m.	**Break**
10:15 – 11:15 a.m.	**Assistive Technology and Accessible Technology Design** Sheryl Burgstahler and Richard Ladner
11:15 a.m. – 12:30 p.m.	**Working Group Discussion**
12:30 – 2:00 p.m.	**Working Lunch and Group Reports**
2:00 – 2:15 p.m.	**Break**
2:15 – 3:45 p.m.	**Landmark College Support Services Panel** Best Practices: Advising and Coaching Services Kathy D'Alessio, Sandy Bower, Ruth Wilmot, Julie Oscherson, and Michael Luciani
3:45 – 4:30 p.m.	**Call to Action, Day 2 Closing Remarks, Evaluation** Partnership opportunities and overview of minigrant projects

Presentation Summaries

Welcome

Presenter: Manju Banerjee

Technology is a staple of college life and the Internet is an education gateway. Many students today are learning online. The Education Growth Advisors (2013) describe an Iron Triangle of cost, quality, and access that affect student learning. These are things that need to be taken into account given the diverse ways that students in higher education learn. Adaptive learning, through one-on-one instruction, differentiated instruction, or student centered learning, can be one way to provide personalized instruction to a diverse set of learners. According to the Education Growth Advisors (2013),

> …a more personalized, technology-enabled, and data-driven approach to learning… has the potential to deepen student engagement with learning materials, customize students' pathways through curriculum, and permit instructors to use class time in more focused and productive ways.

Dr. Nish Sonwalkar, of Synaptic Global Learning, has developed a brain-based adaptive learning platform based on educational and technological research. Adaptive learning is achieved by real-time analysis of learner behavior and shuffling the content in order to match learning preferences. The result is the highest degree of completion and satisfaction of learners in an online adaptive learning platform at an affordable price.

Landmark College takes an adaptive learning approach that is integrated and holistic, focusing on core skills and the life span of the student. Beyond that, the Landmark College Institute for Research and Training conducts discovery and applied research, a professional development for educators, and a graduate level professional certificate in Universal Design and Technology.

Universal Design in Education

Presenter: Sheryl Burgstahler

The extent to which people with disabilities have had access to higher education has evolved from one of exclusion to one focused on functional limitations and, more recently, to one born out of social justice. Focusing on the functional limitations of people with disabilities leads to trying to accommodate individual students with disabilities. A social justice mindset, meanwhile, focuses on the role of universal design to create an environment accessible to as many people as possible, thus minimizing the need for accommodations.

These are two very distinct ways to create access. Relying only on accommodations as a strategy for creating access means that for each individual with a disability, an alternative service, format, and/or adjustment must be made for that individual every time that they encounter a barrier. UD, meanwhile, calls for "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (The Center for Universal Design, *ncsu.edu/ncsu/design/cud*). Accommodations are reactive whereas UD is proactive. Universal design benefits people who face challenges related to ability, but also socioeconomic status, race, culture, gender, age, veteran status, language, and other challenges. Whereas a set of stairs is inaccessible to someone using a wheelchair, a temporary ramp serves as an accommodation for wheelchair users and an entry that is level with the sidewalk or gradually sloped is universally designed. Likewise, whereas an uncaptioned video is inaccessible to an individual who is deaf, a sign language interpreter or transcript of the video could be used as an accommodation. The availability of captioning on the video is a universal design feature, benefiting people who are deaf or hard of hearing, English language learners, individuals in noisy settings, and others.

In a higher education environment, UD principles can be applied to physical spaces, technology, student services, and instruction. Physical spaces should be designed so that everyone can get to facilities and maneuver within them. Take into account the overall design of the physical space (e.g., aesthetics, routes of travel) and to all subcomponents of the space (e.g., signage; restrooms; and sound, fire, and security systems) and include people with disabilities in the design process. In terms of technology, students who need assistive technology should be able to access it, and electronic resources should be available online in a variety of accessible formats. In order to be universally designed, student services should

- have policies and procedures that ensure access to facilities, printed materials, computers, and electronic resources for people with disabilities,
- include pictures of people with disabilities in publications and websites,
- post ample, high-contrast, large-print directional signs to and throughout the office,
- ensure service counters are accessible from a seated position and that aisles are wide and uncluttered, and
- train staff about how to arrange accommodations.

Universal design of learning (UDL) ensures that curriculum and courses utilize multiple means of representation, expression, and engagement. UD can be applied in the context of overall design of instruction, to specific activities such as a lecture or a role-playing exercise, and in the choice of content, such as including information on UD and accessibility in a course on web design. It is important for

the instructor to consider class climate, interaction, the physical environment, products, delivery methods, information resources, technology, feedback, assessment, and accommodation. The publication *Equal Access: Universal Design of Instruction (UDI)*, available online at *uw.edu/doit/Brochures/Academics/equal_access_udi.html*, contains a checklist—validated at more than 20 postsecondary institutions—that can help educators to apply UD to their courses. You can use the checklist to determine what aspects of UD you already employ and to create a timeline for implementing other practices.

