



# *AccessCyberlearning 2.0* Capacity Building Institute

Proceedings  
January 16 – 18, 2019  
University of Washington, Seattle, WA



# AccessCyberlearning 2.0 Capacity Building Institute

This publication shares the proceedings of the *AccessCyberlearning 2.0* Capacity Building Institute (CBI), which was held at the University of Washington in Seattle, January 16 – 18, 2019. The content may be useful for people who

- participated in the CBI;
- create online learning tools;
- seek to increase their understanding of issues surrounding the participation of students with disabilities in digital learning options;
- would like to make their digital learning tools welcoming to, accessible to, and usable by everyone, including those with disabilities;
- promote the application of universal design principles and practices to digital learning environments for science, technology, engineering, and mathematics (STEM) content;
- have promising practices to share with others; and/or
- seek to establish collaborative relationships and projects with those who have similar or complimentary interests and skills.
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## About the CBI

The *AccessCyberlearning 2.0* Synthesis and Design Workshop is funded by the National Science Foundation's (NSF) Cyberlearning and Future Learning Technologies program of the Division of Information and Intelligent Systems (#1824450). *AccessCyberlearning 2.0* aims to conduct exploratory research to inform the design of the next generation of digital learning environments for science, technology, engineering, and mathematics (STEM) content.

Led by the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center—which has decades of expertise in designing welcoming, accessible, and usable websites, documents, videos, and digital learning activities—the *AccessCyberlearning 2.0* Synthesis and Design Workshop sought to answer four research questions that emerged from its current *AccessCyberlearning* project which is also funded by NSF (#1550477):

1. What challenges do learners with different types of disabilities face in using current and emerging digital learning tools and engaging in online learning activities?
2. How do current digital learning research and practices contribute to the marginalization of individuals with disabilities?
3. What advances in digital learning design are required to support multi-modal learning and engagement that is fully accessible to and usable by students with disabilities?
4. What specific actions can digital learning researchers, funding agencies, educators, and other stakeholders take to systematically address issues with respect to disabilities?

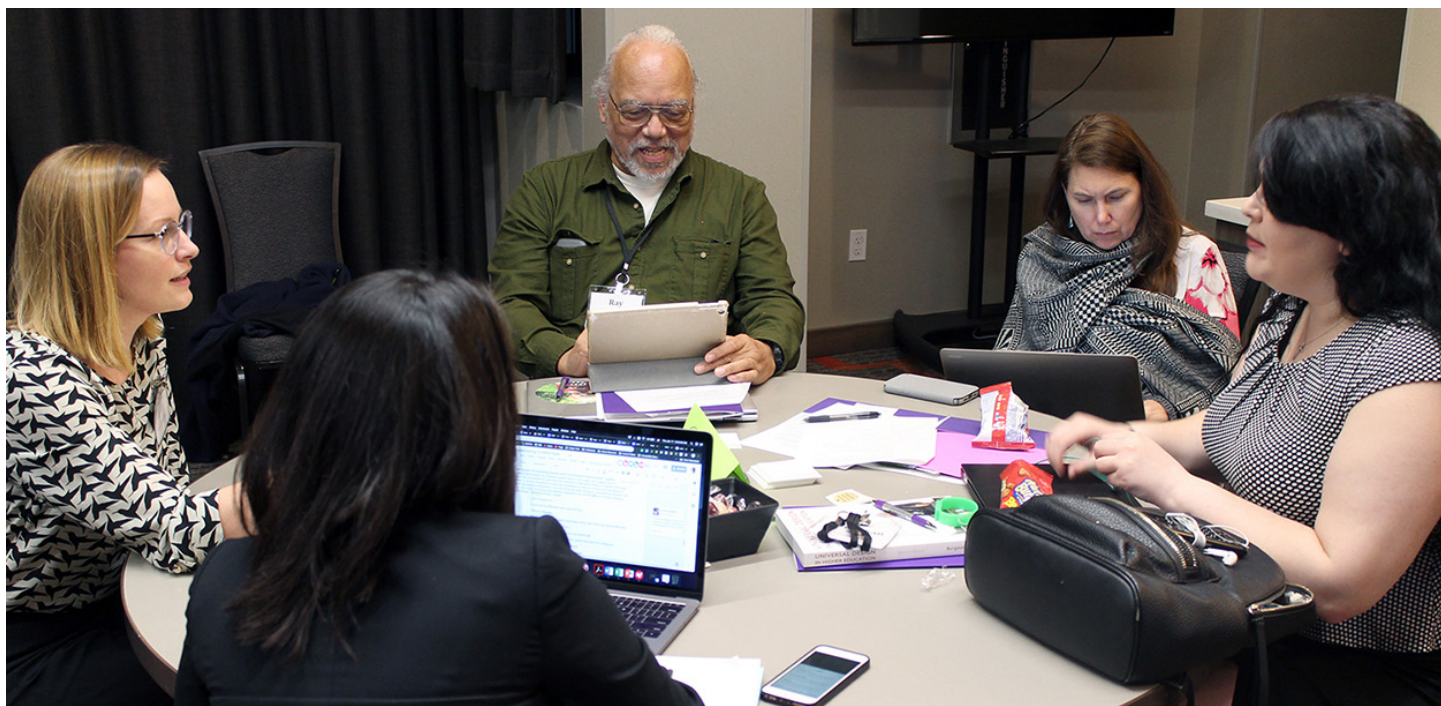
To address these questions, the 2.5-day synthesis and design workshop and follow-up engagement will

- synthesize and integrate existing research related to the accessibility of digital learning to students with a variety of disabilities;
- produce a white paper which addresses the research questions and contributes to the development of forward-looking, highly adaptable, distributed, collaborative digital environments that can personalize learning for diverse learners that include individuals with disabilities with potential applications across multiple and varying (a) domains of knowledge, (b) learning contexts, and (c) time spans; and
- develop guidelines for how researchers can address disability / accessibility-related issues with respect to (a) designing and testing new technologies, (b) analyzing and reporting outcomes, and (c) designing project activities and resources.

In this CBI

- all participants contributed to its success;
- experts in all topic areas were in the audience; and
- new concepts evolved from presentations and discussions.

The CBI included presentations, panel discussions, and group discussions where CBI participants shared their diverse perspectives and expertise. The agenda for the CBI and summaries of the presentations are provided on the following pages.



