

Article

Instructional Strategies for Postsecondary Science Teaching with Deaf Students with Disabilities: An Autoethnographic Approach

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Abstract

Throughout primary and secondary education in the United States, science, technology, engineering, art, and mathematics (STEAM) education has become increasingly important as it promotes critical thinking skills and drives competition in the global economy. While some literature exists on teaching science to Deaf and hard of hearing (DHH) students, to date, few studies focus on teaching Deaf students with disabilities (DWD), particularly in STEAM subjects. In this study, we used a collaborative autoethnographic approach to document, reflect on, and modify the instructional approaches and assessment strategies we developed while working with DWD learners in our postsecondary science courses. We analyzed each strategy and categorized them into three areas: (1) facilitating environmental and physical access; (2) facilitating linguistic and cognitive access; and (3) facilitating formative and summative assessment access. We further categorized each strategy as to their potential applications to other science courses, STEAM courses, and/or more broadly. We present our findings as a description of each strategy, explaining how it was implemented and our observations of its outcomes for access, teaching and learning. We recognize that while our autoethnographic approach provides a rich accounting of these strategies, the efficacy of this study is limited by our individual and collective memory and the lack of consistent, formalized student feedback to further validate these findings. Therefore, we call for additional research to evaluate the efficacy and applicability of these and other instructional strategies across STEAM educational settings.

Keywords: Deaf learners with disabilities; science education; postsecondary; teaching strategies; access



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1. Introduction

Across the globe, many countries have established policies placing significant emphasis on science, technology, engineering and mathematics (STEM) education to become technological competitors and leaders in our ever-changing, interconnected society ([European Commission, 2015, 2017](#); [Federal Republic of Nigeria, 2014](#); [Kennedy & Odell, 2014](#); [NRC, 2012](#); [United Nations, 2015](#)). More recently, some STEM education programs have started to integrate the arts into science and technology subjects (STEAM) as a more interdisciplinary approach to help students develop a range of skills to solve complex problems ([Aguilera & Ortiz-Revilla, 2021](#)). Yet in the United States very limited research exists on Deaf¹ learners in STEM subjects or STEAM subjects, and even fewer studies have

focused on Deaf learners with disabilities (DWD) in these disciplines (Guardino & Cannon, 2015). Of the limited literature that exists regarding DWD students, some of it focuses on describing the prevalence of disabilities within the Deaf population in K-12 (Peterson et al., 2023) and postsecondary contexts (Bloom & Palmer, 2023), and some of it focuses on supporting teachers and professionals who work with K-12 DWD students (Fossett, 2025; Musyoka & Gentry, 2020; Musyoka et al., 2017), but only a small portion of this literature discusses postsecondary STEM teaching with DWD learners.

As university science educators, we have spent several years developing instructional strategies that may benefit STEM learning in Deaf college students with disabilities. In this paper, we focus specifically on science education (in biology, chemistry, and environmental science) for Deaf learners with disabilities (DWD) at the postsecondary level. It is estimated that DWD learners comprise anywhere from 40% to 50% of Deaf students receiving special education services in primary and secondary classrooms across the United States (Bowen & Probst, 2023; Peterson et al., 2023). Bloom and Palmer (2023) found that at the postsecondary level, nearly half of all enrolled Deaf students reported having a disability (Bloom & Palmer, 2023). However, the actual number of DWD students may be underestimated (Gallagher, 2022; Peterson et al., 2023). These students do not have individual education plans (IEPs) to outline necessary support and, additionally, may opt not to disclose their disability status (Sassu, 2018). More importantly, many postsecondary instructors do not have formal training in effective teaching and assessment strategies for working with disabled students in general (Becker & Palladino, 2016; Fernández-Batanero et al., 2022). Thus, instructors may be ill-equipped to work with DWD students, highlighting a need for more research on teaching STEM subjects with this population. This article draws on our practical experiences of what we have learned teaching Deaf learners with disabilities in science education at the postsecondary level. We used an autoethnographic approach (Ellis et al., 2011) to document how we developed and piloted these strategies with our students as well as what we learned in the process. Although our experiences come from teaching science courses in a university context, our strategies may be applicable to other contexts including K-12 education, other STEM disciplines, and beyond.

1.1. Who We Are

The authors collectively have over 40 years of experience teaching science courses to Deaf students with disabilities. All four authors have designed and taught science courses in the Laboratory Science Technology program or taught general science courses to non-science majors, employing several different teaching strategies to effectively develop science literacy. The first author is a hearing Black, Indigenous educator and former molecular biology instructor; the second author is a hearing Black, Indigenous cellular and molecular biologist; the third author is a hearing, white analytical chemist; and the fourth author was a white Deaf environmental scientist. The first two authors are trained teachers of the Deaf, while the third and fourth authors gained most of their professional experience from industry before teaching at our institution. All four authors self-identify as women scientists.

1.2. University Context

We teach at a large, private STEAM university in the northeastern United States with an enrollment of approximately 22,000 undergraduate and graduate students (RIT, 2025). Among this group, in the academic year 2023–2024, 21% of students reported having at least one disability, and 8% reported having more than one disability (NYSED, 2024). Roughly 6% of our student population self-identifies as Deaf or hard of hearing, and within this group, 29% reported having at least one secondary disability (NTID, 2025). Within the

university, there are nine colleges, one of which primarily serves Deaf students. Within that college, our science department employs hands-on approaches in teaching biology, chemistry, instrumentation, environmental science, and general science courses to prepare students to be “workplace-ready”, problem-solving-oriented technicians equipped to work in a variety of scientific careers, such as laboratory technician, pharmacy technician, quality control specialist, research assistant, or forensic analyst.

1.3. Our Students

Within our college, about 1000 students identify as Deaf, 97% of whom come from all over the United States, and 3% come from other countries (NTID, 2025). Many of our college’s students are in technical degree programs such as laboratory science, engineering, or computer and information science. In our science courses, class sizes are capped at 12–16 students for ease of visual access and for adequate laboratory space. In fiscal year² 2023, approximately 14% of our Deaf students received support services for a secondary disability (NTID, 2024). For fiscal year 2024, 29% of our students were reported as having received secondary disability support services (NTID, 2025). Our students self-report they primarily use American Sign Language (ASL) and/or English to communicate, with some students using a variety of other languages including Black American Sign Language, Mexican Sign Language, Spanish, Arabic, and other signed languages and spoken languages. Similarly, these students self-reported preferences for a range of communication modalities: some using only sign language, some preferring to use a sign language and a spoken language together, and some preferring to use spoken language only (NTID, 2025).

