
The Access and Equity for Students with Disabilities (SWD) in STEM Higher Education

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Access and Equity for Students with Disabilities (SWD) in STEM Higher Education

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Abstract: A diverse student body is one that includes students with disabilities (SWDs). A lack of institutional support often marginalizes SWDs from actively participating in the STEM community thus removing a large talent pool from the STEM field. Currently there are several reactive higher education policies that begin to support SWD, and therefore not effective in fully supporting SWD. Mostly accommodations are provided to SWD on request. These accommodations are limited modifications that often do not prioritize the student. By making higher education more proactive and empathetic to SWD, we can truly make the student body diverse.

Keywords: DisCrit; STEM; Higher Education

Knowledge Focus: Best Practices Focus

Topic: Postsecondary Education & Employment

Introduction

Diversity in Science, Technology, Engineering and Mathematics (STEM)

Issues of access and equity in education are often discussed and addressed through notions of diversity. An equitable and accessible institution would recruit and retain a diverse group of students, which include students with disabilities. There has been a big push by higher education to promote and support diversity (Pippert, Essenburg, & Matchett, 2013; Smith, 2015; Smith & Ota, 2013). Universities have adopted several practices to increase diversity like appointing a senior level diversity officer or establishing an office for diversity and inclusion to increase recruitment and retention of students with disability (Kwak, Gavrila, & Ramirez, 2019). Despite such efforts by the institutions to increase diversity, the data on student admissions, persistence and attainment shows that there is still a lack of adequate representation of students with disability (Smith, 2015).

This lack of representation within higher education is also reflected in the Science, Technology, Engineering & Mathematics (STEM) fields. Currently 12% of the U.S. population

has (identified with) some form of disability (Moon, Todd, Morton, & Ivery, 2012). However the numbers in the workforce do not reflect these distributions, especially in STEM fields. Presently only 2% of the STEM professionals are people with disabilities. For students in post-secondary education, the numbers reflect the same issues of underrepresentation: 9% of the student population in undergraduate STEM fields, 5% in graduate STEM programs, and less than 1% in the doctoral programs (Moon et al., 2012).

In order to truly increase diversity in the STEM fields we need to create spaces that provide access and are equitable to a diverse student body that includes students with disabilities (SWDs). SWDs bring in unique perspectives that are essential for innovative STEM research. A range of abilities and disabilities are a part of this diversity. Every student irrespective of ability must have access to opportunities to excel and participate in the STEM field.

For the purpose of this study we use the terms students of color (SOC) and students with disability (SWD) to represent the groups of students discussed in this paper. The Americans with Disabilities Act (ADA) (1990) defines a person/student with disability as an individual who, “1) has a physical or mental impairment that substantially limits one or more major life activities, 2) has a record of such an impairment, or 3) is regarded as having such an impairment” (Americans with Disabilities Act [ADA], 1990, sec. 12102). Although we acknowledge this definition, we also recognize that this definition is derived from a traditional medical model (where the disability is a biological abnormality) and provide a deficit view of SWD. For this study, we utilize the social model to guide and inform our research design and therefore define disability from a subjective point of view—dis/ability arises from social interpretations and responses to bodily differences. This shifts our focus on the strengths, knowledge and skills SWD brings to institutions. Similarly, students/people from non-White identities of race and ethnicity are recognized as students of color, which is derived from critical race theory (CRT), which is one of the guiding theories of our study. CRT prioritizes the voices of non-dominant groups and therefore focus on non-White voices making students of color a priority in the design.

Higher Education Policies for Students with Disability

There are several disability rights laws that discuss the rights of SWD within educational spaces. They include Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA) (1990 and amended in 2008), Assistive Technology Act (AT) (2004), Rights Information and Statute Citations; included is a short summary of these policies (Bersani & Lyman, 2009):

- Section 504 of the Rehabilitation Act of 1973: Prohibits discrimination based on disability.
- ADA: Rules on how to make American society more accessible to people with disabilities. Title II and Title III pertain to accessibility to public services and to buildings.

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- AT: Improve the availability of assistive technology to individuals with disabilities and to develop mechanisms to raise funds for devices.

There are also a number of programs set up by government agencies, private and non-profit initiatives that promote recruitment and retention of SWDs and provide funding for research in disability studies. Some examples are Research in Disabilities Education (RDE), a program within Human Resources (EHR) of the National Science Foundation (NSF), and more recently the EHR Core Research (ECR): STEM Learning and Learning Environments, Broadening Participation, and Workforce Development (NSF 19-508); Improving Undergraduate STEM Education: Education and Human Resources (NSF 17-590); Faculty Early Career Development Program (CAREER) (NSF 17-537).