# CBI Agenda

**Wednesday, January 16, 2019**

8:00 – 9:00 am

**Breakfast and Networking**

9:00 – 10:30 am

**Welcome, Introductions, Overview *AccessCyberlearning 2.0***  
Sheryl Burgstahler, University of Washington, PI

**Research Questions, Project Tasks and Products**

**Overview** of approaches to access for individuals with disabilities, challenges faced by students with disabilities, and teaching strategies that can make online learning accessible to students with disabilities. (addressing research questions 1 and 2)

10:30 – 10:45 am

**Break**

10:45 – 12:00 pm

**Accessible Technology**  
Terrill Thompson, University of Washington  
Current strategies for making websites, videos, documents, and digital tools accessible to and usable by individuals with disabilities (research questions 1 and 4)



12:00 – 1:00 pm	<b>Working Lunch</b> Lunch and discussion: How do current digital learning research and practices contribute to the exclusion and marginalization of individuals with disabilities? (research question 2 and tasks 1 and 2)
1:00 – 2:00 pm	<b>Computing Research Practices</b> Richard Ladner, University of Washington Computing research design practices (including recruiting and analysis) that exclude and marginalize individuals with disabilities; inclusive research design approaches; recommendations for the future of digital learning research (research questions 2–4)
2:00 – 2:15 pm	Break
2:15 – 3:30 pm	<b>Panel: Perspectives of Students and Instructors with Disabilities</b> Participants share their experiences and recommendations regarding engagement of individuals with disabilities in cyberlearning (research question 1)
3:30 – 4:00 pm	<b>Report Out</b> Report out from lunch discussions
4:00 – 4:45 pm	<b>Preview of Tomorrow’s Topics and Work Groups, Complete Daily Feedback Form, and Pose for Group Picture</b>
6:00 – 7:30 pm	<b>Working Dinner</b> Buffet dinner and continued discussion regarding research questions 1 and 2.

## Thursday, January 17, 2019

8:00 – 9:00 am	<b>Breakfast and Networking</b>
9:00 – 9:30 am	<b>Review and Overview</b> Share ideas generated last night. Introduction to today’s agenda
9:30 – 12:00 pm	<b>Panel</b> Panel of leaders share research and practice issues and findings at the intersection of accessibility and cyberlearning. Large group Q&A and discussion <ul style="list-style-type: none"> <li>• Aaron Kline, Stanford University</li> <li>• Prasun Dewan, University of North Carolina Chapel Hill</li> <li>• Shiri Azenkot, Cornell Tech</li> <li>• Sofia Tancredi, University of California, Berkeley</li> <li>• Mike Jones, Brigham Young University</li> <li>• Lorna Quandt, Gallaudet University</li> <li>• Ray Rose, Online Learning and Accessibility Evangelist</li> </ul>

12:00 – 1:00 pm	<b>Working Lunch</b> Lunch and discussion: What specific actions can digital learning researchers, funding agencies, educators, and other stakeholders take to systematically address issues with respect to disabilities? (research question 4)
1:00 – 1:30 pm	<b>Report Out</b> Report out from lunch discussions
1:30 – 4:30 pm	<b>Developing Products</b> Review of project products and organization of groups and tasks. Work within small groups that each focus on a specific contribution to project products (e.g., draft accessibility guidelines for cyberlearning researchers, create online resources, develop a section of the project white paper focusing on one research question)
4:30 – 5:00 pm	<b>Report Out from Small Groups, Preview of Tomorrow’s Topics and Complete Daily Feedback Form</b>

## Friday, January 18, 2019

8:00 – 9:00 am	<b>Breakfast and Networking</b>
9:00 – 9:15 am	<b>Review and Overview</b> Share ideas generated last night and introduction to today’s agenda
9:15 – 11:30 am	<b>Developing Products continued</b> Continue small group work from yesterday
11:30 – 12:00 pm	<b>Wrap up, Discussion of What Remains to Be Done, Community of Practice, Evaluation</b>





# Presentation Summaries

## Overview of Accessibility Issues for Online Learning

Presented by Sheryl Burgstahler, University of Washington

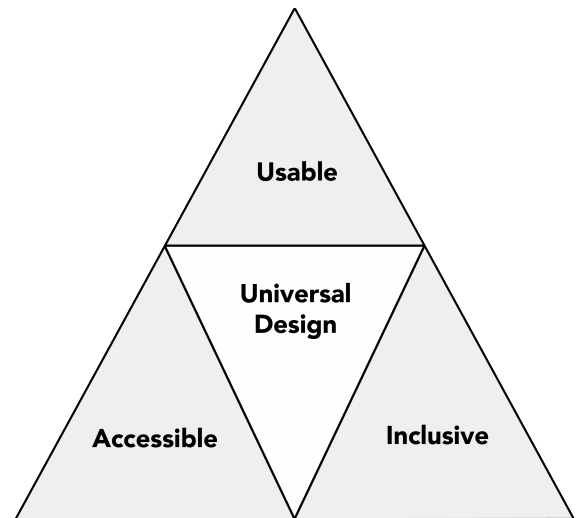
I taught my first online class in 1995, before the internet was widely used. This was a class on adaptive technology for people with disabilities. I taught the class with professor Norm Coombs, who is blind. We took steps to showcase how it is possible to design an online course that's accessible to any potential student, including those with disabilities. Although the digital tools are different and more complex, I strive to reach this goal in the online classes I teach today.

According to the US Department of Justice and the Office of Civil Rights of the U.S. Department of Education, “accessible” means “a person with a disability is afforded the opportunity to acquire the same information, engage in the same interactions, and enjoy the same services as a person without a disability in an equally effective and equally integrated manner.”

There are two approaches for making our campuses accessible: accommodations and universal design (UD). Accommodations are reactive in adapting a product or environment to make it more accessible to an individual who finds it inaccessible (e.g., captioning a video when a student with a hearing impairment requests it). UD is a proactive approach to create all aspects of a product or environment as accessible as possible as it is being designed. As defined by North Carolina State University's Center on Universal Design, UD is “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaption or specialized design.” A building entrance that is technically accessible might have a separate ramp for people with wheelchairs or who cannot use the stairs, while an entrance that is universally designed might have

one wide, gently sloping entrance that is used by everyone entering the building. Universal Designs are accessible, usable, and inclusive. Universally designed technology builds in accessibility features, is flexible, and is compatible with assistive technology.

Ability exists on a continuum, where all individuals are more or less able to see, hear, walk, read print, communicate verbally, tune out distractions, learn, or manage their health. Regardless of where each of a student's abilities fall on this continuum and regardless of whether or not they disclose a disability or request accommodations, we want to ensure that they have access to the classes we teach and resources we share.