In addition, to varying languages and communication modalities, these students have self-disclosed other disabilities, including: dwarfism, traumatic brain injury, visual disabilities (e.g., blindness, color deficiency vision [CVD], Usher’s Syndrome, and light sensitivity); cognitive disorders (e.g., dyslexia, attention deficit hyperactivity disorder, and autism spectrum); psychological disorders (e.g., anxiety, depression, bipolar disorder, post-traumatic stress disorder [PTSD], and memory processing issues); neurological disorders (narcolepsy); and personality disorders (obsessive–compulsive disorder and borderline personality disorder). It is also important to note that some of our students have disclosed other health concerns that impact their learning, such as diabetes or heart disease.

Some Deaf learners have chosen not to self-disclose their disability status or to receive support services for a secondary disability for a variety of reasons (Lindsay et al., 2018; Lyman et al., 2016; Woolf & de Bie, 2022). Similarly, some of our Deaf students have not disclosed having another disability. In addition, we have encountered students who were unaware of having a secondary disability as it was not identified during their K-12 education. Therefore, the exact percentage of DWD students enrolled at our university is unknown. However, between fiscal years 2015 and 2019, an average of 12% of our Deaf students reported receiving services for a secondary disability (NTID, 2025). From 2020 to 2024, this group of students increased to an average of 20% (NTID, 2025), suggesting that the number of DWD learners enrolling at the postsecondary level may be growing.

1.4. Our Audience

Our work resides at the intersection of postsecondary education, STEM education, and the education of Deaf and DWD students. We share our work to support instructors who may lack experience in one or more of these areas, for example, postsecondary STEM educators who are unfamiliar with working with DWD students. It is our hope that all readers will find concrete, useful tools from our approaches and findings.

2. Literature Review

To contextualize our discussion here, we surveyed the literature from the year 2000 to the present on studies about Deaf students and DWD students in science, technology, engineering, and math (STEM). We searched online databases employing Boolean search operators to retrieve articles with any combination of one word from three groups of search terms. In the first group, we included the search terms Deaf, hard of hearing, hard-of-hearing, hearing impaired, and hearing-impaired. In the second group we used the search terms disabilities, disability, disabled, deafplus, Deaf plus, and Deaf-plus. The third group of search terms included STEM, STEAM, science, biology, chemistry, earth science, environmental science, and physics. While the body of research on Deaf and DWD students learning science and STEM is global, our inclusion criteria were restricted to peer-reviewed journal articles published in English, which aligns with our primary language proficiency. We acknowledge that other perspectives were omitted due to this methodological constraint, particularly from the Global South and non-English speaking regions, where unique sociocultural, educational, and economic circumstances shape the realities of Deaf and DWD people from those regions. Our search yielded approximately 80 journal articles, with about 65 of those focusing on Deaf students without disabilities and 15 focusing on DWD students, indicating that the literature on DWD students learning science is rather sparse. The 80 articles we found were published in several types of research journals, including Deaf education, general education, science education, along with science discipline-specific and disability studies discipline-specific journals. The articles were situated across pre-school, K-12, and postsecondary contexts, with the majority being in postsecondary contexts. About three-quarters of the identified articles were situated in the United States. More specifically, about 32 articles discussed teaching strategies, with just 7 of those being teaching strategies for working with DWD learners. As a result, it appears that there is a significant gap in the literature on effective teaching strategies for DWD postsecondary students (Guardino & Cannon, 2015; Hyte, 2017), particularly in science, technology, engineering, art, and mathematics subjects.

2.1. Deaf Learners in Science

Much of the literature on Deaf learners has shown that while Deaf students tend to be underrepresented in STEM fields at the postsecondary level, specialized instruction has been designed to support learners at this level (Braun et al., 2017; Braun et al., 2018; Clark et al., 2021; Gormally & Marchut, 2017; Lynn et al., 2020; Marchut & Gormally, 2019). For example, inquiry-based pedagogy may increase Deaf students' motivation to conduct research on topics that relate to their own lives and may foster an increased belief that science is relevant to their lives (Marchut & Gormally, 2019). In response to the COVID-19 pandemic, instructors of Deaf students documented the strategies they used to deliver chemistry courses via online instruction, including the benefits and drawbacks of this delivery mode, the need for increased social and emotional support of Deaf students, and best practices for mainstream teachers of the Deaf (Lynn et al., 2020). Relating to classroom language use, instructors have developed and deployed a lexicon dictionary of organic chemistry terms in American Sign Language (ASL), which has enhanced Deaf student performance on organic chemistry exams compared to their hearing peers (Clark et al., 2021). Together this research on science instruction of Deaf learners represents a variety of aspects in teaching, including supporting affective outcomes, tailoring instructional delivery, and expanding classroom language repertoire.

A second strand of research focuses on providing strategies and recommendations to optimize research lab environments for Deaf students. These strategies include awareness of Deaf culture and ASL, strong communication between Deaf student researchers and their

PIs, having Deaf peers in the lab, using visual clues and signage for safety, and reducing clutter in the lab (Pagano et al., 2015; Smith et al., 2016; R. E. Rogers & Pagano, 2018; Majocha et al., 2018). Course-based undergraduate research experiences (CUREs) for Deaf learners appear to be effective in helping these learners become part of a learning community, acquire lab techniques, and enhance their ability to analyze data (Pagano et al., 2021). More generally, others have described methods of making college environments more inclusive of Deaf students in STEM (Braun et al., 2018). These methods for promoting more inclusive college environments include encouraging Deaf students to use the disability services office, allowing Deaf students to choose their preferred classroom seat, assisting Deaf students in obtaining access services that meet their needs (e.g., ASL interpreting, real-time captioning, note-taking), and promoting the effective use of mentoring. Interestingly, Braun et al.'s (2018) discussion of Deaf students using their university disability services office only refers to gaining access via ASL interpreters, real-time captionists, and notetakers, without any consideration of Deaf students who may be seeking support services for other disabilities they may have.

