



Making STEM more accessible to disabled students

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HLTH H304: Critical Disability Studies: Theory and Practice

Motivation/Initiative



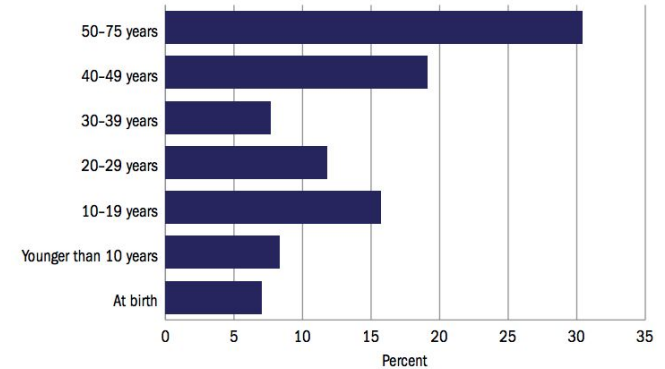
“Undergraduates with disabilities have stated that a key reason for not pursuing STEM fields of study was that they perceived the careers associated with these majors would require significant hands-on job activities inaccessible to them.”

---Bradley S. Duerstock and Clark A. Shingledecker, 2014

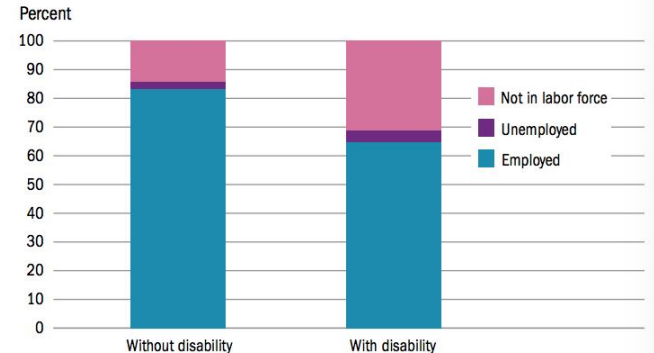
Statistics

- Proportion of deaf and hard of hearing people in STEM (Science, Technology, Engineering and Mathematics) is very small (0.13-0.19%) compared to that of the general population (11-15.3%) (NCSES 1996, 2004, 2009, 2011)
- Persons with disabilities are underrepresented in the STEM field as compared with the whole college-educated population (NSF statistics 2017)
- Disabilities acquired at birth or at an early age may influence decisions to pursue STEM studies (NSF statistics 2017)
- Persons with disabilities among scientists and engineers are more likely than those without disabilities to be unemployed or not in the labor force (NSF statistics 2017)

Age at onset of disability among scientists and engineers: 2015



Employment status among scientists and engineers, by disability status: 2015



Project Outline



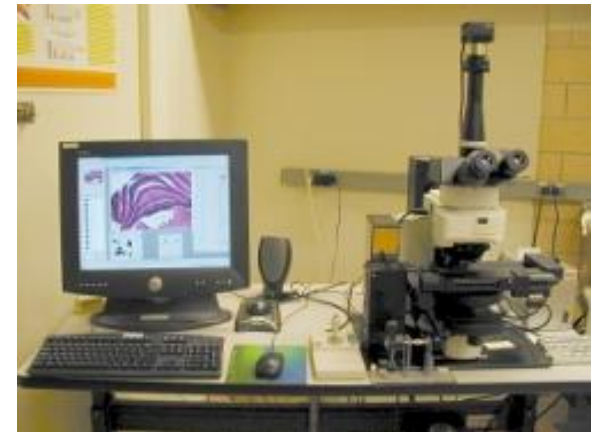
- Discuss current practices to make STEM more accessible in different cases
 - BLV (Blindness or Low Vision)
 - BLV-Blindness
 - BLV-Low Vision
 - Wheelchair users
 - Virtual Tour of the Accessible Biomedical Immersion Laboratory (ABIL)
 - Deaf and hard of hearing
- Case studies
 - Science students at Gallaudet University
 - Daniel Gillen at Haverford College
- Disability as a difference in perspective → call for more disabled students joining a science career
- Research fellowship opportunities for students with disabilities
- Take-away

BLV -- Low Vision

- Aid of extra lighting sources (LED lamps)
- Automated lecture acquisition
- AccessScope Project
 - Accessible light microscope for students with low vision or upper limb mobility
 - Enable automated loading of glass slides and remote control of magnification and change in position
- Screen reading software
 - MAGic: screen magnification program