The U.S. Department of Education (USDOE) also currently houses the Office of Special Education and Rehabilitative Services (OSERS). The OSERS includes both the Office of Special Education Programs (OSEP), which serves children with disabilities, and the Office of Vocational Rehabilitation (OVR) for adults (Bersani & Lyman, 2009). Another relevant division is the National Institute on Disability and Rehabilitation Research (NIDRR) that provides funding to advance research in helping people with disabilities live successful lives.

Institutional Practices for Diversity in STEM Higher Education

Institutional practices for diversity include programs, policies and actions taken for the preparation of SWD for STEM, access to STEM postsecondary education, persistence in the institution and finally graduation, which includes attainment of degree and employability. As we stated earlier, higher education institutions have mission statements prioritizing diversity, however the campus culture and climate often do not align with these statements (Weatherton, Mayes & Villanueva-Perez, 2017). A survey of messages from orientation offices or other representatives of universities do not specify what diversity entails. Diversity is left open to interpretation and there is no targeted or active recruitment of SWD (Haller, 2006; Martin et al., 2011). One of the biggest barriers to college access for SWD is their preparation towards higher education. Munro and Elsom (2000) noted that school counselors and science teachers often did not encourage SWD to pursue STEM paths like taking advanced or required science courses for STEM undergraduate programs, or providing information on STEM careers.

A significant barrier to the persistence of SWD and consequent graduation is the support (or lack thereof) of staff, faculty and peers. Researchers have noted that STEM faculty (Marshak, Van Wieren, Swiss, Ferrell, & Dugan, 2010) and laboratory instructors (Hill, 1996) were often not accommodative towards SWD. They lacked the training to successfully support their students in STEM classrooms or were unaware of the practices and policies of the university for SWD. SWD also have expressed feelings of isolation, the desire to avoid stigma or lack of insufficient knowledge of their own rights and understandings of disability, further

exacerbating the challenges SWD encounter as they progress through their program (Marshak et al., 2010).

Despite the reforms in policy and institutional mission to promote diversity and support SWD, there is a lack of representation of SWD in the STEM field. The first issue often faced as we see above is a lack of institutional support. Some institutions deemed the process for accommodating SWD, especially with visual impairments, burdensome (Oguntoyinbo, 2014). Several higher education systems were also investigated by the federal government for lack of compliance to the ADA requirements. Further complications stem from the unspecific criteria set forward by the Departments of Justice and Education. Another hurdle, according to some administrators, is supply and demand of assistive software that can support the learning of students with disabilities like blindness or deafness. Unless there is high demand the software is not produced by industries nor procured by universities. SWD also often feel the ignorance of faculty and staff members and this makes it difficult to get the help they need. Certain universities do not offer disabilities service training to faculty and staff. This severely hinders their learning experiences and opportunities (Grasgreen, 2014).

The most commonly implemented policy in U.S. colleges and universities is the ADA but, as we stated earlier, its implementation is often left to interpretation by the administration that does not adequately support SWDs (Moon et al., 2012). Beginning from this inadequate enactment of the ADA in higher education spaces, the purpose of our paper is to examine the experiences of a SWD as they enter into a STEM higher education institute and navigate these often inaccessible and exclusive spaces. Through the experiences of the SWD, we hope to illustrate how institutional policy is interpreted and practiced within STEM higher education that despite promoting inclusivity, falls short of that agenda.

Our goal for this study is therefore to develop a model that offers a guide for the interpretation of policies, implementation of programs and practices of faculty and staff in a university. We hope to provide a guiding framework that defines inclusivity from the perspective and voices of SWD in order to truly include them in the discourse and practice of diversity.

Theorizing Institutional Practices for Diversity: Dis/ability Critical Race Studies (DisCrit) Perspective

Disability, due to its origins from the medical model, was often interpreted as a biological category, instead of a social one like race or gender. Due to this, disability was conceived as something to be fixed abnormality that was only the concern of the medical community (Linton, 1998). This caused SWD to be left out of conversations of equity and social justice the way race or gender are often addressed within institutional practices and policies. In addition, SWD who also belong to other minoritized/non-dominant communities often have to

choose where to stand when these forms of identity are in conflict with each other, which is not addressed in earlier disability models and studies.

