Promoting the Support of Learners with Disabilities within Teacher Education Programs

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Individuals with disabilities are the largest minority group in the United States (NIH, 2022), with about 44.1 million of the United States population having an identified disability (U.S. Bureau of Labor Statistics, 2023). Yet in 2023, only 3% of the science, technology, engineering, and math (STEM) workforce reported having a disability (NSF, 2023). Individuals with disabilities have the potential to provide diverse perspectives in science and the STEM community that may otherwise be overlooked. However, educational access, stigma, and discrimination often prevent individuals with disabilities from fully participating and succeeding in STEM fields (Ezeafulukwe et al., 2024; Chun et al., 2023).

Individuals with disabilities often begin to face barriers in the K-12 classroom, where systemic issues in traditional educational approaches can impede access to quality STEM education. As efforts continue growing to support diversity, equity, inclusion, and justice (DEIJ) in science education (e.g., Calabrese-Barton et al., 2021; Morales-Doyle, 2024), the inclusion of individuals with disabilities (physical and/or cognitive) needs more attention. As science teacher educators, it is imperative that we prepare science educators with the ability to implement inclusive teaching practices and support all individuals in science (Steele & Jeong, 2023).

Educational Barriers to Science Education

The first step in addressing barriers for learners with disabilities in science education is becoming aware of the challenges they may face. General science educators will have classrooms with diverse learning needs. Over 60% of students with disabilities in the United States spend at least 80% of their school day in general education classrooms (U.S. National Center for Education Statistics, 2024. Yet, many general education teachers are not adequately prepared to teach students with disabilities and implement instructional practices to meet their needs (Byrd & Alexander, 2020). To identify ways to support learners with diverse needs, we need to help educators gain awareness of the variety of barriers in science classrooms, including physical *and* instructional. Not all disabilities require the same supports or result in the same barriers.

Physical barriers in STEM

The issue of physically accessible labs in science is not a new one. However, for individuals with physical disabilities, mobility in STEM labs can present significant barriers. Classroom educators must consider student mobility and design classroom spaces with attention to access, positioning, social, and communication factors (Moon et al., 2012). This involves not only the physical layout of the classroom but also the tools and technologies students use, depending on their gross or fine motor needs (e.g., thermometers and pipettes). Are the aisles wide enough? Are desks, sinks, and counters accessible to individuals in wheelchairs? Wheelchairs require a minimum clear space of 60 inches to turn 180 degrees comfortably (ADA, 2024). Does a student who needs a modified desk end up off to the side, not included with their peers? Can students with low motor tone grip and manipulate technologies and materials as needed? If not, how can these objects and spaces be designed to ensure students can fully engage in learning? This may include adapting materials and providing flexible workspace options, such as textured grip pads to help grasp materials or grip mats to prevent materials from sliding (Miller & Satsangi, 2018).

As educators, it is essential to work with individuals with physical disabilities to identify potential barriers and take steps to remove them prior to instruction in a non-stigmatizing way. Additionally, educators must be aware of unintended isolation or loss of opportunity. For example, suggesting that a student with dexterity challenges watch a peer handle equipment may be easy to implement, but it can impede the full participation of science learners with disabilities. This approach can unintentionally isolate learners from hands-on laboratory experiences, which are vital for authentic science learning. If activities and related learning objectives require direct experience, using peers to perform tasks can deprive students with disabilities of essential learning opportunities (Moon et al., 2012). Therefore, educators must be able to identify ways to fully engage students in the activity without removing or replacing them.

Cognitive Barriers in STEM

The most prevalent disability among students is a Specific Learning Disability (SLD) (National Center for Education Statistics, 2024). For these students, reading, writing, and mathematics may present significant challenges. When engaging in science instruction, students often rely heavily on these skills, as do scientists in the field (McComas, 2014). As science educators, it is crucial to collaborate with students, special educators, and families to identify tools and strategies that support students in overcoming barriers to achieve success in science. One way to reduce cognitive load for students with disabilities during science instruction is by using assistive technologies such as digital notebooks, screen readers, and calculators. For example, if a student struggles with reading comprehension, providing auditory access to reading materials may reduce cognitive load and aid in comprehension. Additionally, if a student struggles with organizing ideas, a simple graphic organizer may serve as an effective scaffold. If written communication is difficult, using graphics, images, or speech-to-text tools may be a better way for the student to express their ideas (Miller et al., 2013). Finding ways to reduce extraneous load during science instruction allows students with SLDs to focus more on the science objectives by alleviating some of the cognitive load. Supports should never be enforced onto a student but rather identified and implemented with students' input, suggestions and feedback (Scarparolo & MacKinnon, 2024). To create a classroom culture that embraces inclusivity, incorporating Universal Design for Learning (UDL) can be an effective approach to meeting the diverse needs of all students and providing supports in a non-stigmatizing manner.

Universal Design for Learning

Universal Design for Learning (UDL) is an instructional approach that seeks to make learning more accessible for all students through an intentional flexible instructional design. The goal of UDL is to incorporate these practices for all students, promoting flexibility in how they access, communicate, and document their learning as part of the classroom culture rather than singling out any specific student (see Table 1). The three main principles of UDL include:

1.
    1. Multiple means of representation- How can I present information and resources in various ways?
    2. Multiple means of expression – How can I provide opportunities for students to demonstrate their knowledge in different ways?
    3. Multiple means of engagement- How can I stimulate interest, foster learning, and maintain engagement using diverse methods?

Table 1
Universal Design for Learning in the Science Classroom

Multiple Means of Representations	Multiple Means of Expression	Multiple Means of Engagement
• Visual Aids • Graphic organizers • Text Alternative's (Screen Readers, Audio output, Video) • Visual Alternatives (transcripts, text descriptions) • Interactive Activities (hands on labs, simulations)	• Written, Spoken, models, creative project ideas, presentations, posters, graphics • Use of technology supports and scaffolds (graphic organizers, digital notebooks, speech to text) • Scaffolding: Prompts (verbal, written), outlines, graphic organizer,	• Provide student autonomy through voice and choice (choice in tasks, areas of deeper inquiry, approaches to solving a problem) • Authentic real-world connections relevant to students lives (current events, local contexts, community, personal or family connections) • Provide opportunities for collaborative learning (group work, peer interactions, social support, productive discourse, teamwork and problem-solving)

Individuals with disabilities are an underrecognized dimension of diversity in STEM. Despite their potential to bring unique perspectives and enhance creativity in scientific fields, systemic barriers persist. Including the voice of individuals with disabilities in addressing these challenges is vital for identifying sustainable and effective supports (Huss et al., 2021). These challenges often start in the classroom, where physical, cognitive, and instructional barriers impede equitable access to science education. By understanding these challenges and implementing inclusive practices, science educators can play a vital role in fostering an environment where all students, regardless of ability, can thrive. Strategies such as Universal Design for Learning (UDL) offer promising frameworks for making science education more accessible to everyone, ensuring that all students can contribute to the STEM community. Removing barriers is not just about compliance or accommodation but about recognizing and valuing the contributions of all learners. As science teacher educators, we are responsible for preparing future teachers to build inclusive, supportive, and engaging science classrooms where every student can reach their full potential. General education teachers often lack the training and professional development to successfully create an inclusive setting (Al Jaffal, 2022; Gomez-Mari et al., 2022). Pre-service teacher programs should not only include courses dedicated to inclusive practices specifically for individuals with disabilities, but inclusive practices should be embedded into their science methods coursework and emphasized throughout their pre-service preparation. While UDL is a starting point for meeting the needs of individuals with disabilities, more attention is needed going forward to implement this approach and others within science instruction.

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