A third area of research on Deaf learners in science and STEM has focused on the factors that contribute to the academic success and retention of Deaf students in these disciplines. One study that examined the learning styles of Deaf students in an introductory biology course found that having a competitive learning style was a positive predictive indicator of success in the course, while a dependent learning style was a negative predictive indicator (Lynn et al., 2017). Other research indicates that while Deaf students in inquiry-based biology lab courses may hold stereotypical perceptions of scientists, they may themselves not feel like scientists due to misalignment of their conceptions of scientists and their own self-perceptions (Gormally & Marchut, 2017). For these students, their views of the field of science appear to influence their choice to major in science or not (Gormally & Marchut, 2017). With respect to retention strategies for Deaf students in STEM, mentoring (Braun et al., 2017) and meta-cognition (Franklin et al., 2018) are key. More specifically, Deaf students report that their own mentoring relationships are more successful when the mentor is familiar with Deaf culture, facilitates communication access for the student, and supports the student in asking for and securing accommodations; these aspects of mentoring appear effective regardless of the mentor's status as a Deaf or hearing person (Braun et al., 2017). At one university, Deaf students who engage in structured metacognition activities, such as reflecting on their sense of belonging with respect to their choice of STEM major or modeling the interdisciplinary connections between different branches of the sciences in a summer program and academic coursework, appear to be more likely to persist in STEM majors (Franklin et al., 2018). Collectively, these studies elucidate factors, behaviors, and activities that can support student retention in STEM at the postsecondary level; however, they do not address the educational experiences of Deaf students with additional disabilities in those same settings. In our review of this literature, we noted that while a few studies recommended that Deaf students visit their university disability services office to gain access via ASL interpreters, real-time captionists, and notetakers (Braun et al., 2017; Braun et al., 2018), none of the studies reviewed here discussed the needs of Deaf students who may be seeking support services for additional disabilities.

2.2. Deaf Learners with Disabilities (DWD)

While being Deaf is a relatively low-incidence condition in the United States (U.S. Department of Education, 2004), the subset of Deaf students with additional disabilities is disproportionately high within the Deaf population. The United States Government Accountability Office estimates that 25% of Deaf children have a developmental disability (2011). In its Annual Survey of Deaf and Hard of Hearing Children and Youth, the

Gallaudet Office of Research Support and International Affairs (2014) found that as many as 41% of Deaf students in the United States may have an additional disability. Much of the literature on DWD focuses on children in K-12 settings, with relatively little in post-secondary settings. For example, Kwon et al. (2022) conducted a case study of a young, Deaf autistic learner from an immigrant family, elucidating the linguistic and educational considerations for multilingual and disabled Deaf learners. They found that most of the support from interventions was focused on the learner, with minimal attention given to other aspects of the learner's experience, such as supporting the learner's parents and teachers or making modifications to the classroom and social environments. Kwon et al.'s (2022) study contributes to the body of knowledge on Deaf learners with disabilities, but because it is situated at the K-12 level and focuses on a single student, their findings may not be generalizable.

Guardino and Cannon (2022a) compiled a volume of evidence-based strategies for supporting Deaf and hard of hearing students with disabilities, but the contributions to this book focused on the issues in primary and secondary education. Guardino and Cannon (2022b)'s chapter on cycles of support, however, contained a teaching-learning framework that may be relevant to university-level teaching. They proposed a *Nested Cycle of Support*, which addressed four common themes of effective school support at three levels of intensity for DWD students: (a) assessment, (b) identification, (c) planning and placement, and (d) instruction (p. 290). Based on tiered support frameworks such as Response to Intervention (RIT) and Multitiered System of Supports (MTSS), the *Nested Cycle of Support* contains tiers in which students are offered less support at level 1 and more intensive support as students move through levels 2 and 3. Guardino and Cannon (2022b) argued that their *Nested Cycle of Support* should be used within the framework of the *Tenets of Effective Practice for Deaf Learners Who are d/Deaf or Hard of Hearing With Disabilities* (p. 298). The *Tenets* framework contains four pillars: (a) methods of collaboration, (b) an asset-based approach, (c) scaffolding instruction using Vygotsky's zone of proximal development (ZPD), and (d) The Radical Middle (TRM) perspective (pp. 298–299). In collaboration, a DWD student's family, school personnel, and community share their expertise and work together to provide support. Asset-based approaches focus on DWD students' strengths and what they can do. When scaffolding instruction using Vygotsky's ZPD, teachers use a DWD student's current strengths to support acquisition of new knowledge and skills. The TRM perspective is based on respecting the collective viewpoints of the DWD student, their family, and the professionals working with them to discuss and identify the approaches for the DWD student (Guardino & Cannon, 2022b). Taken together, the *Nested Cycle of Support* and the *Tenets* frameworks incorporate several best practices in teaching and learning to address the complexities of working with DWD learners. While we agree that these frameworks are effective for educating Deaf students with disabilities, how these frameworks may be used or adapted in postsecondary contexts has yet to be explored. Many university instructors do not have formal training in Universal Design for Learning (UDL) or best practices in teaching. Furthermore, the tiered levels of school support and levels of family and community support vary greatly when students move into a university.

Taking a broader look at the literature on DWD students in education, there is a call to move beyond mere compliance with accommodation requests towards accessibility as being fully integrated into curricular design (Comeaux et al., 2021). To date, the medical model of disability, which localizes the "problem" as being within the disabled student, has constrained access for disabled students due to rigid institutional structures and lack of training for faculty (Fernández-Batanero et al., 2022). To confront this, enhanced teacher preparation is needed, particularly for teachers and specialists serving DWD students (Musyoka, 2023; Musyoka & Gentry, 2020), and especially in STEM (Chini & Scanlon, 2022;

Oreshkina & Safonova, 2022). Recently, theoretical papers and systematic reviews of the literature reveal frameworks in Deaf education, such as translanguaging (Musyoka, 2023), campusmaking (Comeaux et al., 2021), and Deaf aesthetics (Weber et al., 2025), that aim to push the field towards more inclusive, asset-based, and Deaf-centric methods. At the same time, the literature lacks a practitioner perspective and detailed “how-tos” for teaching and supporting DWD students (Chini & Scanlon, 2022; Oreshkina & Safonova, 2022), and further, there is a lack of empirical studies on the efficacy of teaching strategies for these students (Weber et al., 2025).

While some research exists on teaching and supporting Deaf students in postsecondary science courses (e.g., Braun et al., 2018; Clark et al., 2021; Gormally & Marchut, 2017; Lynn et al., 2020; Marchut & Gormally, 2019), and other studies exist about the educational experiences of Deaf students with disabilities (e.g., Kwon et al., 2022; Guardino & Cannon, 2022a), there is a significant literature gap at the intersection of these domains. Thus, this article serves as an initial step towards closing that gap. In the following sections we provide examples of strategies we have developed to support DWD students’ learning in postsecondary science courses. As we describe the strategies we have implemented, we tie these strategies to extant supporting literature, including but not limited to: supporting students with disabilities in postsecondary education; teaching ELL students and Deaf students using multilingual and multimodal strategies; communicating about science using American Sign Language; and incorporating explicit instruction to improve learning and retention of information in science classrooms.