Postsecondary efforts to include students with disabilities typically focus on making accommodations for students with disabilities. At the UW, we remediate over 30,000 PDFs and caption over 60 hours of video each quarter as accommodations for students. If faculty designed their classes with universal design in mind, these numbers would be reduced because documents would be universally designed in accessible formats and videos would be captioned for the benefit of everyone. Students wouldn't need to be accommodated. More than just people with disabilities are helped by UD—sloped entrances benefit people moving carts, and captions help those learning English or viewing in noisy environments.

UD values diversity, equity, and inclusion and can be implemented incrementally. Universal design of instruction (UDI) focuses on benefits to all students, promotes good teaching practice, does not lower academic standards, and minimizes the need for accommodations. UDI can be applied to all aspects of instruction, including class climate, interactions, physical environments and products, delivery methods, information resources and technology, feedback, and assessment. For specific tips on designing an accessible course, follow the *20 Tips for Teaching an Accessible Online Course* at [www.uw.edu/doit/20-tips-teaching-accessible-online-course](http://www.uw.edu/doit/20-tips-teaching-accessible-online-course). Other resources can be found in DO-IT's Center for Universal Design in Education (CUDE) at [www.uw.edu/doit/programs/center-universal-design-education/overview](http://www.uw.edu/doit/programs/center-universal-design-education/overview).

## IT Accessibility

Presented by Terrill Thompson, University of Washington

How do we overcome large barriers? We innovate, and we refine our innovations over time until they're better and more inclusive. Throughout history, innovation has often initially excluded groups of people. For example, the Gutenberg Printing Press produced the first mass printing in 1452, but print remained inaccessible to people who are unable to see for nearly four centuries (Braille was invented in 1829, and the first electronic screen reader was introduced by IBM in 1986). Similarly, television appeared in the 1920s, but the first captions for people who are deaf or hard of hearing didn't appear until 1972, and audio description for people who are blind followed in 1988.

In contrast, HTML included accessibility features from the beginning (e.g., alt text for images, hierarchical heading tags for document structure), demonstrating that it is possible to innovate without erecting barriers.

When we're creating digital content such as web pages or online documents, we may envision our typical user as an able-bodied person using a desktop computer. In reality, users utilize a wide variety of technologies to access the web, including assistive technologies and mobile devices. Everyone has a unique combination of levels of ability when it comes to seeing, hearing, or using a mouse or keyboard; there is a wide variety of technology and software tools that people use to access information online. But are digital learning environments always accessible to or usable by students or instructors using assistive technology? In order to ensure our digital resources are accessible, designers, developers, and content authors must understand that users are technologically diverse, and familiarize themselves with a few simple accessibility standards, tools, and techniques. One simple test is to try navigating your own online resources (e.g., websites, software, assessment tools) without a mouse (*nomouse.org*). HTML websites, rich web applications, Microsoft Office documents, and Adobe PDF files can all be accessible to all users, but only if they are designed and created with accessibility in mind.

Most students now interact with an Learning Management System (LMS) for accessing course materials, engaging in class discussions, turning in assignments, completing assessments, etc. Most LMS's have reasonably good accessibility. However, each educator must keep accessibility in mind as they select plug-ins and create or upload course content. Many students and professionals may interact with web conferencing, videos, and collaboration tools as well—these tools also need to be made accessible and easy to use by all.

The most common guidelines for designing accessible technology are the Web Content Accessibility Guidelines (WCAG), published by the World Wide Web Consortium (W3C). WCAG 2.0 (2008) is organized into four main principles; information should be perceivable, operable, understandable, and robust. Each of these principles is defined by more specific guidelines, and those are further defined by specific success criteria, each assigned Level A, AA, or AAA, in descending order of priority. WCAG 2.0 Level AA is widely identified in legal settlements, resolutions, and policies as the expected level of accessibility for websites.

If websites include rich, dynamic content (as opposed to static materials), ensuring their accessibility will likely depend on use of Accessible Rich Internet Applications (ARIA), a markup language that supplements HTML with attributes that communicate roles, states, and properties of user interface elements to assistive technologies. ARIA answers questions like "What is this?", "How do I use it?", "Is it on/selected/expanded/collapsed?", and "What just happened?" The W3C maintains an extensive set of design patterns for common web widgets within its WAI-ARIA Authoring Practices document (ref). If creating web applications that include any of the components defined by the W3C, their recommended design patterns should be implemented in order to ensure that users encounter consistent, reliable user interfaces. Otherwise, users (especially keyboard users and assistive technology users) have to learn an entirely new interface every time they visit a new website.

For more information about IT accessibility, consult the following resources:

- 30 Tips for Improving Web Accessibility at [www.uw.edu/accesscomputing/30-web-accessibility-tips](http://www.uw.edu/accesscomputing/30-web-accessibility-tips)
- Accessible Technology at the UW at [www.uw.edu/accessibility](http://www.uw.edu/accessibility)
- Accessible University Demo Site at [www.uw.edu/accesscomputing/AU](http://www.uw.edu/accesscomputing/AU)
- ARIA Authoring Practices at [www.w3.org/TR/wai-aria-practices-1.1/](http://www.w3.org/TR/wai-aria-practices-1.1/)



# Cyberlearning for All

Presented by Richard Ladner, University of Washington

What is Cyberlearning? According to the Center for Innovative Research in Cyberlearning (CIRCL), cyberlearning “applies scientific insight about how people learn, leverages emerging technologies, designs transformative learning activities, engages teachers and other practitioners, measures deeper learning outcomes, and emphasizes continuous improvement.” In looking over this description I found it needed something more. As such, I’ve added another focus: It supports cyberlearning for all. Cyberlearning is about people, particularly students, and they come in a wide variety of abilities.

I am a professor emeritus at the University of Washington, and I’ve been on the faculty since 1971. I have seen the growth of computer science over the past 48+ years. For the past 15 years, my focus has been on accessibility research and two collections of grants: *AccessComputing* and *AccessCSforAll*. My accessibility research in learning has focused on K-12 and college levels, as can be seen in the following projects: Tactile Graphics ([homes.cs.washington.edu/~ladner/tactile.html](http://homes.cs.washington.edu/~ladner/tactile.html)), ASL-STEM Forum ([aslstem.cs.washington.edu/](http://aslstem.cs.washington.edu/)), ClassInFocus ([dhhcybercommunity.cs.washington.edu/projects/classinfocus/index.html](http://dhhcybercommunity.cs.washington.edu/projects/classinfocus/index.html)), BraillePlay ([homes.cs.washington.edu/~milnel2/LRMProjects.html](http://homes.cs.washington.edu/~milnel2/LRMProjects.html)), Blocks4All ([stemforall2018.videohall.com/presentations/1078](http://stemforall2018.videohall.com/presentations/1078)), and Accessible Computer Science Principles ([quorumlanguage.com](http://quorumlanguage.com)).