Examples of UDI practices include

- arranging seating so that everyone has a clear line of sight,
- welcoming students by name,
- avoiding stigmatizing a student by drawing undue attention to a difference,
- using large, bold fonts with high contrast on uncluttered overhead displays and speaking aloud all content,
- providing multiple ways to gain and demonstrate knowledge and using multiple senses,
- avoiding unnecessary jargon and defining terms,
- providing scaffolding tools (e.g., an outline),
- selecting materials early,
- providing materials in accessible formats,
- providing corrective opportunities,
- testing in same manner in which you teach,
- minimizing time constraints as appropriate, and
- knowing how to arrange for accommodations.

Ultimately, UD of instruction minimizes the need for individual accommodations, can be implemented incrementally, does not lower academic standards, and values diversity, equity, and inclusion.

For more information about UD in higher education, refer to the book *Universal Design in Higher Education: From Principles to Practice*, published by Harvard Education Press and including the work of 42 authors. Also visit the Center for Universal Design in Education website at *uw.edu/doit/CUDE*.

Overview of Profiles of Invisible Disabilities

Presenters: Manju Banerjee, Linda Hecker, Ibrahim Dahlstrom-Hakki, and Sapna Prasad

A learning disability is a significant difficulty in the acquisition and use of listening skills, speaking, reading, writing, writing, reasoning, or math abilities despite average to above average intellectual abilities. It is presumed that learning disabilities occur due to nervous system functioning. They are not due to sensory impairment, mental retardation, psychiatric disabilities, cultural and instructional deprivation or cultural differences.

The DSM 5 (Diagnostic and Statistical Manual of Mental Disorders) will have a diagnosis of "Specific Learning Disorder" which will replace dyslexia, written expression disorder, and dyscalculia based on specific characteristics of an individual's reading, writing, and math that negatively impacts their academic achievement, work, or daily living.

There are many misconceptions about dyslexia, including that letters are seen reversed, that it's related to IQ, that it is uncommon, that it can be outgrown or cured, and that it is rare in females. S. Shaywitz

(2003) referred to dyslexia as an "unexpected weakness in a sea of strengths." Phonological processing difficulties on single words or rapid naming tasks can lead to difficulty reading, spelling, and writing. Both eye-tracking data and brain scans show evidence that eye movement and brain activity are different in individuals with dyslexia. Dysgraphia, also a language-based disability, affects an individual's ability to write. Individuals with language-based issues may

- avoid reading, writing, speaking; need extra time to read of write; or be easily fatigued and frustrated;
- have trouble following directions;
- have difficulty learning new words or organizing thoughts in speaking and/or writing;
- misuse in words when writing or speaking;
- produce written work that is sparse and filled with mechanical and spelling errors or that doesn't seem to reflect the caliber of thinking shown in class;
- need extra time to read or write; and
- have significant trouble learning second languages.

People are widely aware of Attention Deficit Hyperactivity Disorder (ADHD) and associate it with the stereotype of a hyperactive individual. Many falsely believe that you can outgrow ADHD and that it can be cured with medication. In reality, a multi-dimensional approach is more effective. "ADHD disrupts the development of inhibition and other self-directed executive functions producing a disorder of self-regulation across time and so interfering with the capacity to choose, enact and sustain actions towards goals" (Barkley 2011). ADHD typically manifests early in life. Core symptoms include inattention, impulsivity, and hyperactivity. It may affect executive functions such as planning, management, working memory, self-monitoring, inhibition, and metacognition. In students this may be seen to affect

- organizing, prioritizing, and activating to work;
- focusing, sustaining, and shifting attention to task;
- regulating, alertness, sustaining effort, and processing speed;
- managing frustration and modulating emotions;
- utilizing working memory and accessing recall; and/or
- monitoring and self-regulating action.

Dyscalculia refers to difficulty understanding, translating, and performing basic math functions with accuracy such as estimating; comparing quantities; retrieving numerical facts; understanding numerical symbols or math concepts and procedures; and using basic arithmetic. Other factors that may affect math performance include poor language and reading skills; poor visual-spatial skills; attention difficulties; weak executive function coordination; weak working memory; and weak long-term memory.

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that starts in childhood. In the DSM 5, Asperger's, PDD-NOS (Pervasive developmental disorder not otherwise specified), and high-functioning autism will all be folded into the ASD diagnosis. No two individuals with ASD present exactly the same characteristics. ASD is characterized by fixed interests, repetitive behaviors, and deficits in self-regulating emotions, planning ahead, social-emotional reciprocity, and nonverbal communicative behaviors.

Accessibility: Past, Present, and Future

Presenter: Richard Ladner

People with disabilities can do almost anything in almost any scientific field. Technology is often a key factor in their success. Individuals with disabilities are underrepresented in the workforce, especially the STEM workforce. Although 16% of the US population between the ages of 15 and 64 has a disability, 10% of individuals in the workforce have a disability, and 5% of individuals in the STEM workforce have a disability, only 1% of STEM PhD holders have a disability. Students with disabilities are also less likely to complete a bachelor's degree than students without disabilities.