3. Methods

3.1. Autoethnography as Both Process and Product

Autoethnography involves the analysis of personal experiences to better understand cultural experiences (Ellis et al., 2011). When conducting autoethnographic studies, researchers write about key moments or events that had a significant impact on their lives, resulting in a documented account of those experiences (Ellis et al., 2011). Thus, autoethnography is both a process and product in which researchers create a retrospective accounting of a phenomenon they want to understand. Initially we did not consider our self-reflections and observations as data. An essential component of autoethnography, however, is using the researcher’s experiences as data (Tarisayi, 2023), including self-observations, fieldnotes, and journals (Cooper & Lilyea, 2022). Thus, we began documenting our reflections and the thoughts that resulted from these discussions as data sources to analyze the strategies we developed.

We also collected artifacts, including quantitative data and qualitative feedback from our teaching evaluations; self-observations of positive classroom interactions with students; email and in-person communications with students lauding specific strategies; and self-reported reflections on what “felt” like students’ improved understanding. For example, in each of our teaching evaluations we looked for comments that included words such as “helpful” or “learned a lot” and identified which teaching strategies could be tied to those comments. As another example, we examined the second author’s teaching journal for self-reported instances of success. In one such instance, a journal entry described how modifying a protocol for accessibility and clarity appeared to result in less student confusion, whereas the unmodified protocol generated significant student confusion in the previous year. Further, we drew from our personal memories (Cooper & Lilyea, 2022) to recall some of the techniques we used. While we did not specifically collect data on the efficacy of our strategies, we viewed the overall positive comments from our students and seeing students improve on tasks and projects after employing these strategies as indicators of effectiveness.

3.2. Analytical Approach

By analyzing our retrospective reflections on teaching over the years, we also identified three key philosophies which had informed and grounded our instructional strategies (Tarisayi, 2023):

1. Postsecondary students are experts on their own lived experiences and knowledgeable of the techniques and strategies that benefit their learning;
2. As instructors, we should actively engage with students early and communicate with them regularly to get feedback on which strategies are working and which strategies can be improved upon;
3. When implementing new or existing strategies, we aim to respect student preferences whenever possible.

These philosophies emerged through our shared identity as female scientists. In a male-dominated field, we have often navigated situations where we were not positioned as experts or knowledgeable despite years of formal training and professional experience. We recognized that many Deaf students, and particularly those students who are disabled, may have faced similar marginalization of their experiences. Therefore, we were intentional about ensuring our students were engaged and full participants in making decisions about modifications to various aspects of their learning. After reviewing and analyzing our notes and artifacts, we agreed to document and disseminate the strategies that aligned with our philosophies and clearly supported students in learning science content and/or promoted access and reduced barriers to learning. We refined and organized these strategies into three categories: *Strategies to Facilitate Environment and Physical Access*; *Instructional Strategies to Facilitate Linguistic and Cognitive Access*; and *Assessment Strategies*. As instructors, our primary focus has been on delivery of science content in postsecondary science courses; however, many of our instructional approaches may be applicable to other STEAM subjects or general education classrooms. Below we describe strategies for enhancing accessibility in our classrooms and materials, as well as approaches for alternative assessment. We also labeled each strategy according to its application specifically in science courses, STEAM courses, and all subject areas. Each of the strategies is briefly outlined in Tables 1–3. An “x” indicates the strategy is applicable to the specific content area noted.

Table 1. Strategies to facilitate environmental and physical access.

Strategy	Science	STEAM	Any
Modify lab bench height seating and seating configuration	x	x	x
Adjust classroom lighting	x	x	x
Contain writing to specific areas on whiteboards	x	x	x
Use specific colors on whiteboards	x	x	x
Modify font size and paper colors for printed materials	x	x	x
Provide lighted magnifying glasses	x		
Adjust lab materials to use smaller fluid volumes and glassware sizes	x		

Table 2. Strategies to facilitate linguistic and cognitive access.

	Science	STEAM	Any
Collaborate with low vision sign language interpreters	x	x	x
Increase “wait time” for shifting visual attention and cognitive processing	x	x	x
Model organizational skills with lab materials and equipment	x		
Demonstrate experimental procedures in multiple modalities	x		
Deliver “mock” presentations in ASL	x	x	x

Table 3. Strategies to facilitate formative and summative assessment access.

Strategy	Science	STEAM	Any
Provide flexibility on timing, format, and modality	x	x	x
Use class-wide collaboration for building complex models	x	x	x
Assign hands-on and/or visual performance assessments for individual work	x	x	x
Permit lab report “redos” (rewrites)	x	x	
Dedicate class time to practicing science writing	x	x	
Create an ongoing feedback loop	x	x	x

4. Results

Here we present each of the strategies in detail, including a rationale and the results of implementing these techniques with our DWD students.

4.1. Strategies to Facilitate Environment and Physical Access

Our department faculty collectively engaged the students to learn their preferred accommodations (Neely, 2007; Rogers-Shaw et al., 2023) in classrooms and labs. Requested adaptations to the physical classroom environment included changing the layout of the laboratory; providing alternative furniture or scientific equipment; and using adjustable overhead lighting (see Table 1).

4.1.1. Modify Laboratory Seating Height and Configuration

For Deaf learners, adjusting classroom seating arrangements to minimize distractions can improve the students’ behavior and engagement with the topic (Guardino & Antia, 2012). A U-shaped configuration and proper lighting facilitate visual communication via sign language (Guardino & Antia, 2012). In our classrooms, students were consistently seated in a U-shape for both lecture and laboratory procedures. In addition, we privately consulted with our DWD students one-on-one to determine preferred seating arrangements, such as choosing the distance from the projectors and whiteboards and where to place the low-vision interpreters during class. Rearranged seating enabled the low-vision students to see the whiteboards within their visual field while also accessing the interpretation and participating in class discussions. We also found that the height of the workstations was a consideration for our students’ access.

The laboratory benches in our lab rooms range from 76 to 91 cm (29.9 to 35.8 inches) tall for standing work. This posed a barrier for our Deaf dwarf³ student in chemistry courses. This student requested a special 41 cm (16.1 inch) stool to access the lab benches and fume

hoods. To facilitate access in all areas of the laboratories, the department purchased several bench height stools and placed them in several key areas—near sinks, eye washing stations, and near safety equipment in addition to the benches. These modifications made it easier for the student to complete experiments alongside their classmates, clean their work area, and return equipment to their proper storage locations.