There are a lot of students with disabilities. The Individuals with Disabilities Act (IDEA) covers about 13% of K-12 students with disabilities nationally. These students have Individual Education Programs (IEPs) that establish their educational goals and identify accommodations they need to reach these goals. In addition to IDEA, about 2% of students with disabilities are covered by Section 504 of the Rehabilitation Act. These students have the same education goals as mainstream students but require accommodations to ensure access to the curriculum. In total, about 15% of K-12 students in the US have identified disabilities. In Washington State the percentages are higher with 13.8% IDEA students and 3.2% Section 504 students. These add up to about 17% of the 1.1 million K-12 students in Washington State public schools. In higher education, 11% of undergraduate students have disabilities and 5.3% of graduate students have disabilities.

The biggest barriers to education are teachers’ and administrators’ attitudes. Students with disabilities were historically excluded, though more recently they became included through accommodations and the application of Universal Design for Learning (UDL). Nonetheless, the IEP process can lead educators to set a low bar for the educational goals of their students with disabilities. Attitudinal barriers for students with disabilities can come from low expectations and a focus on compliance, rather than on welcoming students as part of a diverse student body. Technology is often a barrier because almost all new educational technology is not accessible to many students with disabilities from the beginning. This includes most cyberlearning tools. Cyberlearning should be for all students regardless of disability.

There are multiple design concepts in human computer interaction to think about when designing a cyberlearning tool. You can design for accessibility using universal design and ability-based design. We also use user engaged design, which includes three perspectives: user-centered design, participatory design, and design for user empowerment.

- Universal design aims to make products accessible to the largest group possible.
- Ability-based design leverages the full range of human potential by creating systems that can adapt to the abilities of the user.
- User-engaged design recognizes that the intended users of a technology may be different than the designers.



The design cycle has four phases: analysis of the problem to be solved, design of a solution, prototype, and testing. This cycle is repeated until the problem is solved satisfactorily as judged by the testing. Designs created with the engagement of the intended users will more likely be adopted. User-centered design involves the users just in the testing phase, participatory design involves the user in both the testing and design phases, and user empowerment involves users in every phase of the design cycle.

User empowerment requires that the users have self-determination and the technical education needed to participate fully in the design cycle. Self-determination means that the person with a disability has the power to make change, and in this case solve their own accessibility problem. Education mean they have the wherewithal to design, build, and test their solution. Such individuals are not waiting for someone else to solve their accessibility problem, but can do it themselves with the help of allies.

Demographics, equity, and quality all need to be considered when thinking about accessibility. Demographics refers to the large segment of the population that have disabilities. Equity refers to the concept that this large segment should be included and have power. Quality refers to the idea that better solutions to problems often come from diverse approaches to the problem. Disability is one facet of diversity. My closing thought can be stated succinctly that research fields need more people with disabilities because their expertise and perspectives spark innovation.

## **Autism Glass Project: Expression Recognition Glasses for Autism Therapy**

Presented by Aaron Kline, Stanford University

Many students with autism cannot read people's facial expressions and gauge emotions. Technology in the Autism Glass Project, which works similarly to Google Glass and is connected to a smart phone, will read people's emotions and feed that information back to the wearer by showing the expression as a word or emoji back to the wearer. We are also testing different audio feedback options. When looking at people's faces from different directions in larger groups, it is difficult for the technology to read people's facial cues.

The technology also records different interactions and a viewer can go back to review these interactions and read facial expressions again, with their parents or others. This technology is aimed at increasing people with autism's facial engagement. It gives people with autism the tools and empowerment to learn and grow in social situations. There are options for children to play with games around facial cues and expression to learn in a game setting.

We ran a study where students wore our technology in social settings. Many participants became more likely to look at people's faces and engage with facial expressions. Students became more comfortable with the headset after wearing it for a length of time and weren't overwhelmed by visual or audio feedback. They expressed a desire for more gamification, feedback and rewards, and personalization. More advanced students also wanted levels and more ways to challenge themselves with the technology. We have now moved on to randomized control in future studies.

Our project team currently does not include any people with autism. In the future we have to include people with autism in the design, development, and evaluation. As seen in other projects, having the students involved in the design of their technology makes them more excited to wear it. Furthermore, we are exploring other uses for this technology, including reading people's levels of interest in meetings or showing what content is in pictures or real life to someone who is blind.

## Cyber Support for Difficulty Resolution to Make Learning More Accessible?

Presented by Prasun Dewan, University of North Carolina Chapel Hill

Accessible cyberlearning should address not only delivery of knowledge but also creation of learning-inducing artifacts. Our research involves systems that (a) allow both textual and visual user-interfaces to create artifacts, automatically translating between two; (b) use machine intelligence to detect task difficulties and communicating this inference to those who can help with the task; and (c) use machine intelligence to automatically recommend solutions to difficulties. Such systems have the potential to increase accessibility for workers and/or helpers with visual impairments, limited motor skills, and autism. Investigating this potential requires getting enough data for both training the machine-intelligence algorithms and evaluating their impact on task creation and learning.

Our work addresses difficulty resolution and spans two projects:

- **Difficulty Detection in Programming:** We are building a system that uses machine learning to automatically determine if programmers are facing difficulty, conveys this information to interested potential helpers, and provides an environment to offer help with the problem.
- **Difficulty Amelioration in Data Science:** Data science involves connecting programs into workflows. Traditionally, this connection has been done using command languages, but because these are considered difficult to learn and use, some modern systems offer visual alternatives. This project is using machine learning to automatically recommend workflow steps to users in difficulty.

Can these cyberinfrastructure projects on ameliorating difficulties make learning and teaching more accessible? We say yes, based on several hypotheses below.

**More impact on challenged populations:** Our programming studies with the average population found that difficulties were rare (which is to be expected if problems are matched to the workers) but took long to resolve. Arguably those who face atypical challenges will (a) encounter certain kinds of difficulties more often, especially if instruction does not accommodate these challenges, and (b) take longer to resolve difficulties. Hence, digital support for difficulty resolution should have larger impact on atypical populations.

**Second pair of eyes more effective for visually impaired:** Our programming studies also show that the vast majority of the fixes involved a helper recommending change to a single line of code, which took the workers much longer to identify on their own. This means that the time required to make the fix was a small fraction of the time required to read the code to find the problem. A second pair of eyes of a human or system should be more effective for visually impaired programmers using a screen reader to find the “fix needle” in a large “code haystack.”