Over time, accessible technology has led to innovations to assist people with disabilities. At times, these innovations lead to solutions for all users. Optical character recognition (OCR) was first invented in the 1970's to allow blind people to access print books. Now there are OCR applications for smartphones and Bookshare has more than 200,000 accessible books on-line, almost all that have been scanned from print copies using OCR. More than 30 million books are now available and searchable in Google books thanks to OCR. Similar patterns can be seen elsewhere as well. The telephone, now a mainstream device, was first invented by Alexander Graham Bell as a byproduct of his attempt to build a device that provided a visual representation of sound vibrations to aid deaf children learning to talk. In the 1960s Text telephones (TTY) were devised to allow deaf individuals to use telephones. This early technology has been supplanted by SMS (short message service) texting, which is now a mainstream technology. Likewise, speech recognition was originally devised to allow for hands-free access by people with little use of their hands. The videophone, a version of which was introduced by AT&T at the 1964 World's Fair excited the signing deaf community. In the past 10 years thse products have become mainstream.

Other technology used by people with disabilities includes screen readers used by individuals with print disabilities. Screen readers read aloud text that is displayed on the screen and use the keyboard to navigate. Their functionality, however, is limited by how accessible particular documents and webpages are. For example, in order to be accessible via a screen reader, images must have alternative text descriptions. In addition to specialized software like screen readers, many devices today have built-in accessibility features such as Windows 7's Magnifier and iPhone's VoiceOver technology.

There is significant research being conducted today in order to make computing more accessible. Researchers interact at mainstream computing conferences, as well as conferences specifically related to human computer interaction or accessibility. Examples of recent research projects include

- VoiceDraw, which allows a user to draw using vowel sounds and speech
- WebAnywhere, a web-based screenreader that does not require users to download special software
- Supple, a system to automatically customize user interfaces for people with low-vision and/or mobility disabilities
- ASL-STEM Forum, a web portal for people to document and discuss sign language for terms specific to STEM fields
- Slide Rule, a precursor to VoiceOver that demonstrated that touch screens can be made accessible
- GoBraille, an accessible smartphone-based tool to help blind people using public transit
- VizWiz, which allows blind users to take a picture and ask a visual question such as "what does this street sign say?" Crowdsourcing is then used to generate an answer

Individuals with invisible disabilities may benefit from accessible technology as well. Some individuals with invisible disabilities use speech recognition for text input or use a screen reader or magnification for reading. Research is being done in this area by the Center for Defining and Treating Specific Learning Disabilities in Written Language and the Center for Game Science at the UW as well as the Mind Research Institute in Irvine, CA.

Several aspects of human-computer interaction (HCI) can be used to empower users with disabilities including

- user-centered design—to involve the user at every step and to use feedback to influence future designs
- universal design—to design for the maximum number of users rather than just the average user
- ability-based design—to design for varying abilities by incorporating customizable features in the design itself
- design for user empowerment—to design to enable people to solve their own accessibility problems, whenever possible

User empowerment can be particularly important because it allows smartphones to become accessibility tools, users to interact to accomplish an accessibility goal, or allows people with disabilities to use their knowledge and education in computer science or other fields to solve accessibility problems.

Case studies of individuals with disabilities and accessibility highlight the importance of these technologies.

- Anandya is both deaf and blind. He uses a Braille device wirelessly tethered to his iPhone to access standard applications that are accessible because of VoiceOver. He often travels by himself on public transit, including airplanes.
- A high school student who is deaf, has low-vision, and has a mobility disability took part in a workshop at the University of Washington that used Scratch, a graphically based programming environment designed for youth. With magnification, an enlarged keyboard, and a joystick she could navigate the Scratch interface. Unfortunately, she was unable to master the nonstandard select and drag mechanism in Scratch because of the level of fine motor control that was required. Scratch was not designed for people with mobility-related disabilities in mind.
- Nicole, who now works at Google, is blind. As a high school student, she learned to program in her AP computer science class. She had difficulty in her math classes because her teachers did not understand the Nemeth Braille code she used for math. An aide translated her solutions to written math for the teachers. At a workshop at the University of Washington she learned about LaTex, a commonly used markup language for math, that when processed and printed yields beautiful looking equations. She came up with the idea of writing a computer program to translate Nemeth to LaTex using her knowledge of programming and her newfound knowledge of LaTex. She was successful and used it in her math classes. In the end, her solutions were the most beautiful in the class. She was able to solve her (rather, her teacher's) accessibility problem on her own. This is the highest level of user empowerment.

Assistive Technology and Accessible Technology Design

Presenters: Sheryl Burgstahler and Richard Ladner

It is important for individuals with disabilities to have access to information technology (IT) because it changes the way we live, work, learn, communicate, and play. Technology can increase an individual's independence, productivity, and participation in education, careers, family life, community, and recreation. Beyond that, IT drives advances in other fields and powers the economy. Data from the Bureau of Labor Statistics (*bls.gov/opub/mlr/2009/11/art5full.pdf*) predicts that computer specialists alone will account for over 57% of the growth in science and engineering occupations between 2008 and 2018. If individuals with disabilities can't access technology, they won't have access to these jobs.