4.1.2. Adjustable Classroom Lighting

In general, proper lighting for Deaf learners can increase students' attention and engagement in classroom activities (Guardino & Antia, 2012). For Deaf students with sensory disabilities, however, bright lighting can cause overstimulation and headaches, as was the case for some of our students. In our classrooms, when students requested dimming the lights, the instructor discussed this adjustment with the entire class to ensure that the classroom environment remained adequately lit for other students. We adjusted the brightness in one area of the classroom, and students who preferred more lighting sat in the other area. Over time, we observed that whenever they wished, students requested that we dim the classroom lights and expressed appreciation for making the classroom a more comfortable environment. Dimming the lights and using specific colors of paper and ink made classroom activities more visually accessible for all the students (Marwati et al., 2023).

4.1.3. Whiteboard Use

During lectures and labs, we often used whiteboards to draw examples and illustrate certain processes and procedures. For Deaf students with limited peripheral vision, we restricted our writing to specific areas of the board. While this does limit the amount of usable whiteboard space, it improves the overall experience for these students as it narrows the visual space students must attend to. In addition, some students informed us that specific marker colors were difficult to see, such as red or green. Consequently, we applied their feedback and avoided using these colors on the whiteboards and on our presentation slides. When the third author privately asked one student with a visual disability for his thoughts on changes in the class materials, that student shared that the simplified color scheme of the presentations was much better in his opinion.

4.1.4. Changing Size and Colors for Instructional Materials and Specimens

In addition to the main classroom whiteboards, we set up mobile computer monitors for students to view the instructors' projected slides up close. Some students requested handouts printed on specific colors of paper with specific font sizes and font styles. Again, to minimize attention to individual students, we often prepared handouts for the entire class based on these requested color and font specifications (Wedler et al., 2022). For example, if a student requested materials in size 14 Arial font, we printed handouts and materials for the entire class in the same format. In addition to using these formatting strategies with students, we also tried integrating innovative technological solutions for classroom access using computer software and smartphone applications.

Microsoft's Zoom Text Magnifier/Reader can be used to enlarge the classroom computer's cursor, change the cursor color, and adjust colors in web browsers for better visual contrast. This software also has screen-reading capabilities and can significantly enlarge text and images. In larger classrooms where students may have difficulty seeing signing at a distance, the authors asked students to sign into the Zoom meeting platform and project the participant view so that the signing was larger and within the field of vision for other students.

Neely (2007) argued that students with disabilities are the best advocates for their own learning needs. Consistent with this assertion, we purchased lighted magnifying glasses that students requested to improve visual access (Wedler et al., 2022). During a fetal pig

dissection, one of the authors passed out magnifying glasses to the entire class to avoid calling attention to the specific students who requested them. These lighted magnifying lenses have also helped students perform other lab tasks such as adding samples into spectrophotometers. An entry in the second author's teaching journal contained an anecdote about one student's excitement that she could see fine details of specimens she did not know were there. Similarly, some students used smartphone apps to make class activities more visually accessible. VisionAssist and TextGrabber enhance and enlarge pictures of data and specimens (Neely, 2007) and work well for items that cannot be photocopied well for enlargement. These apps enlarge the screen or document text (Wedler et al., 2022) in smaller sections, providing the student with a focused viewing area, rather than enlarging the whole document. Utilizing these tools empowered students with a range of visual acuity and color perceptions to use the same laboratory equipment as their peers. We note, however, that these apps were sometimes just a "quick fix" during class when we realized our materials were not visually accessible. We found it necessary to meet our DWD students outside of class to develop longer-term accessibility support.

4.1.5. Modified Fluid Volumes and Glassware Sizes

In chemistry laboratories, students are required to conduct titration experiments, using different volumes of reagents. The glassware, however, may be difficult for students to safely handle due to limb differences and/or gross and fine motor movement control. Thus, one of the authors has adjusted the volumes of the experimental chemical solutions while retaining their concentrations to accommodate students with physical disabilities (Redden, 2022). The author found that reducing liquid volumes and using smaller glassware benefited their students with smaller hands. Conversely, using larger volumes and larger glassware was effective for students with palsies and tremors. These adjustments not only improved students' ability to fully participate in the lab experiments (Redden, 2022) but also conserved resources, reduced waste, and bolstered students' confidence in demonstrating their skills using scientific equipment.

4.2. *Strategies to Facilitate Linguistic and Cognitive Access*

While the above section primarily focused on accessibility within the physical classroom environment, some of these strategies overlap with improving DWD learners' access to visual language and reducing some of the cognitive load for students. Here we further expand on the strategies that we found benefited students' access and learning (see Table 2).

4.2.1. Collaborate with Low-Vision Sign Language Interpreters

Some of our Deafblind students requested low-vision interpreters to sit close to the student to either copy sign the instructor and other students and/or interpret from spoken English to ASL. Each of the instructors worked closely with the student and the interpreters. This involved meeting with any assigned classroom service providers to establish expectations and arrange classroom seating at the start of the semester and then revisit these discussions periodically. We also provided all our classroom materials in advance of each class session, which helped the interpreters prepare and interpret effectively. The interpreters we worked with stated that the preparation materials that we sent them were clear and comprehensive, and the consultation time we had with them was invaluable. Our interpreters expressed feeling confident in facilitating communication in our classrooms.

4.2.2. Increase "Wait Time" for Shifting Attention and Processing

Teacher pauses between utterances, or "wait time," have been well established as an effective practice to facilitate student processing and understanding (Ingram & Elliott, 2014; Tobin, 1987). Furthermore, increased wait time has shown positive effects among

children with multiple disabilities and severe disabilities (Johnson & Parker, 2013; W. Rogers & Johnson, 2018). As experienced teachers of Deaf students, we were accustomed to pausing throughout our lectures. With our DWD learners, however, we increased our wait time, anywhere from 5 to 10 s each time we switched between the whiteboard and presentation slides to allow students to shift their visual attention before signing explanations. This allowed Deafblind and low-vision Deaf students adequate time to track to the visual information source. Students with cognitive processing delays also commented that the extra time helped them better understand the information presented and feel less overwhelmed.

4.2.3. Model Organizational Skills with Lab Equipment and Materials

For DWD students with executive functioning challenges, establishing proper bench-space organization, material placement, and workflow habits was important for ensuring safety. One strategy we employed was to explicitly demonstrate for students how to set up and maintain their lab workspace (Therrien et al., 2017). For example, we instructed students to keep unused glassware on the left side of the lab bench, place completed chemical solutions on the right, and leave “in-process” chemical solutions in the center of their space. Moving completed or not-in-use items to a different location in the lab may also be helpful in supporting the mental organization of procedures (McGlynn & Kelly, 2020; Neely, 2007). Another approach we used was creating tangible boundaries with colored labeling tape adhered directly on the bench or using drawing boundaries for each section on butcher paper with a marker. These practices also enabled students to keep their materials within their visual field. Similarly, for protocol workflow, we trained students to create chemical standards and samples in a sequential order that made sense to them, for example, high volume to low volume, alphabetically from A to Z, or in placement order from left to right. Another organizational strategy we modeled was to color-code lab materials using colored lab tape. Color-coding lab equipment helps students with working memory issues (Morey, 2019) to differentiate between sets of pipettes and beakers that appear similar, preventing the risk of cross-contamination of chemicals. Demonstrating and practicing these techniques with our students resulted in higher scores on the second author’s end-of-semester lab practical exam. Further, students commented they felt greater confidence in following step-by-step processes.