For this study, we utilize the dis/crit model (Annamma, Connor, & Ferri, 2013) to inform our design and analysis because it offers a ‘dual analysis’ of ability and race utilizing concepts from Critical Race Theory (CRT) and Disability Studies (Annamma et al., 2013). DisCrit framework is about critically exploring and analyzing the ways in which race and ability (and other aspects of identity like gender and class) are constructed in society through social interactions and institutional practices and policies. We investigate the structural powers of racism and ableism by, “recognizing historical, social, political and economic interests of limiting access to educational equity to students of color with disabilities” (Annamma et al., 2013, p. 7). This critical examination also extends to understand how these institutionalized practices (macro-levels of racism and ableism and other structural discrimination) are enacted affecting students of color with disabilities (SOCWD) than white students with disabilities (Crenshaw, 1993; Solórzano & Yosso, 2001). Crenshaw’s (1993) intersectional theory in CRT strengthens the understanding of the intersections of race, ability and other identity elements.

We also re-conceptualize disability and therefore our definition of a SWD. Within this view, dis/ability is viewed as subjective – dis/ability arises from social interpretations and responses to bodily differences. This understanding of dis/ability acknowledges a dominant normed body against which all other differences in the body is compared against. Ability/Disability is also dependent on context. For example, individuals in wheelchairs are ‘disabled’ by buildings with stairs. We provide a brief description of the essential elements of the DisCrit framework below that informs our model.

Tenets of DisCrit:

1. DisCrit illustrates how racism and ableism circulate interdependently, often in neutralized and invisible ways, to define what or who is considered ‘normal’ (Collins, 2013; Ferri, 2010). Institutionalized racism and ableism alone do not shed light on the persistent inequities that student of color with a disability (SOCWD) encounter because both whiteness and ability are seen as normal and every other individual is identified in relation to this (Annamma et al., 2013; Ladson-Billings & Tate, 1995). DisCrit also does not claim to want to achieve whiteness or ableism standards for these students but instead recognizes the unique perspectives and values SOCWD bring to the table (Erevelles, 2000).
2. “DisCrit values multidimensional identities and rejects notions of a singular identity such as only race or dis/ability or class or gender or sexuality, and so on” (Annamma et al., 2013, p. 56). DisCrit includes recognizing how race, immigration status, gender, class and other markers of difference contribute to the understanding of dis/ability. It therefore

acknowledges the difference in experiences in SOCWD and how they negotiate these complex identities.

3. DisCrit emphasizes the social constructions of race and ability (rejecting race and ability as *biological facts*) and yet recognizes the material and psychological impacts of being labeled as raced or dis/abled, which sets one outside of the western cultural norms.
4. DisCrit privileges voices of marginalized populations, traditionally not acknowledged within research. It creates a space to encourage or attend to counter-stories (Solórzano & Yosso, 2001) of non-dominant students illustrating the ways the students navigate these deficit perspectives. DisCrit also insists on reading these narratives “against the grain of master narratives” (Annamma et al., 2013, p. 13).
5. DisCrit considers legal and historical aspects of dis/ability and race and how both have been used separately and together to deny the rights of some citizens. This is especially important in the STEM field because science was often used as a tool to justify discrimination. Phrenology, eugenics, etc. were utilized to ‘prove’ that people of color (POC) and people with disabilities (PWD) were less than - less intelligent. This ‘pseudoscience’ was then reified through modern clinical and medical practices maintaining the deficit views of SWD and SOC.

We also see how legal policies have offered specialized services that have failed to support SWD through varied, inadequate and deficit interpretation leading to segregation and stigmatization of these students.

6. DisCrit recognizes whiteness and ability as ‘property’ and that gains for people labeled with dis/abilities have largely been made as the result of interest convergence of White, middle-class citizens. Whiteness and/or ability (normalcy) are linked to economic benefits to those who possess or claim these ‘properties.’
7. DisCrit requires activism that links academia to the community and supports all forms of resistance. This ensures that theory and ideas include the experiences of SWD thereby making it more practical in serving these students for whom the theory is constructed. It also recognizes various forms of activism beyond those are ableist like sit-ins and marches to include ways in which SWD advocate for themselves and others.