Assistive technology (AT) is software or hardware that helps individuals gain access to IT. In the past thirty years, as there has been an explosion in computing technology, there has also been a significant increase in the AT that is available. Examples of AT include

mobility
- mouse/pointer alternatives such as keyboard commands, headpointers, touchpads, trackballs, joysticks, foot-operated mice
- keyboard alternatives such as on-screen keyboards, mini keyboards, expanded keyboards, one-handed keyboards, ergonomic keyboards, software tools such as sticky keys

low vision
- large monitor
- enlarged keyboard labels
- screen and text enlargement
- video magnifiers
- large print documents

no vision
- scanner, OCR, and speech output
- Refreshable Braille and embossed displays

learning disabilities
- scanner, OCR, speech output
- Word prediction or abbreviation expansion software
- flexible, multi-feature software that can be used with Microsoft Word and other software such as the Read & Write GOLD toolbar with a collection of literary support tools including OCR, scanning, speech output, and voice recognition
- large print, highlighting, color options
- speech input
- idea organizers
- spelling or grammar checkers
- smart pens with OCR and speech output, including those that record lectures linked to specific notes (LiveScribe)
- talking calculators
- Post-It notes, highlighter pens, and other low-tech tools
- large-print documents on colored paper

Many current operating systems have built-in accessibility features. Macintosh OS X and/or Windows 7 have features including sticky keys, mouse keys, keyboard and mouse customizations or shortcuts, visual notifications for audio alerts, variable colors and contrast, screen or text enlargement, speech output, and speech recognition. iOS has features include speech output; speech input; screen or text enlargement; variable colors and contrast; audible, visible, and vibrating alerts; assignable ringtones; and Bluetooth connectivity for keyboards, refreshable Braille displays or other devices.

The Americans with Disabilities Act (along with its amendments of 2008) and the Rehabilitation Act are generally interpreted to mean that colleges must develop and use accessible IT. Universities need to be sure that their websites and other resources are accessible. At the University of Washington, an Accessible IT Task Force is responsible for enhancing online resources, promoting accessible IT, and exploring policies and processes. Universally designed websites are perceivable, operable, understandable, and robust (World Wide Web Consortium Web Content Accessibility Guidelines 2.0). Universally designed IT benefits a variety of people including those who

- are unable to hear the audio, see the screen, and/or use a mouse;
- are limited in English skills or do not speak English;
- are in a noisy/noiseless location;
- have slow Internet connections; or
- need to find content quickly.

Accessible websites use standard HTML, alternative text for images, simple backgrounds, high contrast color schemes, descriptive link text, and avoid reliance on mouse-only input. Test a webpage for accessibility by turning off the graphics and sound, using only the keyboard, or using accessibility checking tools such as SiteImprove. Learn more about accessible web design through the Web Design and Development Course Curriculum available online at: uw.edu/accesscomputing/webd2. The course teaches standards-based, accessible web design where accessible design is taught early as a core design principle and reinforced throughout the course. Students must use valid code on assignments and conform to accessibility standards.

Universally designed videos

- address multiple audiences in their design;
- film with captions in mind;
- have large, clear, searchable captions;
- are designed so that key content is spoken as well as visually presented;
- clearly organize content; and
- have an audio-described version available.

Find universally designed videos at uw.edu/doit/video.

There are many conferences that focus on technology for people with disabilities:

- Closing the Gap Conference, October, Minneapolis, MN
- California State University Conference on Technology for People with Disabilities, March, San Diego, CA
- Accessing Higher Ground, November, Colorado

With accessible IT, students with disabilities can independently complete homework in a way that works for them, access webpages and videos, use a telephone, engage in conversations, and go online to do research, bank, shop, or take classes. Regardless, there are still many ways that AT can be improved in the future, including voice recognition in more languages, more accurate automatic captioning for videos, better customer support, and lower cost options. We need to ensure that developers are aware of the need for AT and universally designed IT.

Panel Presentation Summaries

Landmark College Student Panel

Landmark College students with invisible disabilities participated in a panel discussion at the CBI. The students offered the audience comments and suggestions:

- College exams do not match up well with what students will be expected to do in "the real world" after graduation. It may be better to assign project-based assessments that more closely resemble real world applications of the knowledge that students have learned.
- All faculty members, including adjunct faculty and lecturers, should participate in training to learn more about how to work with students with disabilities and about support services. Universal design of instruction and accessibility should be treated as important campus-wide issues rather than as a disability services issue.
- Faculty members are most likely to engage with their peers. Colleges and departments should consider having faculty liaisons that can help ensure that faculty members are knowledgeable about disability issues.
- Consider setting up a system to review classes to ensure that they are accessible to students with disabilities, including those with invisible disabilities.

Landmark College Faculty Panel

Michelle Bower, Geoff Burgess, Frank Kluken, Anita Long, and Melissa Wetherby

Landmark College faculty members have a unique perspective on teaching studies with invisible disabilities since all of the students in their classes fall into this group. During a panel discussion, faculty members discussed many strategies for teaching students with invisible disabilities, including the following:

- When students are completing work in class, allow them to choose whether to complete the work on their own or in a group. One or the other may work better for particular students.
- Consider using PowerPoint during class and providing students with a copy of the slides before class. Students can take notes on printed copies of the slides.
- Small, individual white boards can be useful for in-class work, whether students are working alone or in groups. When the work is complete, students can take pictures of the white board to use as notes.
- Give students the option of using different size papers.
- Consider accepting multiple stages of writing for some students to give them feedback throughout their work on the assignment. Some Landmark instructors review small parts of writing assignments and allow students to build on them.
- Be sure to talk through any math that you are doing on the board. This allows students to access the visual information while also receiving the information audibly.
- Allow students to use calculators. A student can demonstrate that they have learned what steps need to be followed.