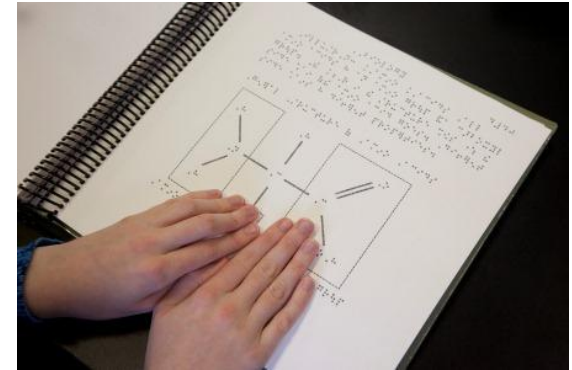
Purdue research intern with low vision micropipetting while performing a Western blot with the aid of task lighting from LED lamps



Accessible light microscopy (AccessScope)

BLV -- Blindness

- Accessible course materials
 - Braille: represent letters and other printed symbols using rectangular arrays of six or eight raised dots
 - Hard copy
 - Need to order months in advance → school should allow students needing accessible documents to pre-register early
 - Too heavy and thick to carry around
 - Can be easily damaged
 - Electronic devices that function as native braille computers or notetakers
 - Refreshable braille display: output Braille text one line at a time
 - Contains braille keyboard: useful for generating notes and other written homework



Braille textbook

Paths to Literacy: for students who are blind or visually impaired. About This Site. (n.d.). Retrieved May 10, 2019, from <http://www.pathstoliteracy.org/about-site>



Brailnote Apex BT 32 notetaker
(Humanware, Drummondville, QC, Canada)

BrailleNote Apex BT 32 Braille Notetaker. (n.d.). Retrieved May 10, 2019, from <https://store.humanware.com/europe/review/product/list/id/167/>

BLV-Blindness

- Screen reading software: convert speech into audible or tactile format
 - Job Access with Speech (JAWS): compatible with Windows
 - VoiceOver: compatible with iOS and MacOS
 - Benetech's Math Support Finder: online tool which helps identify technologies for accessible math readout (<http://msf.mathmlcloud.org/>)



Scheme showing a variety of screen reading software

A screenshot of a web interface titled "Search for a setup". It features a "DETECT MY SETTINGS" button and five dropdown menus for selecting platform, assistive technology, application, file format, and output. At the bottom are "SEARCH" and "CLEAR" buttons.

Search for a setup	
DETECT MY SETTINGS	
Pick a platform	Any platform
Pick an assistive technology	Any assistive technology
Pick an application	Any application
Pick a file format	Any file format
Pick an output	Any output
SEARCH	CLEAR

Benetech's search function window

WikiHow. (2019, March 29). How to Use a Computer if You Are Blind or Visually Impaired. Retrieved May 10, 2019, from <https://www.wikihow.com/Use-a-Computer-if-You-Are-Blind-or-Visually-Impaired>

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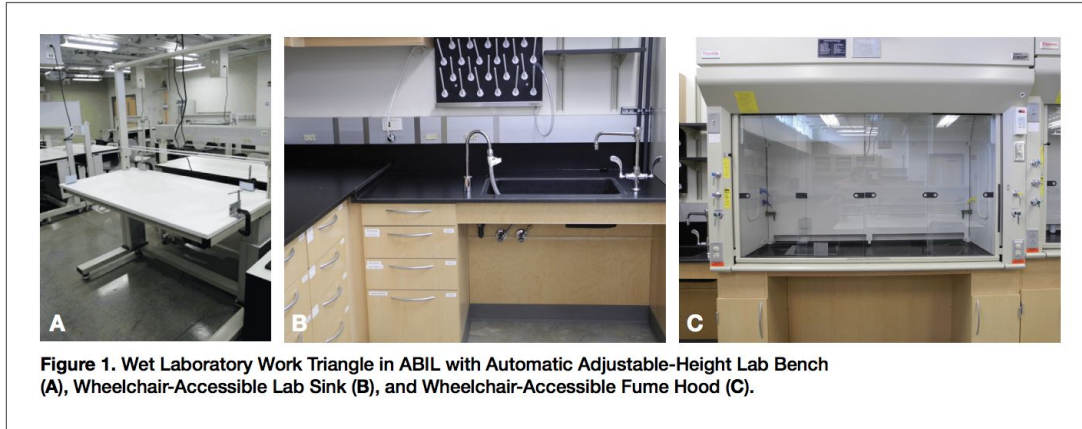
BLV -- Blindness