Towards a Model of Dis/Crit Institutional Praxis for Diversity in STEM

Figure 1. Three Part Model for Insitution Diversity Praxis

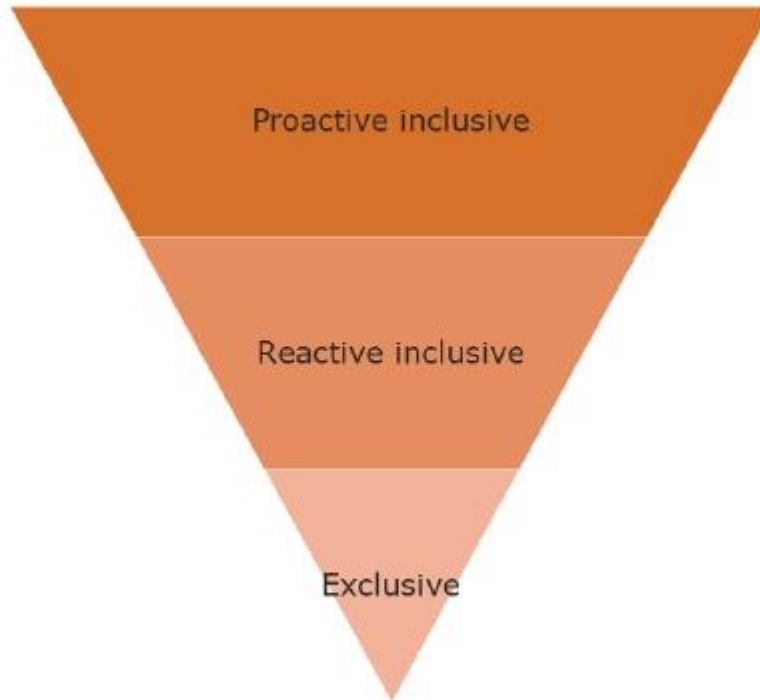


Figure 1 Image Description: Image of inverted triangle with three tiers: “Proactive inclusive,” “Reactive inclusive,” and “Exclusive.”

The above figure depicts the three-part model for Institutional Diversity Praxis. We use the term praxis instead of practice to denote the shift from habitual or customary action (practice) to informed and committed action through critical reflection that leads to empowerment and emancipation (praxis) (Yamamoto, 1996; Zuber-Skerrit, 2016).

This model distinguishes praxis into three categories, each occupying a level based on inclusivity: (a) exclusive praxis - least inclusive and therefore lack of diversity, (b) reactive inclusive praxis - inclusive, but does not promote diversity, and (c) proactive inclusive praxis - most inclusive and promotes most diversity.

Proactive/reactive practices have been discussed previously in the literature, however, they have not been formally conceptualized leaving these terms vague and open to interpretation. We argue that due to this lack of clarity, there is an assumption that any practice taken towards diversity is inclusive. We illustrate through our examination of the university and the experiences of SWD, that reactive practices, although can be considered inclusive, often continue to marginalize SWD perpetuating the status quo with no real transformation of the university or experiences of SWD. We consider this important especially for STEM education,

because identity and the experiences of students are often not considered or valued in STEM education due to traditional notions of universal, authoritative, objective science (Harding, 1998).

We begin from the definition of proactive and reactive that is discussed in the literature and expand the definitions utilizing DisCrit to present a framework to guide institutional practice for diversity that truly is inclusive.

Exclusive

Actions taken by institutions that exclude SWD from participating in higher education due to lack of programs and practices that enhance college access, help retain students in institutions or support their success in attaining the degree and employment. These actions maintain whiteness and ableism as the norm, fail to acknowledge the experiences of SWD, especially SOCWD and view them as deficit or lacking. Implications for STEM include maintaining authoritative, White (eurocentric) perspectives of scientific knowledge and practices like inaccessible laboratories or scientific research that is irrelevant to the lives of SWD. These practices:

- View disability as a deficit and therefore does not consider to include SWD.
- Ignore multidimensional identities failing to account for gender, class, and race issues.
- Maintain disability as only a ‘biological fact.’
- Does not include voices of SWD in the design and development of services or practices for SWD.
- Does not consider legal and historical aspects of disability and its consequent interpretation.
- Actively discourage students’ advocacy, activism, and empowerment.
- Maintain the inequitable status that centers only whiteness (along with universal science) and ableism and marginalized or excluded students outside this category.