During the discussion, faculty members also highlighted technology that can be helpful for teaching students with invisible disabilities:

- LanSchool (*lanschool.com*), which allows the image from any computer in the classroom to be displayed on a monitor.
- Microsoft OneNote (*office.microsoft.com/en-us/onenote*) can help students take notes or can allow you to create a notebook that students can access.
- Cloud storage through your school, SkyDrive (*skydrive.live.com*), or Google Drive (*drive.google.com*) can be used to share PowerPoint slides, OneNote notebooks, or other documents with students quickly and easily.
- Equation Editor is an easy way to write equations in Microsoft Word.
- Livescribe pens (*livescribe.com*) are smart pens that create an audio recording while a student writes notes. Students can go to a specific point in the recording by touching the pen to their notes. These can be useful for anyone, not just students with learning disabilities.
- Dragon Naturally Speaking (*nuance.com/dragon*) is speech recognition software that allows students to type by talking to the computer.
- Inspiration (*inspiration.com*) is mind-mapping software that allows students to brainstorm and organize concepts.
- Tinkerplots (*keycurriculum.com/products/tinkerplots*) statistical software can be used for data analysis and modeling.

Working Group Discussion Summaries

During the working group discussions, participants discussed ways in which disability support services, faculty, and IT personnel can work together to support students with invisible disabilities.

Working Group Discussion 1

During one working group discussion, a variety of topics were reviewed related to supporting students with invisible disabilities in computing fields. Working groups were provided with the following discussion questions:

1. What steps can your department take or are currently taking to embrace the UDI paradigm?
2. How can disability support staff, counselors, educators, and IT personnel work together to support students with disabilities to create a UDI-friendly environment?
3. What procedures/protocol does your institution use to facilitate communication and collaboration between different groups such as disability service providers, IT personnel, and educators to stay informed about cognitive disability needs on your campus?
4. What are your ideas about specific steps that you could take to engage students with cognitive disabilities and to promote self-advocacy?
5. For students: Why computer science and gaming? What are the barriers in the computing fields for students who learn differently? Student recommendations for faculty and service providers?

Discussions highlighted many ideas that stakeholders should take into account, including the following:

- The importance of self-awareness and emotional intelligence among faculty, parents, students, and administrators. These traits mean that stakeholders are empathetic to students, more willing to try new tactics, and create a better learning environment.

- Students can be reluctant to accept their diagnose and to disclose it with educators. This form of self-advocacy is important for students' success.
- Training related to socialization skills is critical for student success. Students need to accept responsibility for what they can control.
- Hands-on-learning is a great way to help students understand social pragmatics and develop academic skills. It can be more effective than video or graphic stories.
- Showing applications of math principles can help students learn the principles.
- It is important for faculty to learn from students' experiences to understand how to best work with students with invisible disabilities. In addition to understanding, faculty should be empathetic.
- Peer mentors, especially those who have received some training, can be invaluable in helping younger students develop skills and strategies that will help them to be successful in postsecondary education.
- Parents may be embarrassed or reluctant to admit that their child has a problem. This can be a barrier to students' getting the support that they need in order to be successful.
- There are systemic barriers to success for students with invisible disabilities. Teaching to standardized tests takes away time from pragmatic education. There are not enough resources to allow for differentiated instruction for students with invisible disabilities because teachers must teach to the average.

During this discussion, students with invisible disabilities highlighted a few issues that they thought were important for educators to understand:

- There is pressure for students to be sure that they have the right preparation, to get into the right college, and to finish college on time. Using opportunities in high school and college for career exploration, including counseling and internships, can help students decide what the right path is. Some students may find that they are more successful if they spend time at a community college or take some time off to regroup after graduating high school before starting college.
- There are ways for faculty to help develop important social skills. For example, before a student takes an internship with an outside organization, consider having them complete an internship in your department where they can learn about time management, the importance of being on time, and other work-based skills.

Working Group Discussion 2: Case Studies

During this working group discussion, groups focused on two case studies to focus discuss on real world experiences that students with invisible disabilities may encounter.

Case Study 1:

My name is Stacey. I am a freshman in college with a major in computer science. I have a language-based learning disability that makes it difficult for me to understand and organize large amounts of written and textual information. Reading and writing were my most challenging academic areas in high school. I use text-to-speech software for course texts and I am worried that I will not be able to access the course material and keep up with the reading assignments in my computing courses.

- What can I do as an educator/IT person/disability support person to provide equal access to Stacey?
- What can we do together to help Stacey?