- Accessible class meeting places
 - Classroom should be carefully chosen → avoid poor acoustics or background noise
 - Need to plan out route → any location changes of classroom should be conveyed to student as far in advance
- Accessible scientific computing
 - Data collection and analysis software Logger Pro: compatible with Job Access with Speech (JAWS)
 - Lots of softwares and programs are inaccessible: MATLAB, Linux command lines and Origin
 - Wolfram Language interpretation helps blind user perform computation in Mathematica

Wheelchair users

- Laboratory reform
 - Accessible fume hood, lab bench, sink
 - Accessible safety setup
 - Example of accessible lab: Accessible Biomedical Immersion Laboratory (ABIL) at Purdue University
 - Virtual tour video available at:
<https://stemedhub.org/resources/2637/video?resid=2638&time=00:05:21>



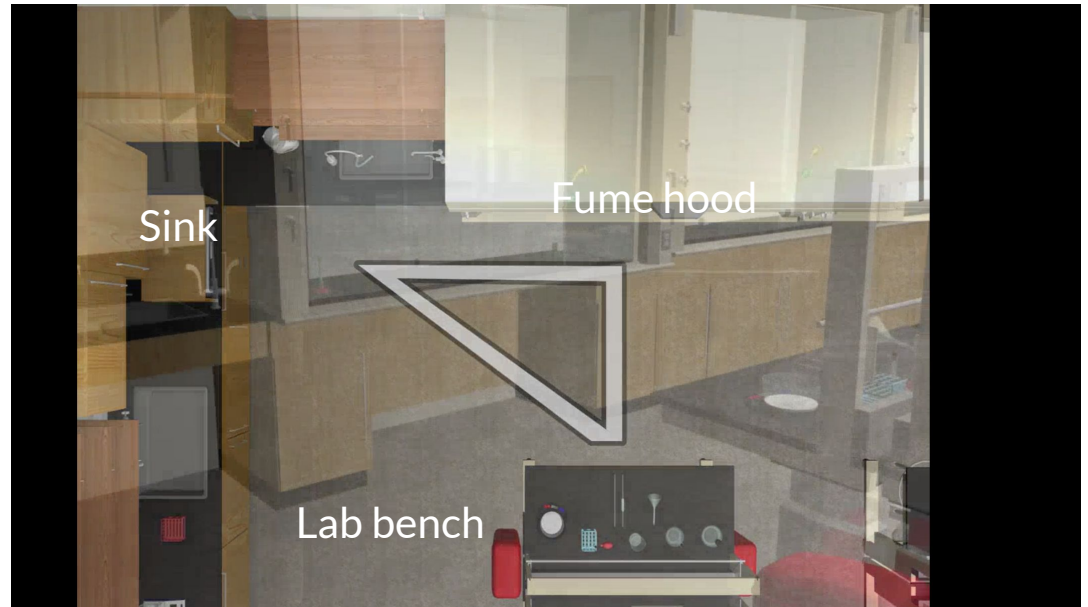
Virtual Tour of the Accessible Biomedical Immersion Laboratory (ABIL)

- Laboratory safety is critical for scientists
- Standard lab safety equipments are often difficult for research scientists with disabilities to use
- Safety setup (Emergency Shower and Eye Wash) designs for the ease of use for persons with mobility or visual impairment
- More leg room for wheelchair users
- Shower pulls handles: 2 different heights → fulfill the needs of both standing persons and wheelchair users
- Braille labels on the shower pulls
- 3D lamp sign behind
- Signs about the direction to the safety setup on the floor



Virtual Tour of the Accessible Biomedical Immersion Laboratory (ABIL)

- Laboratory Triangle:
laboratory bench, sink and fume hood
- The three most commonly used areas are placed in close proximity in order to enhance
 - Work efficiency
 - Ease of use