Reactive Inclusive

Actions taken by institutions through accommodations provided on request or when a need is identified. These accommodations are adjustments to an environment when it is not accessible to a specific student, for example, providing a sign language interpreter to translate a video presentation for a student who is deaf. These practices may encourage SWD to engage in higher education. These practices:

- Maintain racism and ableism as the norm. Therefore, SWD are viewed as lacking certain characteristics that can be ‘fixed’ with institutional support rather than acknowledging and appreciating the diversity in body and experiences.

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- Ignore multidimensional identities failing to account for gender, class, and race issues.
 - Maintain disability as a ‘biological fact.’
 - Does not include voices of SWD in the design and development of services or practices for SWD.
 - Does not consider legal and historical aspects of disability and its consequent interpretation. Does not consider how science was historically used a tool of oppression and maintains universal notions of science, instead of multicultural views.
 - Maintain the economic benefit of whiteness and ability, which demonstrates that gains for people labeled with dis/abilities have largely been made as the result of interest convergence of white, middle-class citizens.
 - Does not actively encourage student advocacy, activism, and empowerment.

Proactive Inclusion

Actions taken by institutions that adopt practices that are pre-empted and inclusive for many. For example, captioning the video so that all students can benefit from the enhancement is an example of Universal Design (UD). The captions not only benefit students who are deaf, but also English language learners and those viewing the videos in noisy (for example, a student union building) and noiseless (for example, a library). These practices:

- Do not claim to want to achieve whiteness or ableism standards for these students but instead recognize the unique perspectives and values SOCWD brings to the table (Erevelles, 2000).
- Recognize how race, immigration status, gender, class and other markers of difference from norm contribute to the construction of dis/ability. It therefore acknowledges the difference in experiences in SOCWD and how they negotiate these complex identities.
- Emphasize the social constructions of race and ability, rejecting race and ability as biological facts, and recognizes the material and psychological impacts of being labeled as raced or dis/abled, which sets one outside of the western cultural norms.
- Privilege voices of marginalized populations, traditionally not acknowledged within research. It creates a space to encourage or attend to counter-stories (citation) of non-dominant students illustrating the ways the students navigate these deficit perspectives. DisCrit also insists on reading these narratives “against the grain of master narratives” (Annamma et al., 2013, p. 13).
- Consider legal and historical aspects of dis/ability and race and how both have been used separately and together to deny the rights of some citizens.
- Are built on multicultural views of science.
- Require activism that links academia to the community and supports all forms of resistance. It also recognizes various forms of activism beyond those are ableist like

sit-ins and marches to include ways in which SWD advocate for themselves and others.

Case Study

We utilized methods of a qualitative case study (Stake, 1995) and critical participatory action research (CPAR) (McTaggart, 1997) to examine the experiences of a SWD in the context of the practices and policies enacted by an accessible university. Qualitative case study is a “study of the particularity and complexity of a single case, coming to understand its activity within important circumstances” (Stake, 1995, p. xi). We utilized semi-structured interviews to gather data to analyze the experiences of a SWD. The primary data sources include the audio recorded interview and transcript. This is supported by secondary sources, which include the university's information about accessibility, our email correspondences and reflective writings.

For this study, the researcher also is the participant because CPAR demands reflection on our own praxis and experiences in order to bring about change through action. We use our own experiences of the university as a starting point of reflecting on the inclusivity of practices to support SWD. The first author is a 35-year-old South-Asian, immigrant, heterosexual, and cis-gender woman who was born in Dubai, U.A.E. and moved to U.S. to pursue graduate education. She also identifies as a person with a disability. She was born with the condition muscular dystrophy which affects the strength of her limbs and therefore limits the mobility of her arms and her legs and uses a wheelchair. The second author is a 32-year-old South-Asian immigrant, heterosexual, cis-gender women who was born in India and moved to the U.S. to pursue higher education. She identifies as being able-bodied. Due to our focus on SWD, we only utilized the first author's reflection to understand the experiences of her multiple identities. The second author analyzed the interview data to create themes, which were shared with the first author to maintain truthfulness and trustworthiness of the study.

Context: The University

The study examines the practices of a predominantly white institution (PWI) in the southeastern part of the U.S. One of the main goals the University promoted is to become a globally and nationally recognized university. To achieve this goal, they state the following four characteristics and strategies:

- A diverse student body, faculty, and staff working in a climate of inclusion and respect;
- Technologically innovative and flexible learning environments that foster collaboration and student entrepreneurship;
- University-wide, comprehensive, user-friendly advising that empower students to achieve at every stage of their academic career;
- Increased affordability and accessibility.