**Difficulty inferences useful for autistic/visually impaired helpers:** In a face-to-face programming lab, an autistic or visually-impaired helper who has difficulty reading faces to discover confusion, can use automatic difficulty detection to find struggling workers too shy or flustered to ask for help.

**Command languages more useful for visually impaired:** A simple workflow composition task of connecting the output of a program to the input of another involves (a) typing a few characters in a single command line, and (b) interaction with six screens (forms / menus) in a visual system. Consistent with the accessibility principle of ensuring that content is accessible using the keyboard alone, command languages are more appropriate for visually impaired workers who can master them as they require smaller read / write ratios to perform the same task.

**Polymorphic workflow composition more accessible:** Based on the accessibility principle advocating multiple ways of obtaining the same knowledge, supporting and translating between text-based and visual user interfaces for workflow composition should increase accessibility by accommodating multiple forms of challenges, and allowing problems to be solved collaboratively by people with different abilities.

**Automatic recommendations for visual impairment and motor-skill limitation:** Automatic recommendations are more useful for those (a) with limited motor skills as they do not have to use the keyboard or mouse to enter the recommended information, and (b) visual impairment, as they do not have to read documentation to determine the recommended information.

Research to investigate these hypotheses faces the problem that it is difficult to get enough subjects from atypical populations to gather (a) training data for developing the machine-learning innovations, and (b) usability data from our innovations. Our expectation is that training data from typical populations will also be useful for predicting and ameliorating difficulties of atypical populations. Longitudinal field studies of a few subjects are an answer to (b).

## **Sensables: 3D Printed Models for Students with Visual Impairments**

Presented by Shiri Azenkot, Cornell Tech

3D models are very important learning tools. With 3D printing, there are even more 3D models available. There is huge potential in using 3D printers to teach, especially to portray visual materials to students with visual impairments. Visually impaired students may be able to better see a building, a terrain, and or a 3D tactile globe that is more accessible. However, with a 3D globe, you may lose information such as country names, and differentiation of countries. So we developed a tool kit that tags (Markit) and senses (Talkit) models. In Markit, you can download a model and attach labels to different parts. Then, after printing the model, Talkit will use the camera on the device and read those labels on the model marked up in Markit. Talkit uses the keyboard to choose which model, reads hand gestures, and responds to speech output.

We ran a study to see how teachers could use this technology. Three different teachers of the visually impaired over six weeks developed models with their students: A volcano, a plane, and a small map, and could incorporate sound effects as well as stating what the part of the model is. The images on the screen could also show high contrast visuals with accompanying descriptions.

# Sensory Regulation and Embodied Math Design

Presented by Sofia Tancredi, University of California, Berkeley

Math instruction is moving in exciting new directions. Designers and researchers are recognizing and expanding the use of whole-body movement, gesture, and manipulatives for learning math concepts. This movement is inspired by a paradigm shift in the philosophy of cognition from computational models of cognition (input, processing, and output) to embodied cognition models, which see our bodies and interactions with the environment as centrally constitutive of how we think and learn.

As movement-based learning activities expand, it is important to address the accessibility of such activities to all students. One critical and generally overlooked parameter is that of sensory regulation.

Individuals have different sensory needs in order to attend and learn. Sensory processing exists on a spectrum based on neurological threshold. Individuals with a high threshold are less sensitive to sensory input and need more sensory input to stay regulated. For example, one student with math difficulties that I worked with in 2010 would become exhausted whenever he tried to work at a desk. However, when this student had access to sensory regulation tools such as a balance board that provided amplified sensory input, he was able to focus and engage with math learning for long stretches. Individuals with low neurological threshold are more sensitive to sensory input. Sensory differences are associated with ADHD, ASD, mental and emotional disorders (OCD, schizophrenia), and genetic syndromes (Fragile X), and have also been linked to academic performance.

So how might students with diverse sensory regulation needs access math embodied design? Some key questions to answer towards this goal are 1) How can we both serve students' sensory regulation needs and include them in learning through movement (that is, give a student a balance board, but also have them engage in a walk-the-number-line activity)?, and 2) How can we accommodate different and often opposing sensory profiles?

I propose that the answer to question 1 lies in the integration of conceptual learning and sensory regulatory affordances of movement, or what I call sensory regulatory embodied mathematics design. An example from a current project is a walk-the-number-line activity adapted to high neurological threshold students through the wearing of ankle weights. In this example, the weights play the dual function of (1) providing regulatory sensory input to the proprioceptive system, and (2) providing sensory input that is relevant to the learning movement. Rather than engaging in competing regulatory and conceptual learning activities, sensory needs can be met harmoniously through task-relevant sensory input. In cyberlearning design, sensory inputs (particularly to the vestibular and proprioceptive sensory systems) might take the form of vibration, whole-body movement, weights, rotation, or orientation changes. These dimensions of movement learning activities need to be adjusted differently for students who need more or less sensory stimulation. Adaptive cyberlearning tools are a promising pathway towards achieving this.

As movement-based cyberlearning activities proliferate, these are poised to improve or exacerbate learning access for students towards both ends of the sensory spectrum. Which occurs depends on our ability to intentionally design sensory dimensions of learning activities for sensory diversity.



# **Learning in Sign Language Using a Head-Mounted Display**

Presented by Mike Jones, Brigham Young University

Deaf students who primarily learn and speak in sign language can find it challenging to look at visuals while also using an interpreter to relay the otherwise verbal instruction and information. How can sign language be watched while also looking at models or away from the speaker?

There are foundations in multimedia learning (Mayer, 1998; Mayer, 2005): Students learn better when hearing instruction while viewing visuals. Do deaf students learn better when viewing an animation accompanying by sign narration rather than captions? Do deaf students learn better when the signer is closer to the visual aid verse further away?

Students use a head-mounted display in the form of eyewear to see the signer while looking at other visuals. The signer can be anywhere (same room, another room, pre-recorded, etc.) and watch a presentation or visual aid at the same time. This may be especially helpful in museums, planetariums, or other places of learning outside the classroom that have been historically hard for deaf students.

We tested various types of equipment and where the signer would be view in the equipment. We studied how it would be done with split attention, how the signer position mattered, and how the fit affected learning. In a planetarium, we focused on how the signer helped the student understand the material either through a head-mounted display or projected on the planetarium itself.