The laboratory Triangle

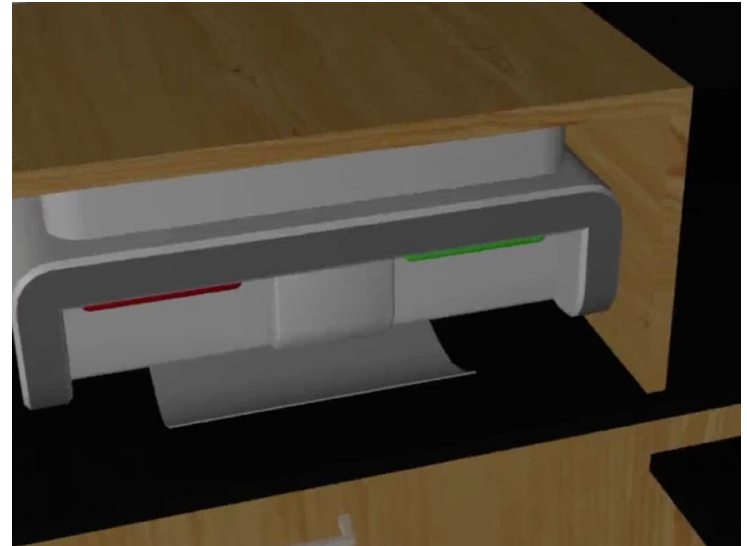
Virtual Tour of the Accessible Biomedical Immersion Laboratory (ABIL)

- Leg space underneath the sink for wheelchair users
- Larger paddle style handle that is easy to manipulate



Accessible lab sink

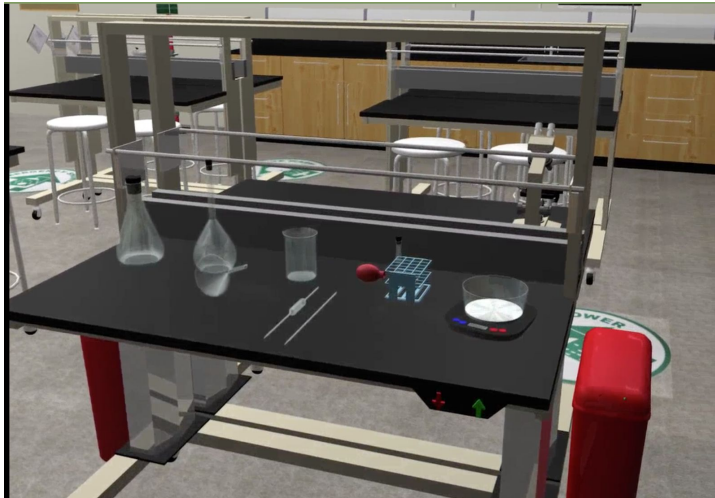
- Motion-activated paper towel dispenser and cutter---CleanCut



Automated paper towel cutter

Virtual Tour of the Accessible Biomedical Immersion Laboratory (ABIL)

- Motion-activated biohazard dispose bin
- Sound-controlled scale
- Lab benches with adjustable-height with a simple push button
- Standard twist-style valves are replaced with paddle-style valves which are easier to turn on or off



Accessible lab bench



Valves on the side of the fume hood

Deaf and hard of hearing

- Develop strategies for improving and expanding interpreter and captioner vocabulary
- Increase the inclusion of people who are deaf and hard of hearing in ongoing, federally funded research projects
- Develop strategies on how to facilitate interactions between hearing people and deaf/hard of hearing people



Workshop for Emerging Deaf and Hard of Hearing Scientists at Gallaudet University

Deaf and hard of hearing

- Accommodations in lab
 - Visual lab warning signals (such as strobe fire alarms)
 - Written instructions provided prior to lab activities
 - Extra time allowance for setting up and finishing up lab work
 - Preferential setting → ensure visual access to the instructor, demonstrations and captioned videos
 - Accessible lab space where lab benches and ventilation hoods are configured in ways that will not obstruct sight lines



New accessible lab room for the deaf and hard of hearing students at Gallaudet University. Professors' movements were filmed and a design was made based on the filmed observations.

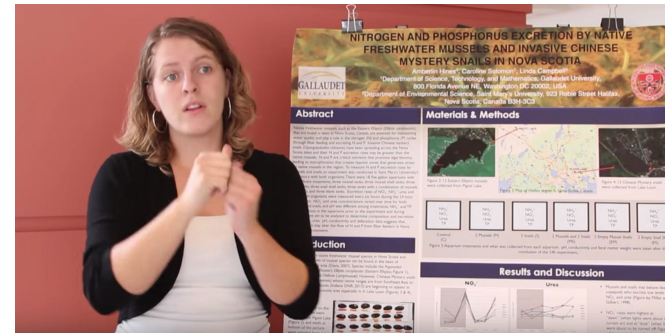
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Case study 1 -- Science students at Gallaudet University

- Actively signing in lab as a mode of effective communication
- Workshops for emerging deaf and hard of hearing scientists
 - Vertical mentoring
 - Network mentoring
- Create access to summer research at other institutions
 - “STEM Matters Poster Session”