The University has already shown commitment to the cause discussed in this brief. The biggest support in the University for SWDs is the Office of Access and Equity (OAE). The OAE coordinates policy and programs that work towards ensuring equal opportunity through compliance with federal, state and university policies, education and training programs, outreach programs, and research and evaluation. As part of their services the OAE works to comply with the requirements stated in the ADA and Section 504 of the Rehabilitation Act of 1973 to provide resources to students, faculty and staff through the newly constituted Student Accessibility Service (SAS).

The SAS is a system that provides resources and accommodations to students when requested. The resources include assistive technologies like read aloud software, screen magnification software, smart note taking pens, accommodations for housing and dining on request (catered to undergraduate students only) and sign language interpreters, often with additional costs for the student. For access to buildings and other physical barriers, there is currently an accessibility barrier report form. These physical barriers are only brought to notice through these report forms. Information to faculty to support SWDs is limited to only accommodations in classrooms made only on request through the SAS and only accommodations that prioritize the nature and content of the course before the student.

Participant: Sherli's Story

Sherli was a graduate student in the University. She loves Star Wars, Harry Potter, Mathematics, and game nights with her friends at her home. She was also actively involved in campus student organizations including the graduate student government. Sherli was born with the condition muscular dystrophy which affects the strength of her limbs and therefore limits the mobility of her arms and her legs. She moves around in an electric wheelchair faster than most of us can. Sherli identifies herself as a mathematician from U.A.E and India who is a wheelchair user.

On her first day here at the University she met with the Student Disabilities Services (now Student Accessibility Services, SAS). Sherli knew of such services provided by some universities from her experience with her previous university in another state in the U.S. Because of her experiences and being an older graduate student, she was able to ask the SAS for their support and accommodation. The building that housed her classes and office did not have door openers and the doors that were present were too heavy for her to open. Her first fall semester here she would wait outside in the cold, until a student walked by, who she could then ask for help to open the door. The restrooms were not accessible either so she would wait till she could go home. Sherli has a strong spirit and therefore is preserved despite these obstacles. She found support in her building administration and within a year there were door openers to her buildings. Within four years of her duration at the University, she could enter most, but not all buildings. She still however could not use the restrooms at the university, access buildings like

the conference center and often requires a friend to open doors because most buildings still lack door openers or they are placed too high for her.

Discussion

“Nothing about us, without us” (Charlton 2000).

In the above narrative that summarizes the experiences of Sherli, we see the numerous challenges she encounters and the ways in which she negotiates it, along with support from the institution. Most buildings and bathrooms were exclusive due to lack of door openers and heavy doors, despite following ADA recommendations. The institution offered support to Sherli in many ways to offset some of the initial challenges, but only after Sherli herself or her supportive department requested or demanded for it. These practices are reactive because:

- Services were asked for, initiated by SWD who built skills as a self-advocate. SWD also often feel it a ‘luxury’ when they do get help and therefore do not demand for equal rights but are grateful for minimal accommodation. (Oguntoyinbo, 2014).
- Installed door openers only for classrooms that she attended, not the entire university.
- Case-to-case accommodation. One of the University’s proactive practices is the accessible transport system. The university not only works in collaboration with the city to run accessible buses but also provides transportation to SWD when needed like rides to the airport or a conference.

Utilizing the DisCrit model, we also begin to see how immigration and class affect experiences of disability. Due to her socioeconomic class, Sherli was able to purchase an electric wheelchair, which is often not the case and further challenges SWD. We also see how her previous experiences in U.A.E. and India have helped her understand what accessibility means and the importance of it because of the lack of inclusive policies in the country. She learned to negotiate and navigate difficult situations, building resilience, which she utilized to overcome the challenges she faced in higher education to thrive in a STEM field.

Using our model, we see the range of institutional praxis, extending from exclusive to proactive inclusive. We believe that this is a great initiative, but there is still a lot more room for improvement. In order to achieve these goals, they must continue to support the existing SWDs and invite new SWDs through a more proactive system, rather than a reactive one. This would require making financial commitments for diversity a priority, a team of individuals dedicated to the cause and modifications on campus that are universally accessible. They already have the groundwork laid down in the University for these resources– the OAE, the SAS, and the financial plans laid out in future plans. We can expand these resources by tapping into other sources that encourage the support of SWDs like NSF grants that support diversity recruitment and retention and the other grant sources to support construction of accessible buildings. With the new recognized status of a quality institution that is also inclusive they would attract more students, community members, and industrial donors that would further invest in their cause.