## **Signing Avatars and Embodied Learning in Virtual Reality**

Presented by Lorna Quandt, Gallaudet University

Signing avatars have the potential to be a powerful communication and accessibility tool. They are programmable, responsive, iterative, create digital storybooks, online courses, and can share content in American Sign Language (ASL) online. Online courses could be aided in receiving presentations and other help with an online avatar that can sign in ASL. Thanks to a recently funded NSF EAGER grant (Signing Avatars & Immersive Learning, SAIL), we are now working on a project to further develop these signing avatars and place them in a virtual reality environment to teach users ASL. This virtual reality environment will create an immersive, embodied learning experience.

Our avatars are designed from actual motion capture recordings of fluent signers. We use this data to build avatars which resemble fluid signing, instead of the unnatural signing that comes from computer-based models. These avatars can be used to teach people how to sign ASL in a virtual reality learning environment. This system is based on principles of embodied learning. Students learn better when they can use their bodies to learn, and our new ASL learning system will harness this fact to create a better way to learn ASL. Even more, virtual reality and gesture tracking will allow your own hands (in virtual reality) to demonstrate ASL from a first-person perspective. In SAIL, a student will be able to interact with virtual teachers and see their own virtual hands sign in response. Currently, SAIL is for teaching ASL to non-signers. But eventually, it can open up to a large population and other applications.

# The More Accessible Webinar

Presented by Ray Rose, Online Learning and Accessibility Evangelist

We were asked to do a webinar for the United States Distance Learning Association. We asked them to include real-time captioning, but they said it was too expensive. So we chose to use Google Slides with a transcription.

If you convert a PowerPoint to Google Slides, captions will appear as it listens to you. This means there is no excuse to not have an accessible meeting. If you have your slides paired with Google captions, it becomes more accessible—these captions may not be perfect, but they allow the viewer and listener to gain more context than they would have before.

There is no extra cost for using Google captions. All you need is a microphone in your computer to record speaking and to turn on the widget. The captions are relatively accurate, compared to other auto captioning services. If you use Zoom or another lecture recording service, it can save and record the captions as part of the slides, though it does not create a separate transcript for the captions.



## Panel: Perspectives of Students and Instructors with Disabilities

Facilitated by Sheryl Burgstahler. This panel featured students and instructors with a variety of disabilities that included those related to sight, mobility, hearing, and learning. Below are questions posed and a summary of answers provided by the panelists.

### What accommodations do you use?

- I use captions and a note taker.
- I need slides and notes shared digitally and tagged for a screen reader.
- I have audio book format for reading, spell checker for exams, and/or longer time so I have more time to write and spell out works. Grammarly is very helpful.
- Computers are very helpful, but also cause problems. If people aren't creating accessible technology, then technology is only creating another barrier to education.

### What should online learning developers and educators consider?

- Offer multiple ways to gain knowledge, such as through a video paired with printed materials.
- Provide all materials that are accessible to students with disabilities at the same time they are provided to other students.
- Caption videos to benefit a wide variety of students, including English language learners, those in noisy (e.g., airports) or noiseless (e.g., libraries, buses) environments, individuals who want to search content, in addition to people with hearing and learning disabilities.
- Design videos to include audio content for visual elements of a video whenever possible (e.g., have the credits and other information at the end of a video spoken by the narrator) to maximize access for individuals who are blind or otherwise cannot see the screen. Consider adding audio description to describe other key elements of the content presented visually.
- Provide text descriptions for all visuals.

- Use accessibility designed documents (e.g., PDFs, PowerPoint slides).
- Engage with students in multiple ways.
- In online discussions, to help students, especially those with learning and communications challenges, provide a specific focus to each discussion question, provide guidance in how to answer the question, engage in and guide the discussion, and summarize the group of responses.
- For any on-site components of a course, make sure the facility can be easily maneuvered with a wheelchair.

## **What issues do you have that you need a solution for?**

- Add more diverse graphics and diverse methods for learning or input into a discussion.
- As a student with a disability, I'm often expected to have the solutions to my problems when I approach a professor. I would like more help in finding those solutions.
- I wish there were more organic and easy ways to communicate with the professor. When I'm online, I can often feel alone in my learning, and it would be nice to feel more connected and like it was easier to ask questions and communicate with other people.
- Online learning can feel unfriendly. Teachers often seem closed off to communication. I'd love to have more relationship building with my peers and teachers online. Online learning can often be very compartmentalized.
- Wheelchairs can sometimes not fit in physical rooms for classes. I often get shoved in a corner and can't move for the entirety of class. I'd like classes to be designed more accessible just in the physical aspect.
- Academia isn't always updated. People can use outdated terminology or don't update their understanding of a subject.
- Professors aren't always uploading accessible content to their LMS. How can we ensure that all content being uploaded is accessible? There are not enough incentives to professors to do this.

## **How do you interact with your other students and peers in online learning?**

- I went to smaller schools that helped promote peer engagement and discussion. I really needed this engagement to help me understand the materials we were reading and studying. My peers can help me discover way more by bringing different sides and nuances to a subject.
- As an instructor, I host more discussions and promote student engagement. A lot of students attend online classes because they don't have time to attend a class—how do you get students to have an engaging conversation? The educator needs to promote that.

## **How do current digital learning research and practices contribute to the exclusion and marginalization of individuals with disabilities?**

- Classes that use Google or other collaboration tools are often inaccessible to students with specific disabilities.
- Since accessibility became a legal liability, many faculty and staff on campus can be scared to deal with accessibility issues for fear of the legal liability, and then no one gets direction or feels empowered.
- Professors often feel overloaded with online classes and don't have time to meet with students, connect, or provide accommodations.
- Professors claim they don't have students with disabilities and therefore do not feel responsible for accessibility. Community is then not built because students don't feel comfortable disclosing.
- There can sometimes be high costs for captioning and other services; however, the more



demand there is for a service, the cheaper and better a service can be. If we all demand captioning, it will become the norm.

- I often don't get to meet people in my online classes, I need to have names reiterated.
- Faculty get very little training. Faculty need to join forces with Disability Resource Services and Teaching and Learning Centers—if we can partner, we can offer more accessibility and universal design training.
- Students often have to manage their own accommodations. Faculty are often unaware, and students have to walk the faculty through giving them their accommodations. Students may need training on how to manage these relationships.
- Most faculty have never been trained in using technology. Some don't even know how to copy and paste. If a faculty member can't even handle the basics of technology, they often can't make accessible content for their students.
- There's no incentive structure for faculty to make their courses more accessible. We need accessibility standards for teaching online and quality checks to pass.