Participants discussed a variety of strategies that might help Stacey be successful:

- Ask Stacey more about her experiences with reading and writing, including strategies that worked for her when she was in high school. Help her develop ways to apply these strategies in her new environment.
- Stacey should learn about resources and tools that can help her access reading or course materials in accessible formats. This might include Bookshare.org, an online library for people with print disabilities; DAISY (*daisy.org*), the Digital Accessible Information SYstem; Learning Ally (*learningally.org/*), a collection of audio textbooks; or Apple online course textbook tools (*apple.com/education/ibooks-textbooks*).
- Stacey should make an effort to get her course texts early to ensure that she can locate them in an accessible format. Educate faculty to ensure that they are selecting course texts that are available in accessible formats.
- Faculty need to provide more "live feedback on student performance."
- Each syllabus should have a disability statement on it.
- Peer grading can help to redesign assessments in a way that may be more accessible to students who have difficulties with reading and writing.
- Encourage faculty to set up alarms using Moodle (*moodle.org*) or another learning management system, if students don't log in to the class website.
- Stacey should be encouraged to contact disability services office, if she hasn't already.
- Solicit tips from previous students with invisible disabilities about how to do well in the class to share with incoming students like Stacey.

Case Study 2:

I'm Brad, and I am a freshman with an autism spectrum disorder. I am in a web design and gaming program at a large university. I score well on exams and always attend class on time, but I can't understand what else my instructors expect from me. I am eager to learn, but I don't like working in groups and my instructors tell me that I interrupt their classes with too many questions and comments. I often feel left out. I have disclosed my disability. How can I work with my instructors and classmates to make this course more enjoyable?

- What can I do as an educator/IT person/disability service provider to provide equal access to Brad?
- What can we do together to help Brad?

Participants discussed a variety of strategies that might help to ensure that Brad is successful:

- Encourage faculty to offer students multiple ways of expressing knowledge and commenting on lecture material including: tweeting comments to lectures, rotating which students are responsible for responding to questions, or limiting students to asking three questions per class session before asking them to come to office hours.

- It appears that communication is a problem for Brad. He should be encouraged to go to a leader when he encounters trouble. This might include a faculty member, the disability services office, or another person on campus. Students need to know that it's okay to ask for help.
- Although computer science might be more tolerant of employees who struggle with social skills, these are important skills to help students develop. Many companies would expect interns to be able to work in a group, for example. Group work in classes helps students develop an understanding of the process of group work as well as the product that results at the end.

Working Group Discussion 3

Group members were each asked to identify a complex student or faculty-related situation regarding providing equal access to students with disabilities and discuss possible strategies for the situation they chose. Groups were provided with the following sample situations:

- faculty members reluctant to address invisible disabilities
- buildings or offices inaccessible to individuals using wheelchairs
- a new student on campus is deaf and uses a wheelchair. A faculty member has trouble arranging the classroom and discovers that the new interpreters have interpreted other students' side conversations
- a faculty member suspects that a student has an invisible disability, but the student has not disclosed that diagnosis to the faculty member
- making sure that a product designed by a small team takes into consideration the tenets of universal design

One group chose to discuss faculty members who are reluctant to address or stubborn about addressing invisible disabilities. They identified multiple challenges, including faculty members' limited time, energy, and expertise; resistance to change; and insecurity. The group also felt some institutions may lack a clear policy about how to deal with faculty members who have a negative attitude about invisible disabilities even if they provide students with the required accommodations.

Group members recommended the following:

- Provide faculty members with professional development training to educate them about issues that students with disabilities face. This training might be a set of online training modules, completed at a faculty member's convenience, that both address particular disabilities and specific strategies and ideas for accommodating those disabilities. The training should emphasize that although a strategy might not work for every student with a particular disability, the strategies discussed will be successful the majority of the time.
- Provide faculty members with clear tip sheets about invisible disabilities such as the single-sheet, double-sided tip sheet developed by Lone Star College.
- Develop a clear policy about students audio- or video-recording classes, requiring that such recordings be used solely for personal study.
- Recommend or require professors to record every class and provide full lecture notes to all students.

CBI Participants

Stakeholder groups represented in the CBI included

- student services leaders and administrators,
- faculty members,
- technology specialists, and
- individuals with disabilities.

Manju Banerjee
Landmark College Institute of Research and Training

Michelle Bower
Landmark College

Sandy Bower
Landmark College

Loring C. Brinckerhoff
Educational Testing Service (ETS)

Geoff Burgess
Landmark College

Sheryl Burgstahler
University of Washington

Winston Chen
Voice Dream Reader App developer

Karen Clark
Community College of Vermont

Caleb Clark
Marlborough College Graduate School

Kathy D'Alessio
Landmark College

Ibrahim Dahlstrom-Hakki
Landmark College Institute of Research and Training

Kelly Emrich
Pathfinder RVHTS

Aaron Ferguson
Worcester Polytechnic Institute

Holly Hayes
Landmark College, Board Member

Linda Hecker
Landmark College Institute of Research and Training

Lori Jabar
Londonderry High School

Chaundra Jesenski
Fair Haven Union High School

Frank Kluken
Landmark College

Richard Ladner
University of Washington

David Lindenberg
Southern Vermont College

Anita Long
Landmark College

Michael Luciani
Landmark College

Trudy Mandeville
TCP Learning

Roxanne McCarty
Paul Smith's College Arts Science

Kurt Mueller
University of Massachusetts, Boston

Lorraine Norwich
Boston University

Julie Oscherson
Landmark College

Sandi L. Patton
Lone Star College - University Park

Janelle Pease
Long Trail School

Sapna Prasad
Landmark College Institute of Research and Training

Rich Simmons
Johnson State College

Joseph Stallsmith
Dresden

Patrick Sullivan
Trocaire College

Melissa Wetherby
Landmark College

Ruth Wilmot
Landmark College

Communities of Practice

Among the strategies for meeting *AccessComputing* objectives are Communities of Practice (CoPs) for stakeholder groups. Communicating using email and other electronic tools, CoPs share perspectives and expertise and identify practices that promote the participation of people with disabilities in computing fields. The CoPs are described below. Members in all CoPs

