Broadening the Equity Lens for STEM Teacher Education: The Invisibility of Disability

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Joe Schneiderwind hosts a science demonstration for neighborhood students and parents.

In this blog, we examine STEM teacher education as a means of broadening the equity lens to regularly include disability. We invite you to be co-learners with us. Some of you may be new to this topic; others may be experts. We need ALL of you. Normalizing the conversation around disability in STEM will benefit each of us and the teachers and students with whom we work.

We are not experts in this field. We are learners. As educators and researchers who are focused on STEM equity, we have become painfully aware of the exclusion of disability from discussions on equitable STEM teaching and learning and personal experience. Joe has been in the STEM field since he graduated with a B.S. in Engineering Physics in 2009. He was heavily impacted by a progressive disability that halted Ph.D. research and has been pursuing secondary teaching licensure at Metropolitan State University in Denver since 2019. During a "Call to Action" assignment in Janelle's multicultural education course, Joe became aware of the lack of literature relevant to students with physical disabilities in STEM courses and has been committing time to researching this issue further. He has been working to bring this apparent invisibility to light in order to improve educational opportunities for an underserved population. He has been learning a lot about STEM equity and pedagogy along the way as a Noyce Scholar, undergraduate research assistant, and Learning Assistant.

Janelle has been doing STEM equity work since 1997. For many years, she found that equity in STEM was typically associated with gender-based inequities, but her own work focused more on closing opportunity gaps in underserved racial, ethnic, and linguistic minority communities, along with intersectional identities. But she had never delved into any research related to disability; she felt that since she did not have any specialization in "exceptional education" that it would be inappropriate to consider that lens. Though she teaches about inclusive pedagogies such as Universal Design for Learning, it was Joe's research as a student in her multicultural education course that served as a wake-up call. She wants to "out" her own ignorance about disability because this is an issue that deserves far more attention among educators in general, and among STEM educators in particular. This dialogue should not be limited to the pages of special education journals.

Inequities and Underrepresentation in STEM

The current focus on broadening participation in STEM has led to increased attention to racial disparities and social justice. One general consensus among stakeholders is the need to racially diversify the STEM teacher pipeline. Research has shown that having a teacher of the same race/ethnicity can have positive impacts on a student's attitudes, motivation, and achievement and minority teachers may have more positive expectations for minority students' achievement than nonminority teachers (NCES, 2019). **Students certainly value seeing themselves in the curriculum and among their teachers, but where is the representation discussion for students with disabilities?** It does not seem to be a focus even within the field of special education, and is nearly invisible among general educators and teacher educators (Neca, Borges, & Pinto, 2020).

The STEM pipeline metaphor has been widely critiqued since it's only a "pipeline" for students who represent dominant identities. The underrepresentation of people with disabilities in the STEM fields is a persistent problem and is under-researched relative to other inequities in STEM (Duerstock & Shingledecker, 2014; Lee, 2020; Lindsay & Hounsell, 2017; Voelker, 2018). This problem is amplified for STEM teacher education. Teacher educators lament the challenges of recruiting students with STEM-focused majors into teaching, and there is an ongoing and intensifying shortage of teachers for the STEM fields. What can we do to build and diversify the STEM teacher pipeline to include and support educators with disabilities? "The well-known fact that efforts to increase the participation of women in STEM careers must start long before the university stage suggests that efforts to increase undergraduate disabled researchers must also start before the university level and that one has to expose disabled students in high school and earlier such as is done with girls" (Lillywhite, 2019, p. 10). Such efforts must be built on a strong foundational body of research, however, the amount of currently available research that could be used for these purposes is disappointing. Massive gaps in the research are made even more complex and challenging by the widespread underreporting and misreporting of disabilities among adults, making the issue even more invisible.

Trends in the Research on Disability, Teacher Education, and STEM

A search of the research literature for studies about STEM students and/or teachers with disabilities provided limited and largely outdated results. Our difficulty in identifying helpful research reflected the work of Peña (2014) who conducted a thorough search of peer-reviewed articles published in four of the top academic journals and found that only 1% of published work in these journals centered on disabilities. This underrepresentation of disability in the literature is even more troubling in the context of increasing college enrollment of students reporting disabilities. A smattering of articles can be found in the specialized disability/exceptional learners journals. Further, the articles that we found tended to be theoretical, medical, and/or pathological in nature, and did not offer the practical action steps we needed.

