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Leading Practices for Improving Accessibility and Inclusion in Field, Laboratory, and Computational Science – A Conversation Series
Transcript of keynote talk by Dr. Brad Duerstock

NOTE: This is an unedited transcript of a keynote presentation prepared for the Accessibility and Inclusion in STEM conversation Series held on January 25, 2022. The transcript was prepared by Katalyn Voss and is not an official report of National Academies of Sciences, Engineering and Medicine. Opinions and statements included in the transcript are solely those of the individual speakers at the Accessibility and Inclusion in STEM conversation, and are not necessarily adopted or endorsed or verified as accurate by the National Academies.

Hi, I'm Brad Duerstock at Purdue University. I use the pronouns he/him. I'm a white male and a tetraplegic wheelchair user due to a spinal cord injury. My virtual background shows the Purdue campus. Itis my pleasure to talk to you about the lessons learned and strategies we developed for improving accessibility of biomedical lab environments. I hope this will be instructive for further conversation on promoting the inclusion and active learning experiences for persons with disabilities in STEM.

Traditional biomedical lab environments or wet labs are pervasive in secondary and post-secondary educational institutions and research centers across the country. They typically have similar features and fixtures:sinks, fume hoods, cabinets, lamps, lab benches, and a variety of scientific instruments for different life sciences and engineering disciplines; however, frequently these elements pose significant barriers for students with physical disabilities, preventing them from actively participating in basic lab activities.

I like to show this slide that shows us where we've been and kind of help us propel prepare ourselves to where we'd like to be.

In this slide on the left side is a World War II era poster that reads: America needs all of us and it shows a worker with a hand amputation performing some type of engineering task. This was a reaction to the dearth of workers needed at the time because of the absence of able-bodied workers that joined the war effort. On the right hand side are two pictures of motion studies being conducted by Frank and Lily Gibrath. Both professors at the time at Purdue University they evaluated the movements of return returning soldiers with disabilities performing vocational tasks such as typing. This work began during World War II and continued on until after World War One started andcontinued to after World War II. They saw such a large influx of disabled soldiers that were unable to return to the workplace due to inaccessible condition. There's a quote by them that reads: "the injured man must be made to feel that he is not an object of charity but that he is a handicapped contestant in the world of active people."

So they saw this challenge of how to get these young people back to their original lives. The prevailing thought was among really a lot of people in health care in this area was that how do we fix these people to become more normal again and many of you familiar with the medical and social models that portray the prevailing idea or view of disability but the Gilberts were big proponents on defining that the problem is not in the person but in the environment, so how do we make workplace conditions more accessible.

We go today and look at the area of STEM inclusion and we see that there is the same number of students with disabilities or without disabilities that are wanting to enroll in post-secondary education in the sciences and engineering; however the number of students with disabilities that actually and ultimately get a career in STEM is quite low. The attrition rate is very severe of students with disabilities going and getting a degree a doctorate of masters in STEM which are important to become a scientist or engineer or a physician.

So this is the problem that we decide to look at in an initiative called the Institute for Accessible Science or IAS which was established through the NIH Director's Pathfinder Award. We wish to facilitate the practical or hands-on lab activities, which we found to be a major barrier to the ultimate success of students in post-secondary and advanced graduate degrees pursuing STEM.

One of the reasons is activity-based learning is critical to STEM pedagogy, and we found that students with physical disabilities often stayed away from lab-based undergraduate courses due to perceived and real barriers. And then upon reaching graduate school there is a need for conducting independent research that is also daunting to those with disabilities. So we focused on how to promote their accessibility not to do away with practical education and independent research because research is very dependent on the technologies that you use the scientific equipment understanding how that equipment works and their limitations is very important in designing experiments for research.

So we first wanted to look at the lab environment, the architectural access. We were lucky to have access to a state of an art wet lab that we could study to investigate. In this facility we found that in the periphery of the lab was the stationary fixtures: the fume hoods, the sinks, the cabinets. And then the middle center of the lab were mobile lab benches that could be reconfigured according to how many students were taking the class or to accommodate those students with disabilities that needed more space.

In addition these lab benches were height adjustable so that it could accommodate wheelchair users, those wanting to stand, those seated on stools.

In terms of performing activities lab tasks within this environment we decided to look at three stations: the lab bench, the fume hood, and the sink. And you see all these are wheelchair accessible using the idea of the kitchen work triangle again proposed by Lillian Gilbreth. And if you're not familiar with that, that's the idea of for maximum efficiency in the kitchen think about the proximity of the kitchen sink to the refrigerator and the stovetop but instead in the lab we look at the sink, fume hood, and lab bench as being three crucial areas that students with any disability or with that disability need to navigate. If they're too clustered together it causes a lot of congestion. If it's too far apart it causes a lot of wasted energy and is also very inefficient. So the different sides of the triangle show an optimal position distance of these three areas for students with disabilities especially those with visual or mobility impairments being able to navigate that without really having to worry about running into other students or without expending a lot of energy, really increasing their efficiency.

Another aspect of the wet lab environment was looking at lab safety.

Of course that's an important part and this lab also had your typical emergency shower and eye wash. You can see here in the left image that we had to extend them out from the water line because it didn't allow for the knee clearance of wheelchair users. We also added another pole for the emergency shower because the other one was too high and could not be reached from someone sitting in a wheelchair.

Other tips that we found was using motion activated containers for receptacles, for sharps disposal, for waste, for soap and paper towel dispensers. This allows it to be very accessible because it's hands-free and does not require fine motor skills and also decreases overall contamination among different users. A lot of the solutions that we found that makes the lab accessible for people with disabilities really this makes good common sense and improves efficiency for all users.

Last I'll be talking about lab instruments. Every physical, every wet lab has an array of different lab instruments, some more sophisticated than others.