In early versions of our handouts, students were given a printed protocol with step-by-step instructions without guidance on how to group similar tasks. As an example, a student would obtain one volumetric flask, make a solution, cap it off, and set it aside. The student would repeat this process separately for each solution, collecting the glassware one step at a time. This indicated that grouping similar tasks may not be intuitive for our students. We revised our protocols and grouped similar tasks together. For more complex experiments, we separated tasks into shorter, logically ordered segments (Therrien et al., 2017). Additionally, we explained when the steps of a protocol must be strictly followed or when flexibility is possible (such as using different glassware sizes). These modifications also helped students to be adaptable while still successfully completing their experiments based on the resources available to them. In general, our efforts in revising lab protocols have led to a stronger understanding of overall lab procedures. Creating organizational systems and workflows encourages students to work independently and improves overall safety in the lab.

We also encouraged our students to think about how they use and manage their time when running experiments. To this end, we indicated time-sensitive steps in our revised protocols. This helped students determine how to use their laboratory time effectively.

Ultimately, students who understand how to use time are empowered to complete tasks in a way that suits their working style in the allotted lab period.

4.2.4. Demonstrate Experimental Procedures in Multiple Modalities

Standard lab experiment protocols in college classes are typically provided in written English, and students are expected to read through the protocol and begin each experiment independently or with a partner. Providing these protocols exclusively in English may present challenges in comprehension for Deaf students whose first language is not English (Berent et al., 2008) and/or for Deaf students who may have limited prior exposure to science laboratory procedures (Enderle et al., 2020). Early in our teaching careers, we each started lab sessions by giving students a printed paper protocol and then providing the class with a brief overview in American Sign Language. We expected our students to then decode the written English protocol on their own. Our students expressed frustration and confusion with this approach. Thus, we altered the labs by first explaining each step in the protocol in American Sign Language, spoken English, or a combination of sign and speech together, depending on our students' specific communication preferences (Easterbrooks & Stephenson, 2006). Using ASL classifiers to explain the technical procedures better facilitated students' understanding of science-specific vocabulary and concepts (Easterbrooks & Stephenson, 2006; Henderson et al., 2023); however, students continued to seek clarifications and repetitions of certain tasks. Therefore, in addition to the verbal explanations, we also began incorporating simple black and white iconography supported by brief English descriptions (typically a phrase or single sentence), which we termed "workflow diagrams," into each protocol.

The workflow diagrams indicate key information, such as numerical sequencing of the steps, the needed laboratory equipment, and critical reminders such as tracking the time for the experiment or specific temperature settings for water baths and incubators. The visual nature of these diagrams combined with the printed and verbal protocol explanations reinforced key information that should be included in their final report write-ups. Presenting the same information in multiple ways (McGlynn & Kelly, 2020) also benefitted students' cognitive processing of scientific protocols (Asghar et al., 2017), as we observed students more readily began and completed their experiments while asking fewer clarifying questions along the way. Over time, the students' satisfaction increased on our teaching evaluations, as reflected by higher scores with respect to instructor communication skills.

4.2.5. Deliver Mock Presentations as Examples

Scientists often disseminate their findings through formal presentations at conferences. To practice developing these skills, each author requires students to present at least one formal presentation to their peers in class. The presentation topics vary from researching a specific disease to explaining a scientific process, or presenting results from an experiment. In the past, we would assign students a topic or ask them to choose a topic for their final presentations. We would provide written instructions and explanations in class in ASL, spoken English, or both based on the students' communication preferences. When students gave formal presentations in class, there was great variety in the quality of their work. Some students had slides with a lot of text or used colors and fonts that were not easy to read. Other students expressed anxiety about presenting in front of their peers.

To support the students' presentation skills, we began providing examples of good slide preparation, such as appropriate font sizing, choosing text and background colors, using concise wording, and including proper image attribution. We also conducted mock in-class presentations where the instructor modeled presentation skills, including: refraining from reading directly from the slides; allowing wait time for the audience to read each

slide; and showing confidence by knowing the material in advance. We then also had students practice by giving mock presentations, and after each presentation, led student discussions on what techniques they observed and to explain which techniques they should also emulate or avoid (Hughes et al., 2017) during a real presentation. As a result of the practice sessions, our students created presentation slides with accessible fonts and colors and improved by including appropriate wording and proper image attributions. Our students also demonstrated improved presentation confidence as evidenced by only needing to glance at their slides before signing or speaking directly to the audience.

Although these strategies may seem common practice, many of our students did not have prior experience developing skills in these areas, especially in the context of science courses. Learning to demonstrate clear communication through writing and presentation is critical in life sciences (NRC, 2012, 2013).

4.3. Strategies to Facilitate Formative and Summative Assessment Access

A good instructor will perform both formative and summative assessments of students' learning and behaviors (McMillan, 2024). In college-level science courses, however, students are most frequently summatively evaluated using lab reports and/or lab practicals, which are usually administered in written format and assess a narrowly defined set of concepts, skills and facts. These summative assessments may not accurately capture the extent of a student's mastery of the science content. Moreover, few opportunities exist for students to revise and resubmit their work to demonstrate progress towards mastery. Assigning course grades using a few formal assessments is of particular concern when teaching Deaf with disability learners due to potential accessibility concerns in the design and administration of these assessments. Therefore, it is important for students to have multiple formal and informal opportunities to be assessed (see Table 3). This may be accomplished through receiving ongoing feedback from their instructors and peers as well as through group discussions and collaborative work, which can provide meaningful insights into their grasp of the course content (Henderson et al., 2023).

4.3.1. Provide Flexibility on Timing, Format, and Modality of Assessments

Throughout our various labs, quizzes, exams, projects and presentations, we modified the format and administration of these assignments for our DWD students. As one example, the first author teaches a unit on the etymology and Latin and Greek root words of biology terms and assesses their students' recall of these terms. In the past, the instructor would teach root words, and then students would be quizzed on the terms the following week. One student requested to take her weekly quizzes after meeting with her speech therapist. During speech therapy sessions the student would practice pronouncing the words, which helped her to better memorize the words.