A normal lab scene at Gallaudet University
GallaudetU. (2010, December 07). Retrieved April 23, 2019,
from <https://www.youtube.com/watch?v=L-0gmbh9nVE&t=333s>



A student presenting her summer research at
the “STEM Matters Poster Session”

Case study 1 -- Vertical Mentoring and Network Mentoring



- Vertical mentoring (Cascade Mentoring)
 - Has been successful for Women in STEM
 - Vertical mentoring between the deaf and hard of hearing students who completed the Research Experience for Undergraduates (REU) programs and younger students who might be interested in one
 - Great success in matching people with similar interests
- Network mentoring: mentoring among different people at different levels
 - Study has shown that a successful mentor can differ from the mentee in terms of gender, ethnic background, field of study, disability status and socioeconomic status (Frierson et al. 1994)
 - Having more than one mentor in the field is preferred

Case study 2 -- Daniel Gillen at Haverford College

- Physics:
 - Braille textbook
 - Sonification equipment to transform waves into sounds
 - Programs such as Logger Pro, MATLAB and Mathematica have built-in functions for sonifying data
 - Published the method in *The Physics Teacher*



Aided by sonification equipment, Daniel Gillen in the Physics 211 lab at work on a torsional oscillator.

Breaking Down Barriers in STEM for Students Who Are Blind or Visually Impaired. (n.d.). Retrieved April 23, 2019, from <https://www.haverford.edu/college-communications/news/breaking-down-barriers-stem-students-who-are-blind-or-visually-impaired>

Case study 2 -- Daniel Gillen at Haverford College

- Linguistics
 - Tactile magnetic board
 - Phonemes and various linguistics terms that govern grammar were printed in raised type on sticker paper
 - Around 200 stickers were applied to magnets
 - Double-way communication (accessible both visually and tactically)
 - Daniel can touch the tiles and decipher them
 - Sighted classmates can see the tiles and read them
 - TAs arranged the magnetic tiles on the board to update the information on the chalkboard
 - The magnetic board was also used for in-class worksheet



Daniel Gillen manipulated the magnetic tiles.

Linguistics Professor Helps Create Tactile Magnet-Board System for Blind Student. Retrieved April 23, 2019, from <https://www.haverford.edu/college-communications/news/linguistics-professor-helps-create-tactile-magnet-board-system-blind>

Disability as a different perspective



Q: “What skills and insights do you think scientists can bring to the workplace as a result of their disabilities?”

A: “**Versatility.** Sometimes we have encountered problems or barriers in the workplace due to our disabilities, but we've found ways to remove them. As a result, we tend to have **a greater understanding and awareness of problems and how to deal with them** than do scientists who have no disabilities. We also view the world differently, so we can provide **a different perspective on real-world problems and models.** Colleagues and peers can **learn from these experiences and broaden their own skills and understanding.**”

----Dr. Ken O’Neil, a deaf statistician in the input-output statistics branch of the Office of the Chief Economic Adviser in the Scottish government.


Research Fellowship for students with disabilities



Available through https://stemedhub.org/groups/iashub/research_opportunities

- [IAS Summer Undergraduate Research Fellowship](#)
- [Experiential Learning for Veterans in Assistive Technology and Engineering \(ELeVATE\)](#)
- [Integrative Graduate Education and Research Traineeship in Rehabilitation Engineering](#)
- [National Science Foundation Graduate Research Fellowship Program](#)
- [Lighthouse International Scholarships and Career Awards](#)
- [Lime Connect Fellowship](#)
- [EntryPoint_AAAS](#)
- [AccessSTEM, Washington](#)
- [John Hopkins Summer Internship Program](#)
- [STEP-UP Summer Research Experience](#)
- [TEAM-Science: Training, Education And Mentoring in Science](#)

Take-away



- Inaccessibility has been a huge issue which impedes students with disabilities to enter the STEM field and choose a STEM career.
- There are current practices that increases the accessibility of STEM for blind or low vision people, wheelchair users, deaf or hard of hearing people.
- Two case studies serve as concrete examples of how to make STEM more accessible and tailor to students' need in an institutional setting.
- However, there are much more changes needed to be make to make STEM welcoming and accessible for disabled people who are passionate about science.
- There should be increasing public awareness that the disabled scientists can bring a brand new, different and valuable perspective to tackle real-world problems. There should be a call for disabled people to choose a STEM career.

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