A basic tool of most biomedical labs is the microscope. In a project called Axiscope we automated a research level microscope so it could be completely operable through a computer interface that could be adapted easily according to one's disability. We first looked at those with upper limb mobility impairments who had difficulty hitting all the buttons turning all the knobs of a microscope as well as incorporating an automatic slide loader so they didn't have to put the glass slides on the stage. It could be done through this robotic platform. We also found the system to be very useful for those with low vision by bypassing the eyepieces and allowing them to use a large monitor to view microscope specimens. But not all accommodations for instruments need to be high-tech. In a case study where we helped a veterinary technology student who had low vision were able to use many off-the-shelf solutions.

For histology and psychology we used a microscope - this is a student microscope - with a video camera and a laptop specimen. For near viewing such as for dentistry and gross anatomy, she used an illuminated head loop typically worn by surgeons and for long distance viewing she used a binocular that could be used to observe such things as the gate of running horses to check for lameness.

So a lot of these solutions didn't take a lot of money or high-tech problem solving, but just the ingenuity and ability to put yourself in the place of the person that needed help.

One more area that we're currently looking at is incorporating more lab robotics. These robots can be used for not only high-end scientific procedures but also for more mundane lab tasks such as a mobile robot for conveying specimens from one location to the next without worrying about spelling it or dropping them. Or using a robotic arm for manipulating glassware for pouring solutions from one container to the next.

The issues that we found to be most difficult when using operating robots though was needing to use different ways of interaction. No contact operation, using speech and gesture recognition, was found to be very helpful.

Also getting feedback from these robots is very important.

Instead of relying solely on visual inspection you can get auditory or haptic or temperature feedback of whatever object you're manipulating.

I want to briefly talk about some other barriers to inclusion in STEM that we found was that students have been shown to really benefit from science or STEM internships, but many students with disabilities, such as those with difficulty with self-care, cannot simply go to another state during the summer for an eight-week internship. Sometimes that is not practical or feasible. So how do we provide these internships to students with disabilities and making sure they have the accommodations that they need to be successful?

Current supplemental support to accommodate students through the NSF, NIH,and other agencies in a survey of Purdue researchers, we found that most were willing to provide some level of accommodations and many more were willing, but needed assistance, and just a few felt that accommodations were too difficult and why bother since they already have access to qualified students without disabilities.

So where supplementalsupport for accommodating a student in the lab is very helpful in retaining them it doesn't do a lot with recruiting students in the future because the supplemental support is dependent on the advisor already having an existing an award. So they can't anticipate if the next one will come or if the length of an award which could be two or three or four years is long enough to support that student with a disability. We find that most students with disabilities do need extra time in their programs doing research and that also can be a problem with their success. These extrinsic factors, such as working with a professor that is non-tenured, means that the professor has to come up with funding they may not have, yet putting out a lot of publications in a quick time frame.

So simply having a tenured advisor with consistent funding and having a lab with other staff and students to support the student with disability can dramatically increase their success. So how do we include these factors that are really important to overall inclusion of students with disabilities in STEM?

Since the pandemic we have found a renewed interest in providing virtual training using virtual reality.

We also looked at this.

And on the left you see a video of someone using a typical VR headset, and on the right, an exact replica of the wet lab I was just discussing previously. But in this case they are able to perform a lab task that is annotated and given views take this specimen there and this allows them to understand the lab procedure prior to going or visiting the lab. Also it shows here a wheelchair navigating within that work triangle of the fume hood and lamb bench and sink and so it allows them to see what are the space restrictions they may face. The importance of this is that too often when you go into a lab you're faced with: how do I get accommodated? How do I know I'm not going to hit something? Break something? And they cannot focus on really the science of what they're supposed to be doing in that lab, so VR gives them that preparation. Another benefit of 3Dmodeling is that it can also allow other people without disabilities to get a perspective of what someone with a disability is viewing in the lab. In the left hand top left is a picture showing a wheelchair user at a lab bench.

Wheelchair users are faced with the inability to laterally move side to side, so if something is on the lab bench that is beyond the reach they have to back up the wheelchair, pivot, reposition the wheelchair. Doing that several times can be very inefficient and tiresome.

Likewise there's another picture that shows a tunnel vision view of someone with visual impairments and what they see in the lab, scanning the lab. Seeing all the different areas is very difficult for ; although they can focus on one area, anything outside their field of view they cannot see. So when they're doing a lab task they may be able to use their vision, but getting objects that are outside their field of view they rely on the fact that some objects are going to be where they put them, that they're not going to move, that they're not going to change, so they can focus on the lab procedure while reaching for the different objects they need to form to perform that lab task.

Last I just want to mention that we also incorporated ergonomic analysis in this 3D simulation so that even though something is accessible, perhaps using ADA guidelines, if someone is at the 95th percentile they also face issues of musculoskeletal strain especially doing repetitive motions such as pipetting that is very common in lab environments. So that is something to consider: even though something is accessible, it's not going to be accessible to every single person with a disability; whereas height adjustable lab benches really benefit everyone.

So let me just conclude that STEM does need all of us.

But I don't see it as simply as an issue of wasted resources, of not using people with disabilities, or equity of not having deserved a place that's important but it's also a missed opportunity not to engage people with disabilities in STEM because they have unique perspectives that they can offer. People with disabilities have a special insight in medical conditions and health care that those without disabilities frequently don't have.

Likewise currently how we interact with technology and view the world is very visually-centric and relies upon manual manipulation. People with disabilities can view and interact with the world on a very different level which affords us great possibilities in research in the future.

So thank you for this opportunity to share what we found. I’m very grateful to the National Academies of Sciences, Engineering and Medicine for this opportunity. I provide some contact information. Feel free to reach out to me and I look forward to furthering this conversation during the series. Thank you.