Another student benefited from a different format for the quizzes. The student requested more context information about each root word. Rather than simply matching each root word to its definition on class handouts, the student excelled when he was given a modified handout that included a sentence containing each root word. This, in turn, helped him to gain a better understanding of the root words and build confidence in taking the quizzes. At the end of the semester, both students shared with the first author that they felt the quiz modifications helped them obtain higher quiz scores. These instructional adjustments led to these students recalling more words and retaining word meanings (Neely, 2007; Rogers-Shaw et al., 2023).

As we are preparing our students for hands-on careers in science, students' ability to memorize terms and processes is secondary to their ability to accurately execute specific procedures and demonstrate appropriate techniques using laboratory equipment, reagents,

and specimens. Thus, all four authors have adjusted their mid-term and final exams to support student recall and memorization. These modifications have included allowing “open notes” exams, authorized crib sheets for exams, take-home exams, and in-class group exams. Both open notes and authorized crib sheets alleviate the pressure of memorization and may reduce test anxiety (Whitehouse et al., 2025). The crib sheet method also encourages students to review their notes thoroughly before an exam to identify and consolidate key concepts, aiding in greater information processing (Whitehouse et al., 2025). On a few occasions one instructor administered an in-class group exam. This was found to be beneficial for students who had difficulty articulating their ideas in written English but could easily convey the information in ASL to a classmate who documented it in writing. This peer collaboration not only enables students to better express their ideas, but the students expressed that discussing exams with their peers helped to reduce their test anxiety (Rempel et al., 2021).

The flexibility in these assessments better facilitated students demonstrating progress and mastery of the scientific skills and knowledge they have acquired (Rogers-Shaw et al., 2023). Creating alternative assessments may, however, pose challenges, including dedicating additional time for development; maintaining academic rigor; and ensuring alignment with unit and overall course outcomes. Despite these challenges, alternative assessments offer significant advantages. They motivate students, offer holistic approaches to learning course content, enable students to apply skills and create unique products, foster collaboration, and support the integration of learning into real-life contexts. Most importantly, alternative assessments foreground learning outcomes in educational experiences (Di Stasio et al., 2019).

4.3.2. Use Class-Wide Collaboration for Building Complex Models

Collaboration is not only helpful for exams, but for supporting student learning of other complex concepts. In an environmental science class, one author assigned her students to create a class-wide model of geologic time, representing the 4.6 billion years of Earth’s history on a 46-foot-long piece of butcher paper. The students marked each foot to symbolize one million years and then plotted and illustrated significant events in Earth’s history along the large paper timeline, such as the emergence of multicellular eukaryotes and primates, through scientific model drawings. This informal, low-stakes assessment enabled students to demonstrate their understanding of time on a large scale and key evolutionary events while simultaneously engaging in real-time feedback and support from their peers. This class-wide model also served as a visual reference students could continually go back to, enhancing their recall and comprehension of these concepts. In the fourth author’s teaching evaluations, students commented that class-wide collaboration encouraged teamwork and group bonding, resulting in the students feeling more comfortable working with each other.

4.3.3. Assign Hands-On and/or Visual Performance Assessments for Individual Work

We acknowledge that assessing students’ work individually is also important to evaluate students’ understanding and application of science. Beyond written lab reports, other performance-based assessments require students to apply their knowledge and skills to create a product (McMillan, 2024). In our respective courses, we have asked students to develop research projects and presentations, demonstrate skills through lab practicals, and create video lab reports as hands-on and visual learning opportunities.

The third author designed a semester-long, class-wide experiment on allelopathy of plants on campus. Instead of writing traditional lab reports, the author chose to assess the students’ knowledge through a class research poster. The instructor first prepared

students for the project by showing examples of scientific research posters and discussing the format and common characteristics of each example poster. Then, students each chose a plant to study and created a poster of their research. At the end of the semester, each student presented their research to the science department faculty instead of taking a traditional paper final exam. The department faculty provided feedback to each student on the accuracy and clarity of their poster and how to improve their work for the future. Through this authentic assessment, students had many opportunities to learn and apply science skills and provided a way for the instructor to assess the students' learning through real-life research (Pagano et al., 2021). After watching the student research presentations, the other faculty commented that students applying their science skills to a semester-long project more closely mirrored the internships our students must have to graduate and commended the third author for her efforts.

Two of the authors initially evaluated microscopy skills using written lab reports but realized the reports were heavily assessing English language skills rather than evaluating students' appropriate use of a light microscope. To directly assess students' microscopy skills, the authors instead created a lab practical that requires students to physically demonstrate specimen slide preparation and proper microscope usage to mount and view the slides. The instructors visually observed each student and graded them on their techniques. Similarly, another of the authors directly assessed her students' chemistry skills by requiring students to prepare liquid samples and dilutions, which she then tested for quality. If the dilution samples were within a 5.0% error margin of the target value, then full credit was awarded. Both lab practicals were more effective at evaluating individual students' laboratory skills.

Given that English is not the first language for many of our Deaf students, we have also utilized video lab reports (Henderson et al., 2023). In this format, students video-record themselves identifying and explaining each section of their report (abstract, introduction, materials and methods, results, discussion, and conclusion) using either ASL or spoken English. We observed that students produced more information and details for each section of their reports in the video format compared to the written format. We shared this strategy with several of our colleagues. Based on our success in using video lab reports, another colleague—a hearing, non-signing instructor in another department at our university—began to use video lab reports to specifically support the Deaf students in his classes. Over time, our colleague began permitting both Deaf and hearing students to use this format, which our colleague reported resulted in better access for everyone in his courses. Creating video lab reports can be time-consuming for students, due to the need for video editing, captioning, and adding voiceovers, and time-consuming for instructors to grade via viewing. Our students, however, expressed that it was easier to explain equipment use and instrumentation in a visual manner.

4.3.4. Permit Lab Report Redos (Rewrites)

In courses where written reports are required, we found students needed iterative feedback and multiple opportunities to practice developing proficiency in creating laboratory reports. We, along with our department colleagues, implemented a “redo” system that incorporated several rounds of student-developed drafts, instructor feedback, student revision, and dialog with instructors and peers over several weeks. The “redos” were optional, but many students took advantage of it, particularly those Deaf students who self-identified as having information-processing disabilities and students whose first language was not English. Although the redo system was time-intensive, we found students' writing skills improved, including more detailed explanations of their observations and conclusions. Students also demonstrated increased confidence in producing subsequent re-

ports. The practice of revising and resubmitting is also foundational to prepare students for professional dissemination of their work. Students commented on our teaching evaluations that providing dedicated time to review lab report “redos” and working with students one-on-one helped them improve their writing.