## **What challenges do students and instructors with different types of disabilities face in using current and emerging digital learning tools and engaging in online learning activities? How do current digital learning research and practices contribute to the exclusion and marginalization of individuals with disabilities?**

- When a course is fully online, it is hard to make connections between the students and faculty. People don't feel as comfortable sharing as much when they can't have smaller conversations or share about themselves more readily.
- It can be hard to use a type of technology if it doesn't work with my assistive technology. For example, Blackboard was more accessible in its early days; however, it never updated as times went on, and now it is behind current accessible technology.
- In discussion boards, students need to be taught how to simplify their responses and make sure they are connected back to the original question, not just by visual alignment, but in a text-based manner, since many screen readers won't tell the listener about the formatting of these discussion boards.
- Electronic does not mean accessible. A lot of technology and software cannot be used by screen readers.
- NSF program officers are not necessarily supportive of including disability as a perspective for grants that focus on minority groups. Disability needs to be considered a diversity issue.
- In online discussions, it can be hard for students to parse out meaning and feeling behind a comment. This is especially hard for people with learning and emotional disabilities. Educators should lead the students in how to answer questions, give information, and parse out responses.
- More thought should be given to invisible disabilities. It can be hard for technology designers to think about invisible disabilities when designing, since people with invisible disabilities have a wide range of needs and how they use different tools can be a bit more ambiguous.
- The students we hear from are often the successful students with disabilities, not those who have been failed by the system.
- Deaf students and students with learning disabilities can often feel left out in a text heavy world. If there aren't other modes of learning and interacting, students with disabilities may get left out or feel left behind in discussion.



## Discussion Summaries

Below are participant responses to brainstorming sessions included in the CBI.

### **How do current digital learning research and practices contribute to the exclusion and marginalization of individuals with disabilities?**

- Institutions and instructors continue to select tools and resources without any consideration of accessibility. For example, classes that use Google's collaboration tools are often inaccessible to students with some specific disabilities.
- Designers and developers rarely understand accessibility, which leads to inaccessible technology being created and sold to schools.
- Digital learning research often does not include people with disabilities. It aims to design products for the average student instead of all students.
- Professors often feel overloaded with online classes and don't have time to meet with students, connect, or provide accommodations. Larger classes and amounts of course content can make the task of providing all materials in an accessible format daunting.
- Professors claim they don't have students with disabilities and therefore don't feel a responsibility for accessibility.
- A focus on high-tech tools can often leave students with disabilities excluded. Make sure those technologies are accessible so that everyone can participate and learn.
- Captioning should be a top priority in every class.
- If online classes only provide information in one method without alternative options, students with disabilities may not receive content. The burden of making sure they receive content is also put on the student, even though they may not know all the content they are missing.

- It is hard to connect with people in online classes. Informal communication can often be lost, especially for students with disabilities who may not be able to participate in every facet of a community. These connections should be made multimodally, using different group types and making sure the main method is accessible.
- Faculty often see their students as numbers instead of people in online classes, since they don't have faces to match with names. This can make faculty less likely to want to provide accommodations or humanize their students' problems.
- Faculty get very little training in how to be welcoming and inclusive to students with disabilities. Faculty are often unaware, and students have to walk the faculty through giving them their accommodations. Students may need training on how to manage these relationships.
- There's no incentive structure for faculty to make their courses more accessible. There needs to be more standards for teaching online and quality checks to pass.
- Departments can often collaborate in online learning classes, which can be difficult when departments have historically different theories and approaches (e.g., learning sciences may use situative theory, while special education uses behavioral theory). There can be challenges and oversights when trying to merge the ideologies of two departments.
- Many grant funders don't see how disability affects the greater population. They may not understand why disability is part of the great broadening participation goal.
- Since research about students with disabilities and accessibility in online learning is minimal, it is hard to find data to support the needs of students with disabilities and apply tested practices.
- Accessibility is often an afterthought after tools, software, and curriculum is already designed, and therefore accessibility is sort of tacked on and not thought through.
- Who is responsible for paying for specific accessibility needs (e.g., captioning, audio description, time for making documents accessible) isn't always clear.
- Universal design is still not widely practiced or incorporated into departments.

## **What challenges do students and instructors with different types of disabilities face in using current and emerging digital learning tools and engaging in online learning activities? How do current digital learning research and practices contribute to the exclusion and marginalization of individuals with disabilities?**

- When a course is fully online, it is hard to make connections between the students and faculty. People don't feel as comfortable sharing as much when they can't have smaller conversations or share about themselves more readily.
- In discussion boards, students need to be taught how to simplify their responses and make sure they are connected back to the original question, not just by visual alignment, but in a text-based manner, since many screen readers won't tell the listener about the formatting of these discussion boards.
- Electronic does not mean accessible. A lot of technology and software cannot be used by screen readers.
- In online discussions, it can be hard for students to parse out meaning and feeling behind a comment. This is especially hard for people with learning and emotional disabilities. Educators should lead students in how to answer questions, give information, and parse out responses.
- Give more thought to invisible disabilities. It can be hard for technology designers to think about invisible disabilities when designing, since people with invisible disabilities have a wide range of needs and how they use different tools can be a bit more ambiguous.



- The students we hear from are often the successful students with disabilities, not those who have been failed by the system.
- Deaf students and students with learning disabilities can often feel left out in a text heavy world. If there aren't other modes of learning and interacting, students with disabilities may get left out or feel left behind in discussion.

## **What specific actions can digital learning researchers, funding agencies, educators, and other stakeholders take to systematically address issues with respect to disabilities?**

- To receive funding from specific agencies, accessibility or universal design plans should be required just as broadening participation plans are often required.
- More training is needed about disability for decision makers (they could be based out of *understood.org*).
- Talk to Congress and State Representatives about where funding needs to be and how disability laws need to be supported.
- Pull data from NSF's CEOSE ([www.nsf.gov/od/oia/activities/ceose/index.jsp](http://www.nsf.gov/od/oia/activities/ceose/index.jsp)) database, which includes information on broadening participation.
- Reach into NSF and other big organizations to people you know and use that leverage to make sure disability and accessibility is considered important.
- Talk with the procurement and higher faculty to ensure that software is only purchased once it has been approved to be accessible.
- Students can rally together and report accessibility problems and demand solutions to their access. Often students see problems in the educational system since they are the users in the system compared to the faculty and educators designing the courses.
- Challenge journals and publications and make sure they are both accepting publications on universal design and accessibility as well as working in an accessible manner and putting out accessible articles.
- Educators and stakeholders need to include more people with disabilities in all of their work, including technology and curriculum creation.
- Make sure terminology being used is respectful and follows the wishes of the population in question.
- Accreditation boards can make a difference by adding working about accessibility and disability into their accreditation and certification requirements.