- gain and share knowledge and help identify issues related to the under-representation of people with disabilities in computing fields;
- help identify, field test, and validate Computing Department Accessibility Indicators to make computing departments more accessible to students with disabilities;
- help plan, attend, and recruit others to attend *AccessComputing* Alliance activities;
- recruit students, including veterans, with disabilities into *AccessComputing* Alliance e-mentoring, internships, academies, and workshops;
- co-sponsor events and discuss potential new projects and funding possibilities;
- disseminate information about their projects and results through the Knowledge Base; and
- help *AccessComputing* Alliance staff target articles to publications.

1. Computing Faculty, Administrator, and Employer CoP helps computing faculty and administrators, as well as representatives from industry and professional organizations, increase their knowledge about disabilities and make changes in computing departments that lead to more inclusive practices. Participants

    - introduce Alliance staff to administrators of professional computing organizations so that staff can help these organizations make their websites accessible, their conferences accessible to attendees with disabilities, and their conference programs inclusive of disability-related topics;

- identify campus computing events to which students with disabilities might be invited;
- discuss how to include accessibility topics in postsecondary computing curriculum;
- discuss issues and help locate PhD graduates with disabilities to recruit as faculty;
- provide connections with computing faculty and industry for internships; and
- help Alliance staff target articles to computing publications.

2. Broadening Participation CoP is populated with Alliance collaborators who administer alliances and projects that serve to broaden participation in computing fields. Members

    - discuss how to recruit participants with disabilities and accommodate them in their programs and activities and how to, overall, make their offerings more accessible

3. Disability Services CoP of disability service professionals from community/technical colleges, four-year colleges, and universities nationwide, together with their networks of postsecondary and K–12 schools (e.g., affiliates of AHEAD) and parent groups (e.g., affiliates of PACER). Members of this CoP

    - deliver presentations to computing faculty to share information about accommodations and campus services for students with disabilities;
    - work with computing professors and administrators to invite students with disabilities to career fairs, computing lectures, and other events; work with groups to make sure activities are accessible; and help bring speakers with disabilities and exhibits that focus on disability-related topics; and
    - develop transition and bridge workshops in computing and/or help other Community of Practice members develop such activities.

4. Veterans CoP is populated by veterans with disabilities, service providers, and volunteer mentors. Members

    - interact regularly to improve service to veterans with disabilities and their families;
    - discuss how to recruit veterans with disabilities and accommodate them in their programs and activities;
    - devise solutions that increase the accessibility of their program offerings;
    - develop internships, academies, and workshops to complement their program activities;
    - identify, recruit, and accommodate eligible *AccessComputing* participants;
    - co-sponsor events, discuss potential projects, and share funding possibilities;
    - share common concerns in their practices;
    - identify problems, goals, and resources;
    - form collaborations.

You and your colleagues can join *AccessComputing* CoPs by indicating which of the CoPs you would like to join and sending the following information to *accesscomp@uw.edu*:

- name
- position/Title
- institution
- postal address
- email address

AccessComputing Website and Searchable Knowledge Base

The *AccessComputing* website (*www.uw.edu/accesscomputing/*) contains

- information about project goals,
- the application of evidence-based practices toward project deliverables,
- resources for students with disabilities,
- educational materials for postsecondary faculty and staff,
- information about partners and collaborators, and
- program applications.