4.3.5. Dedicate Class Time to Practicing Science Writing

Constructing written laboratory reports, scientific posters, and formal oral presentations remain the primary communication methods in scientific disciplines. Providing ample opportunities for Deaf students to practice these skills is critical for successful employment. Thus, all four co-authors have dedicated class time to support students’ developing written communication skills by providing clear rubrics, guiding students through examples and allowing revisions after giving feedback. As many of our students are English language learners, we use examples of other students’ work to explicitly teach students (Hughes et al., 2017) how to develop their lab reports. For example, one area where students needed practice was using the third-person passive voice, the widely accepted form for scientific writing. We provided writing samples that used passive voice in class and discussed the sentence constructions. Similarly, we provided counterexamples to highlight errors and writing constructions, such as first-person language, that students should avoid. To specifically support essay writing, we showed exemplars of essay outlines to model how to find library resources. We explained why peer-reviewed literature is considered reliable and how to distinguish it from non-peer-reviewed sources. Our students have shown great improvement in their writing because of these error detection exercises (McMillan, 2024), as evidenced by higher scores on essay assignments. We have also provided examples of full lab reports, essays, and presentations. After guiding students through these examples, we assigned class time for students to work on drafts or revise their previous work. We found that spending time in class doing these activities helped students because they received real-time feedback from their instructors and their peers. As instructors we were also able to identify similar patterns in students’ work, such as improperly labeled figures or identifying primary sources. We used what we observed to develop brief lessons for use in subsequent units and courses. Over the years, we have seen that as each semester progressed, students required less feedback and, in some cases, could even submit well-written lab reports on the first attempt without a “redo”.

Another writing strategy we have used was writing letters for social action. In an environmental science class, one of the authors required her students to write letters addressed to policymakers, CEOs, or local politicians on an issue of their choice, such as pollution, climate change, or renewable energy. The students wrote impassioned letters as a culmination of the in-class discussions they had throughout the semester. These letters facilitated both the students’ ability to communicate the scientific concepts they learned to someone else and to understand the real-life implications of these concepts on their environment (Muega-Geronimo & Estrella, 2021). Again, this approach was used during class time so that students could learn from each other while also developing their individual work.

4.3.6. Create an Ongoing Feedback Loop

Along with each class activity and assessment, collecting student feedback on their learning is essential (McMillan, 2024, Chapter 4). Gathering student feedback is an opportunity for instructors to reflect on how well they presented a topic, reveal opportunities to improve for future lessons, and help students to self-assess their own understanding and application of the material. Two feedback mechanisms we have used were “the minute paper” and “the muddiest point” (Angelo & Cross, 1993). In the minute paper, the in-

structor asked the students to take one minute and answer some brief questions, such as: (1) What is one important thing you learned during this class? or (2) What questions do you have? Similarly, “the muddiest point” technique can be framed in many ways, but two common questions are: (1) What was the muddiest topic in today’s class? and (2) Why was this topic difficult to understand? When collecting feedback, we allowed students to use ASL or English and their preferred communication mode (signing, speech, or sign and speech together) to respond to the prompts. Both strategies provided valuable insights into students’ learning experiences. Taking the time to ask students what they thought was unclear, what they liked, and what they want to see improved helped us to refine our teaching (McMillan, 2024). The first author’s teaching evaluations showed students’ appreciation of her checking that students understand concepts before exams. Many of our instructional adjustments and modifications described above were directly shaped by direct and indirect feedback from our students. We continue to gather feedback from our students to make lectures and labs more interactive, such as allowing students to create their own hypotheses to test and help design experiments. These approaches take additional time and planning with students but shift the class to be more inquiry-driven, thus allowing for more authentic science learning experiences (Passmore et al., 2009). Inquiry-driven and authentic science experiences can positively influence students’ interest and ownership of their work (Hester et al., 2018).

5. Discussion

While many of the strategies we have described above are commonly accepted practices in primary and secondary education, oftentimes a culture of assessment *for* learning is not embedded in postsecondary classrooms (Lakey & Pearce, 2026). As science and STEAM education becomes increasingly critical for career success, postsecondary science teachers need to be equipped with clear and practical techniques to effectively teach Deaf students with disabilities. To address this issue, we tried and adapted these strategies as part of an intentional shift towards a more inclusive science learning environment. The techniques we have outlined in this paper came through iterative cycles of individual and collective action and reflection. Like all educators, instructors of DWD learners must continually notice the cues of confusion, identify student misunderstandings, develop tools and supports to mediate learning, and reflect on the efficacy of those practices. Although most of the approaches we described are not novel, currently there is minimal documented evidence regarding the use of these strategies within postsecondary science classrooms, particularly for DWD learners. This article serves as one step towards sharing instructional tools that may be useful to other science educators.

While we drew from years of our collective experiences to show the evolution of these strategies, we recognize several important limitations. The strategies described here were developed in a single postsecondary setting and intended to support DWD learners. This could limit the applicability of these techniques and modifications to other settings or to other diverse groups of learners. The generalizability of these strategies is further limited because they have not yet been empirically tested, nor have we qualitatively gathered input from our students on how these strategies better facilitate their access and overall learning. Furthermore, much of our data relied heavily on instructor anecdotes, retrospective memories of classroom efficacy, and what “felt” right, supplemented by minimal formal student feedback. We initially came into this work out of real-world necessity to develop practical solutions to support student learning. To build on this work, however, future studies must quantitatively and qualitatively evaluate the effectiveness of these strategies for DWD learners. At the postsecondary level, formal training on teaching disabled students is rare. We believe that instructors would benefit from professional

development in-service on best practices in teaching and how to apply those strategies to working with Deaf learners with disabilities, specifically in science classrooms.

We also believe that research on modifying laboratory protocols and procedures is important. Learning university-level science requires DWD students to develop and master advanced technical knowledge and skills while simultaneously navigating the complex intersection of disability and information processing through multiple languages and modalities. Further refining and evaluating accessibility strategies through future research and dissemination to pre-service and in-service teachers of the Deaf and university instructors will help ensure DWD learners are appropriately supported in science education. Ultimately, improving instructional and assessment strategies has the potential to inspire DWD learners to pursue science or STEAM careers, and foster a more diverse workforce.

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Notes

- ¹ The term “Deaf” is used throughout this paper as an all-inclusive term for individuals who are deaf or hard-of-hearing, or DeafBlind, and may use “sign languages and/or spoken languages.”
- ² As a federally funded organization, our college is required to report student demographics following the United States government fiscal year cycle from 1 October through 30 September.
- ³ The student self-identified as a dwarf. Thus, we use the student’s preferred identity language for this example.

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