## CBI Participants

Participants represent NSF-funded Cyberlearning projects as well as those that work to increase the participation of people with disabilities in STEM. Members of the project planning committee helped design the workshop and project products. The project evaluator tracked activities and collected data on outputs (e.g., products, participants) and outcomes (e.g., changes made) as a result of participation.

The following individuals participated in the CBI.

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Systemic Cultivation of Inclusive Equitable  
Nurturing Classroom Ecology

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Science through Technology Enhanced Play  
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Gaby de Jongh  
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Cyber-Training

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Fengfeng Ke  
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Thinking and Learning via Architectural Design  
and Modeling

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Inclusive Classroom Pedagogy and Practices

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TxDLA Digital Accessibility Certification

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SREMA: Sensory Regulatory Embodied  
Mathematics Activity

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Accessible Technology Specialist  
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Bingran Wang  
Online Course Coordinator  
Promoting Online Course Accessibility in  
Georgetown University



## Communities of Practice

The *AccessCyberlearning 2.0* Community of Practice engages with Cyberlearning projects on how new technologies and strategies for the delivery of online instruction can be made accessible to students and instructors with disabilities. Send a request to join to [doit@uw.edu](mailto:doit@uw.edu).

Other communities of practice hosted by the DO-IT Center can be found on the Communities of Practice page at [www.uw.edu/doit/resources/communities-practice](http://www.uw.edu/doit/resources/communities-practice).





## Resources

The DO-IT website at [www.uw.edu/doit](http://www.uw.edu/doit) contains

- information about DO-IT projects
- evidence-based practices that support project goals and objectives
- resources for students with disabilities
- educational materials for teachers and administration

DO-IT and *AccessCyberlearning* maintain a searchable database of frequently asked questions, case studies, and promising practices related to how educators and employers can fully include students with disabilities. The Knowledge Base is an excellent resource for ideas that can be implemented in programs in order to better serve students with disabilities. 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 postsecondary education.

Examples of Knowledge Base questions include the following:

- Are electronic whiteboards accessible to people with disabilities?
- Are there computer keyboards designed to be used with only one hand?
- Are touch screens accessible?
- Do postsecondary institutions have to provide assistive technology (for example, screen enlargement or voice recognition software) to students with disabilities who enroll in distance learning courses?
- Does a postsecondary institution have to provide specific hardware or software (known as assistive technology) that an individual with a disability requests so that he or she can access information technology used on campus?
- Are funds available specifically for captioning?
- Are there any web-based tutorials on web accessibility?



Individuals and organizations are encouraged to propose questions and answers, case studies, and promising practices for the Knowledge Base. Contributions and suggestions can be sent to [doit@uw.edu](mailto:doit@uw.edu).

To learn more about accessible online learning, universal design, and information on making your technology accessible review the following websites and brochures:

- 20 Tips for Teaching an Accessible Online Course can be found at [www.uw.edu/doit/20-tips-teaching-accessible-online-course](http://www.uw.edu/doit/20-tips-teaching-accessible-online-course).
- A brochure that describes how to make your Cyberlearning project more accessible and welcoming to people with disabilities can be found at [www.uw.edu/doit/equal-access-how-broaden-participation-cyberlearning-projects-ensure-access-people-disabilities](http://www.uw.edu/doit/equal-access-how-broaden-participation-cyberlearning-projects-ensure-access-people-disabilities).
- Guidelines and resources for creating video and multimedia products that are accessible to people with sensory impairments can be found at [www.uw.edu/doit/creating-video-and-multimedia-products-are-accessible-people-sensory-impairments](http://www.uw.edu/doit/creating-video-and-multimedia-products-are-accessible-people-sensory-impairments).
- More information on universal design in education can be found at the Center for Universal Design in Education at [www.uw.edu/doit/programs/center-universal-design-education/overview](http://www.uw.edu/doit/programs/center-universal-design-education/overview).
- A brochure on universally designing distance learning programs can be found at [www.uw.edu/doit/equal-access-universal-design-distance-learning-programs](http://www.uw.edu/doit/equal-access-universal-design-distance-learning-programs).
- A brochure on what accessible distance learning is and how it helps students can be found at [www.uw.edu/doit/accessible-distance-learning](http://www.uw.edu/doit/accessible-distance-learning).
- A brochure on why accessible web design matters, and some resources to make your website accessible, can be found at [www.uw.edu/doit/accessible-web-design](http://www.uw.edu/doit/accessible-web-design).
- A list of thirty different web accessibility tips, and how to implement those tips, can be found at [www.uw.edu/accesscomputing/get-informed/publications/brochures/30-web-accessibility-tips](http://www.uw.edu/accesscomputing/get-informed/publications/brochures/30-web-accessibility-tips).
- The University of Washington's hub for information on accessible technology, featuring how to create and develop accessible documents, videos, and websites, can be found at [www.uw.edu/accessibility](http://www.uw.edu/accessibility).
- The Access Technology Center's website can be found at [www.uw.edu/itconnect/learn/accessible/atc/](http://www.uw.edu/itconnect/learn/accessible/atc/).
- Accessible University's website featuring common web accessibility principles and solutions can be found at [www.uw.edu/accesscomputing/AU](http://www.uw.edu/accesscomputing/AU).



## About AccessCyberlearning

*AccessCyberlearning* works with current and future cyberlearning researchers, technology developers, and instructors to inform their research with what is known about student differences / disabilities; design innovative learning technologies and teaching strategies that are welcoming to, accessible to, and usable by everyone, including people with disabilities; and ensure that project materials (e.g., websites, videos, curriculum) and activities (e.g., meetings, presentations) are welcoming to, accessible to, and usable by all participants.

*AccessCyberlearning* activities are designed to engage Cyberlearning projects and projects with similar goals in ways that explore how current knowledge and studies about people with disabilities can inform cyberlearning research, learning technology development, teaching strategies, and outreach. The goal is to make online learning opportunities high quality as well as welcoming to, accessible to, and usable by the broadest audience, including students and instructors with disabilities.

By addressing disability-related issues, *AccessCyberlearning* will help cyberlearning researchers, technology developers, and instructors work toward the ultimate goal of making the learning experiences of all students more effective and the online teaching experiences available to more potential instructors. Participants in *AccessCyberlearning* will become better prepared to make technological advances that (1) foster deep understanding of content coordinated with masterful learning of skills; (2) draw in and encourage learning among populations not served well by current educational practices; and (3) provide new ways of assessing understanding, engagement, and capabilities of learners.

For more information on *AccessCyberlearning*, consult our website at [www.uw.edu/doit/programs/accesscyberlearning/overview](http://www.uw.edu/doit/programs/accesscyberlearning/overview).



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