Several of the studies we reviewed and found to be more helpful for our purposes advocated for qualitative approaches to researching students with disabilities in STEM fields—these include chapters by Egilson and Traustadottir (2009), Lee (2020), Lindsay and Hounsell (2017), and Murchland and Parkyn (2010). On the quantitative side, Vaccaro et al. (2015) discuss the importance of critical quantitative research to promote equitable outcomes for students with disabilities:

> *For decades, literature has documented that practitioners do not find the scholarly literature useful. As such, critical researchers must strive to make study findings accessible and useful to those who create policy and work directly with students with disabilities (p 37).*

The most practical guide we found was a six-page piece from a journal called *English Education*, published in 2001, where Pope, Bowman and Barr warn us that many preservice teachers with disabilities do not contact offices of Affirmative Action or Disabled Student Services for accommodations. A greater number of the primary research articles were based on studies outside of the United States.

It will be of no surprise to readers that the American Association for the Advancement of Science (AAAS) has provided greater visibility to the issue than other organizations and publications. A recent ARISE blog by Ellis and Yeh reflects on disability and math education.

AAAS Entry Point! is a national effort to discover and develop talent among undergraduate and graduate students with disabilities who demonstrate a talent and interest in pursuing a STEM career.

But from our perspective, we wonder how do those students with disabilities get to college? How well prepared are their pK-12 teachers to engage and support them in building a strong foundation in STEM?

What do the data show?

We began by looking for data to show numbers of enrolled students with disabilities compared to those without disabilities and the types of disabilities, in particular for teachers or STEM teachers. The National Science Foundation's Women, Minorities, and Persons with Disabilities in Science and Engineering (2019) notes that "Women, persons with disabilities, and underrepresented minority groups—blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives—are underrepresented in science and engineering (S&E). That is, their representation in S&E education and S&E employment is smaller than their representation in the U.S. population" (NSF, 2019, p. 2). Figure 1 in the report shows that 10.6% of adults in the US population have a disability. Adding to the confusion, later in the same report the authors state that 19.5% of undergraduates report a disability, and that students with and without disabilities are enrolled in a science and engineering field at the same rate (28%). If those numbers are correct, people with disabilities are overrepresented in undergraduate education, and equitably represented in STEM majors. We find these statistics hard to reconcile. Additionally troubling is the 2019 NSF report title is somewhat misleading since it has sections on field of degree on women and minorities, but does not have a corresponding section on people with disabilities.

Problematizing the statistics even further, a longitudinal study by Newman et al. (2011) reported that roughly 37% of students who are identified as having a disability under IDEA in high school do not consider themselves to have a disability by age 17. This suggests the possible degree of underreporting by adults due to any combination of factors including social stigma, workplace constraints, or lack of accommodations. We were unable to find statistics on the number of teachers or teacher candidates with disabilities in general, therefore have no numbers on the percentage of teachers in STEM fields who have disabilities. Our frustration at what we were able to find in the research literature led us to initiate primary research. (Please read about our survey in the Call to Action section.)

Understanding the term "Disability"

We found that when the term "disability" was used without qualifiers; it was often used erroneously as a synonym for learning disabilities. This often leads to damaging generalizations (some found on the websites of national organizations) that equate to "students with disabilities are struggling readers" and "students with disabilities struggle in science." Much of the literature focuses on the pathology of disability (Lee, 2020). Vaccaro et al. (2015) note that "if included at all, research often utilizes disability as a singular construct, but doing so obscures significant differences among students with disabilities" (p. 29). The U.S. Department of Education and the Office of Civil Rights report on the number of students under the overarching category of "disability." While disaggregating the data could be problematic in terms of student privacy rights, little in these statistics point providers toward any constructive actions they can take. STEM teacher educators must understand the needs of the student in relation to the type of disability they have to facilitate student learning (Lee, 2020). We searched for what research in this area has been funded. The National Center for Special Education Research (NCSER) website (2020) lists research that has been funded on math and science, but links to a page that primarily examines research in math. That document begins with the statement "**Students with disabilities (SWD) lag behind their peers without disabilities at all grade levels in mathematics.**" This quote is also on the main page and refers to NAEP results (still a generalization without caveat or disaggregation). This represents a deficit-based generalization that is an approach common in the literature (Lee, 2020). The funded projects listed on the site overwhelmingly focus on learning disabilities; while certainly important, it does represent disproportionality of the resources and information available on the full range of disabilities.

Teaching and Teacher Education

Professional development on inclusive practices that benefit all students can help close gaps. "**Cultural and attitudinal barriers may exist a lack of understanding by teachers and support staff and result in assigning assistance to students instead of adapting or equalizing curriculum or settings**" (Egilson & Traustadottir, 2009, p. 265). Typical activities like speed-based games should not be overused, and curriculum should not be "dumbed down" (Lindsay & Hounsell, 2017). Teachers need to understand what technology is best aligned with particular student needs (Villa et al., 2005), and they can make assistive technology available to all students to reduce the possibility of stigma (Miller & Satsangi, 2018).