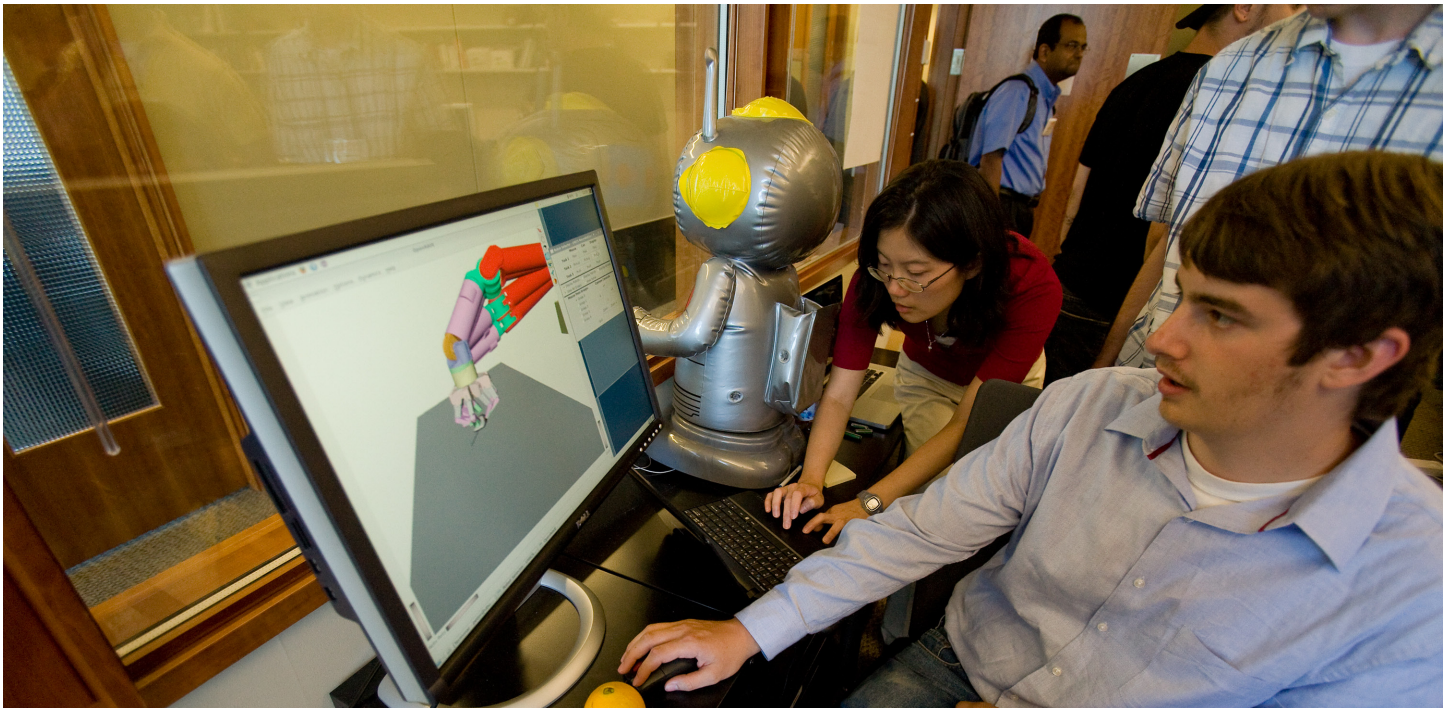
DO-IT maintains a searchable database of frequently asked questions, case studies, and promising practices related to how educators and employers can fully include students with disabilities in computing activities.

The Knowledge Base can be accessed by following the "Search Knowledge Base" link on the *AccessComputing* website.

The Knowledge Base is an excellent resource for ideas that can be implemented in programs in order to better serve students with disabilities. Individuals and organizations are encouraged to propose questions and answers, case studies, and promising practices. In particular, the promising practices articles serve to spread the word about practices that show evidence of improving the participation of people with disabilities in computing. Contributions and suggestions can be sent to *doit@uw.edu*.

Examples of Knowledge Base questions include the following:

- How can I make my computing department more accessible to students with disabilities?
- Universally Designed Webpages: A Case Study on Access Issues for a Student with a Learning Disability.
- What adaptive technology is typically provided to students with disabilities on postsecondary campuses?
- What are specific computer applications that can assist students with learning disabilities?
- Are there any web-based tutorials on accessibility?
- How can principles of universal design be used to construct a computer lab?



AccessComputing Minigrants

For a limited time, *AccessComputing* will offer funding for minigrants to support training, experiential learning, and other computing and IT-related activities nationwide. The ultimate goal is to increase the number of people with disabilities, including post-September 11 veterans, successfully pursuing computing careers.

An institution or other organization can seek funding to support the following:

- an existing computing event in order to attract/involve students with disabilities. Check with your computing department and see if there is an upcoming event to which you could add a mini-program for students with disabilities. For example, *AccessComputing* funds speakers and exhibits focused on assistive technology and other disability issues as part of the UW Engineering Open House. In addition, students with disabilities are invited to a pizza lunch to network with other students, faculty, and mentors.
- a stand-alone new event to attract and support students with disabilities in computing fields.
- a training event for faculty, administrators, or staff to improve access to computing curricula and programs for students with disabilities and/or to include disability-related topics in their course curricula.
- a professional development opportunity for students with disabilities, faculty, and staff to attend a conference or symposium.

Visit *www.uw.edu/accesscomputing/minigrant.html* for more information and email *accesscomp@uw.edu* to consult about the availability of funds.

Acknowledgments

AccessComputing Capacity Building activities are funded by the National Science Foundation (Grant #CNS-1042260). They were coordinated by the Alliance for Access to Computing Careers, which is led by the Department of Computer Science and Engineering and DO-IT at the University of Washington. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the CBI presenters and publication authors and do not necessarily reflect the views of the National Science Foundation.

DO-IT
University of Washington
Box 354842
Seattle, WA 98195-4842
doit@uw.edu; www.uw.edu/doit/
206-685-DOIT (3648) (voice/TTY)
888-972-DOIT (3648) (toll free voice/TTY)
206-221-4171 (FAX)
509-328-9331 (voice/TTY) Spokane
Founder and Director: Sheryl Burgstahler, Ph.D.