Implications: Methods to Broaden Participation and Achievement for SWDs in STEM

To increase access to SWDs to STEM, we suggest a few examples of proactive institutional practices:

- **Universal Design (UD):** UD is “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design” (Burgstahler, 2009, p. 1). These ‘design for all’ principles can work to the benefit of all students in the STEM classroom or laboratory, while also fulfilling the role of accommodations for students with disabilities.

It is necessary to ensure students can enter and exit all available facilities, especially spaces like restrooms and emergency exits, easily and safely, as well as use them in the appropriate manner. The ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) provide important guidance for issues such as parking, entrance, egress, maneuvering through school buildings, and general space and mobility considerations that inform how we can accurately comply with ADA and support our SWD in meaningful ways to ensure their success rather than mere compliance.

- **Assistive Technologies:** Assistive technologies (AT) can assist SWDs in overcoming many of the physical barriers present in the laboratories, classrooms and in the field (American Association for the Advancement of Science [AAAS], 2014):
 1. Light Microscopy for Persons with Upper Limb Mobility Impairments or Low Vision: Light microscopes, an automated microscope workstation (AccessScope) are some of the ways to help with laboratory tasks (Figures 3 and 4).
 2. Accessible Engineering Laboratories like the Human Engineering Research Laboratories (HERL) at the University of Pittsburgh

Figure 3. A wheelchair user in a wheelchair-accessible fume hood.



Figure 3 Image Description: Photo of a wheelchair user in a wheelchair-accessible fume hood in research laboratory (AAAS, 2014).

Figure 4. Wet laboratory work triangle with: (A) Automatic adjustable height lab bench, (B) Wheelchair-accessible lab sink, and (C) Wheelchair-accessible fume hood.



Figure 4 Image Description: Three photos of wet laboratory work triangle with (A) Automatic adjustable height lab bench, (B) Wheelchair-accessible lab sink, and (C) Wheelchair-accessible fume hood (AAAS, 2014).

- **Programmatic Interventions:** We can further strengthen the services of SAS through additional support programs like First-Year College Transition Programs, academic support, mentoring (both professional and peer), exposure to STEM role models, individualized developmental advising (combines aspects of academic advising, counseling, mentoring and case management), internships and research experience as well as non-cognitive and personal skill development (AAAS, 2014).

Appropriate communication of evidence-based approaches and methods is important among all stakeholders involved in the inclusion of persons with disabilities in STEM. Programs that involve communications directed at SWDs should focus on self-determination skills (in particular, self-advocacy skills in postsecondary education), knowledge of and access to accessible technologies, role models and knowledge of STEM career fields. Communication directed at educators, administrators and policy makers should focus on conditions that have led to underrepresentation of SWDs, new technologies to help the students, inclusive teaching, research, and resources.

Conclusion

“We need to give each other the space to grow, to be ourselves, to exercise our diversity. We need to give each other space so that we may both give and receive such beautiful things as ideas, openness, dignity, joy, healing, and inclusion” (DePree, 2011).

Successful inclusive STEM classes are possible with open, accepting classroom environments, administrative support, effective teaching skills, special education support, peer mediation, appropriate curricula (including those with a hands-on approach), and disability-specific teaching skills (Moon et al., 2012). Max DePree’s quote above encapsulates the purpose

of creating diverse and inclusive STEM classrooms thus providing an empathetic space for SWDs.

Authors



Sherli Koshy Chenthittayil, Ph.D. in Mathematics and PostDoctoral Fellow at UConn Health. Her expertise in mathematical biology, helped her as a teacher to understand mathematics education involvement inquiry and participation. To develop participation, she designed group projects as well as mathematics trivia games. As a wheelchair user, she feels a personal need to increase diversity and inclusion at her university. To that extent, she was involved with her university's Accessibility Commission to assist in making Clemson more welcoming to students with disabilities.

Image Description: Photo of Sherli Koshy Chenthittayil



Nikeetha Dsouza has taught schools K-12 for three years and trained public school principals in India. She is currently pursuing her Ph.D. in Curriculum and Instruction at Clemson University. Her research interests include equity, language and culture in science education.

Image Description: Photo of Nikeetha Dsouza

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