Access to STEM

Students with disabilities' limited access to the STEM pipeline is evidenced by notable under enrollment in STEM fields (Linsday & Hounsell, 2017). University faculty in STEM fields may have a deficit-based "weed out" mentality rather than considering inclusive accommodations. Though it may be unintentional, "teachers, instructors, and professors are frequently unable, unprepared, or otherwise ill-equipped to recognize and address the needs of students with disabilities. As a result, course content may be inaccessible" (Moon et al., 2012). An asset-based view of students with disabilities highlights their potential as researchers, more active citizens, and producers of knowledge (Lillywhite & Wolbring, 2019).

Implications for STEM Teacher Education Stakeholders

We would like to offer some recommendations for all STEM teacher education stakeholders, followed by more specific suggestions for teacher educators, in-service teachers, school administrators, university STEM faculty, and educational researchers. All STEM stakeholders need to be aware that while Universal Design for Learning and differentiation are important steps towards meeting the needs of individuals with disabilities, they do not represent a comprehensive solution, nor do they address the issues of bias and discrimination. If we truly want to change the patterns of underrepresentation of students and teachers with disabilities in STEM, there must be adequate and authentic representation at all levels of education. Good intentions are not enough.

One resource we recommend as starting point is a book by Moon, Todd, Morton, and Ivey (2012) that provides recommendations on accommodations for students with disabilities in STEM. The suggestions are based on disability classification and STEM discipline; included in the book is an appendix of NSF-funded projects for students with disabilities and a link to an assistive software database.

Teacher Educators

Critically review potential gatekeeping accessibility issues such as transportation, clinical field placement sites, and course scheduling. Revisit program curriculum for inclusive practices.

Based on our experiences with the teacher education program at our university, we speculate that many new teachers enter the profession relatively underprepared to meet the needs of students with disabilities. In order to obtain licensure in our state, there is only one course, "Exceptional Learners," that addresses some of the possible needs of students with disabilities. However, the course focuses more on diagnostics and legislation than it does on preparing new teachers to meet the needs of students with exceptionalities. Students may major in special education or receive additional endorsements, but especially in a climate which focuses on inclusion, we believe that every prospective teacher needs additional preparation and support in order to better assist these students.

With respect to teacher education students, we found our own program to be structurally unprepared to serve the needs of students with disabilities. In Joe's case, his clinical field placement opportunities were hampered because of a lack of accessibility for specific transportation needs, for example. Our review of the research and our own experience suggest a need for further professional development in all teachers' capacity for working with students with disabilities. A single course on Exceptional Students is not sufficient to prepare future teachers to educate these students. We recommend that programs revisit their curricula to provide practical ways for all teacher candidates to serve the needs of students. Teacher education programs should closely examine their enrollment statistics for proportionality of students with disabilities, and integrate disability as part of larger equity efforts.

In-Service Teachers

Build your toolbox to teach more inclusively and with high expectations for each student by working to unlearn biases.

For too long, we have relied on special educators to serve the needs of students with disabilities. Teachers need to examine their own biases about students' abilities. Assumptions that a student with a disability is less capable represent a microaggression. Disability activist Stella Young cautions against objectifying people with disabilities by praising them for their "bravery" or being "inspirational" or "exceptional" when they are just living their lives (2014). The National Science Teaching Association (NSTA) offers a helpful Glossary of Disability Terminology. The DO-IT website provides resources for teachers working with students with disabilities. It includes a range of information on legal issues, sample accommodations, and pedagogical approaches. NSTA published an excellent piece on motor impairments/orthopedic disability that includes causes, tips for general courtesy, a list of strategies for accommodation, and specific considerations for the laboratory setting, group work, reading assignments, field experiences, research, and testing. The piece also includes a list of organizations that offer information and resources, and a short list of disability-specific information.

School Administrators

Model being a learner to support needed cultural shifts to normalize disability.

School administrators play a key role in closing opportunity gaps for students and teachers with disabilities. Principals play an important role in creating spaces for equitable engagement by students, teachers, and family members with disabilities. School leaders have a strong influence on the topics included in the professional development calendar and can shape the kinds of conversations that are occurring at school. School administrators can serve as key advocates for teachers with disabilities during the clinical field placements in partnership with universities and also during the hiring process with an awareness of the negative attitudes, accessibility issues, and limited employment opportunities often faced by teachers with disabilities.

University STEM Faculty

Create opportunities for students and faculty with disabilities to engage in research and be aware of potential barriers.

Work to build STEM and STEM teaching pipelines for students with disabilities, keeping in mind that college students underreport disabilities. Be mindful of deficit views of the academic potential of students with disabilities by faculty and/or by the students themselves. Duerstock and Shingledecker (2014) recommend attending to assistive technologies, programmatic interventions, and the need for interdisciplinary communication and longitudinal approaches. Their publication is a solid, practical resource with specific recommendations for accommodations for fostering inclusion. Making Science Accessible is a collection of letters from young scientists published in AAAS Science and marking the 30th anniversary of the Americans with Disabilities Act.

Educational Researchers

Research promising practices that center the needs of students with disabilities in STEM learning spaces and institutions.

Literature relevant to students and teachers with disabilities is quite sparse and can frequently only be found in specialized journals. We ask that you contribute to and support both the research and practitioner literature. There is a massive opportunity for research on disability outside of the medical and special education silos. Students with disabilities is not a subject that should be siloed to disability studies; it is a topic relevant to all educators. And while student teachers and teachers with disabilities might be a key to other disability issues, literature specific to them is rare. We found almost no research on or for teachers with disabilities, making it difficult to assess the degree of underrepresentation of people with disabilities in the teaching field. Contributing to the literature on students and teachers with disabilities will help shine some light on this relatively invisible topic. Possible research questions include:

- What practices best support creating and sustaining STEM pathways for students with disabilities?
- What are the most effective ways of addressing educators' implicit biases about students with disabilities?
- What institutional policies and programmatic structures best serve as inclusive STEM teacher pathways?

Call to Action

The issues faced by students and teachers with disabilities must be addressed by all stakeholders– administrators, teacher educators, and teachers themselves. We ask that you advocate for students and teachers with disabilities within your own sphere. Building on that, we invite you to help us to collect data for our own preliminary research by distributing this survey to members of your network. The survey asks adults with disabilities to share their experiences. Please note that many adults may choose not to disclose disabilities. If you have any questions or are aware of additional resources or relevant studies currently underway, please feel free to do the following:

- Use and/or contribute to our Padlet, Supporting Students with Disabilities in STEM
- Watch the webinar, "Invisibility of Students with Disabilities in STEM" featuring three pre-service teachers in the Noyce program at Metropolitan State University in Denver
- Email the authors: Joseph Schneiderwind, jdschneiderwind@gmail.com and Janelle M. Johnson, jjohn428@msudenver.edu

+ References

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Joseph Schneiderwind earned a B.S. in Engineering Physics and a M.S. in Computational and Applied Mathematics at the Colorado School of Mines. He achieved Ph.D. candidacy in Acoustics at Pennsylvania State University working focusing on underwater acoustics. After leaving the Ph.D. program due to further progression of a disability, he decided to follow his passion to teach by seeking licensure in secondary mathematics at Metropolitan State University of Denver. Joe is currently a Noyce scholar and is researching the underrepresentation of students with disabilities in STEM fields. He has multiple publications and conference presentations on this issue and is passionate about continuing to raise awareness of the importance of inclusion for people with disabilities.

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Janelle M. Johnson is an Associate Professor of STEM Education at Metropolitan State University of Denver. She is co-editor of STEM21: Equity in Teaching and Learning to Meet Global Challenges of Standards, Engagement, and Transformation (2018), and principal investigator on two National Science Foundation grants— A Community-based Approach to Engaging Students and Teachers in Effective STEM Education, an ITEST grant based on GLOBE protocols, and Inclusive STEM Teaching Preparation at an Urban Commuter University, a Robert Noyce grant. Her work focuses on professional development with teachers towards interdisciplinary and inclusive STEM teaching and learning, helping them to develop non-deficit lenses while centering the needs of their students who have been less engaged with science.

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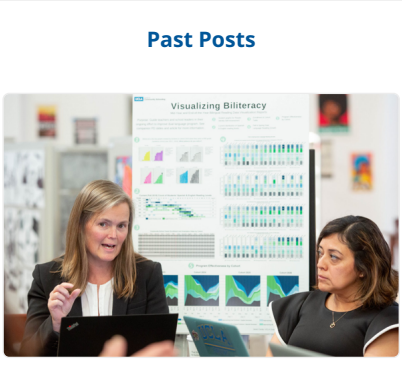

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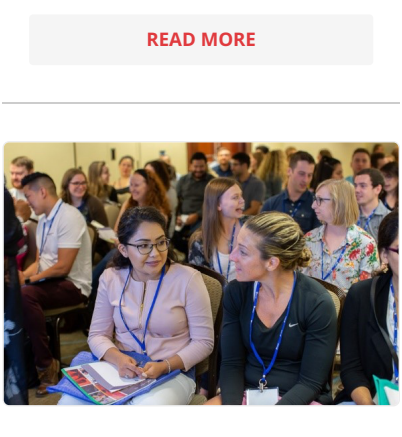

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