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**Reimagining Access: Critical Examination of Barriers to Full STEM Workforce Participation for  
Disabled Individuals**

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## INTRODUCTION

Disabled individuals face barriers to participation in the science, technology, engineering, and mathematics (STEM) workforce due to disablism and systemic ableism (NIH, 2022).<sup>1</sup> The Americans with Disabilities Act (ADA) of 1990 (P.L. 101-336) was enacted in the United States just over three decades ago. Thus, many contemporary STEM workforce members are older than this legislation and some even started careers in a pre-ADA work environment—especially those in hierarchical positions of power, such as hiring managers and committees; deans, directors, and department heads; and organizational leadership (hereafter “STEM leaders”).<sup>2</sup> Modifications to the ADA were made in the ADA Amendments Act (ADAAA) of 2008 (P.L. 110-325), which makes it easier for an individual to establish their disability status; final regulations from the U.S. Equal Employment Opportunity Commission (EEOC) regarding this act were only recently made effective in 2011 (EEOC, 2011d), and the U.S. Department of Justice issued its Final Rule to implement the ADAAA in 2016 (U.S. Department of Justice, 2016). Given the relatively young age of this legislation, many STEM leaders are unaware of the full extent of its stipulations. This legislation is also limited in scope—largely to the practical aspects of fixed building design—and going beyond the ADA is often necessary to make STEM environments physically, technically, and socially accessible (Ellis, 2021; U.S. Department of Justice, 2010).

The most recent National Science Foundation (NSF) data on the STEM workforce shows that scientists and engineers with disabilities make up about 3 percent of the STEM workforce (NSF, 2023). Additionally, this data shows that the workforce has grown substantially from 2011 to 2021, but the proportion of individuals with a disability has remained relatively stagnant. Further, significant salary gaps (approximately \$8,000 difference

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<sup>1</sup> There are two spelling conventions “disablism” and “disableism” that are used by various scholars, with both referring to discrimination against or exclusion of people with disabilities. In this publication, we defer to the author’s selected preference of the term *disablism*.

<sup>2</sup> See Approach section for discussion of language choice and conceptual frameworks.

in median annual salary) remain for STEM occupations, potentially driven by degree rates differing drastically between disabled and nondisabled workers; over 50 percent of nondisabled STEM workers hold a bachelor's degree or higher, while only 35 percent of disabled STEM workers hold such a degree. Other sources suggest this gap may be even higher for scientists with early-onset disabilities (Castro et al., 2022). Finally, the outlook appears even more bleak when obtaining federal grant support. From the NSF fiscal report, the proportion of funding award applicants reporting disabilities is low—just 0.9 percent of applicants in 2020 (NSF, 2021). Similarly, recent work has found that principal investigators reporting a disability among National Institutes of Health (NIH) funding applicants is actually declining, from 1.9 percent in 2008 to 1.2 percent in 2018 ( $p < 0.001$ ) (Swenor et al., 2020). These statistics highlight a gross, and potentially worsening, disparity in access to scientific workplaces and careers.

This review examines considerations related to workplace accessibility, principles, and tools for assessing and addressing barriers to access and disability exclusion in STEM workplaces, supplemented with data and solutions from other environments when appropriate. The content is not intended to be a comprehensive guide to every workplace aspect in need of consideration or every available tool; instead, it should form the foundation of reimagining STEM accessibility and provide concrete steps to begin dismantling disablism/ableism in STEM. Many of these concrete steps utilize retrofitting of existing infrastructure or established procedures, but retrofits should be considered a temporary and individualized solution to an ongoing societal, cultural, and institutional problem—a solution that has no lasting benefit and must be eventually supplanted by reimagination of access. Ultimately, the critical examination presented shows that there is no single checklist to determine if a STEM workplace is accessible and equitable, and that no individual retrofit or set of retrofits will sufficiently enable access. Instead, these tools offer practical steps for minimum immediate actions to assess and broaden access. To achieve access, these steps should not be considered a “one-and-done” approach. Instead, they must be undertaken as part of a broader action plan to disrupt ableist systems at their core. Such action plans will alter the current model of a reactive approach to disability (i.e., one undertaken when a barrier is “discovered”) to a proactive approach (i.e., one where access is a central cultural value and

design consideration). They will shift the locus of the central problem of disability from individuals to environments, institutions, and systems. We encourage readers to consider the principles highlighted within this review and apply them to address disability access and inclusion within infrastructure, policies/procedures, and culture. The central goal would be to shift their organization's approach to disability from a reactive, accommodations-based compliance approach to a proactive, access-centered approach.

## **APPROACH**

### **Literature Review**

It is imperative that employers critically examine all facets of their organization for ableism/disablism, including the infrastructure, policies and procedures, culture, approach to meeting individual access needs, and their ability and willingness to address ableism/disablism in their organizations. This paper aims to highlight critical aspects of STEM workplaces that should be evaluated for accessibility and ableism/disablism. Further, it examines existing tools to assist in organizational evaluation, the best contexts for using these tools, and their limitations. This narrative review draws on literature from business, legal, social science, humanities, historical, and medical literature, as well as first-person narratives and autoethnographies conveying lived experience, with a particular focus on disability justice and disability studies literature when possible. Keyword searches for topics covered in this article were conducted using digital library services provided by Vanderbilt University Medical Center and Vanderbilt University, as well as PubMed. PubMed searches were engineered using Boolean logic and supplemented with MeSH Terms. Searches in both databases were expanded based on the bibliographies of selected publications. The results were further supplemented by social discourse available on common platforms for information exchange in disabled communities (e.g., social media) and by publications, websites, and blogs known to the author. Additional material was added based on the perspectives of panelists and experts who reacted to a summary presentation (Mittendorf et al., 2023) within the National Academies of Sciences, Engineering, and Medicine's Disrupting Ableism and Advancing STEM: A National Leadership Summit workshop series as well as based on other presentations within the series.

## Overview of Conceptual Frameworks and Terminology Choices

Multiple models exist for describing contextualizing and conceptualizing disability. A complete discussion of these models and their various limitations is beyond the scope of this paper. However, it is important to provide a brief, high-level overview of the ways in which these models can be used to perpetuate or challenge ableism/disablism in STEM workplaces and to situate the positionality of this report within these frameworks.

The predominant model of disability that persists in STEM and academia as a whole is the medical model of disability, which positions disability as a defect to be cured (Kafer, 2013; Hammel, 2006; Dolmage, 2018a). This model is frequently used to further ableism/disablism in society and workplaces, because it sets up disabled individuals as “less than,” “less valuable than,” or “deviant” from their nondisabled peers, who are defined as a “norm” for which to strive. On the opposing end of the spectrum is the social model of disability (Oliver, 1990), which positions disability as solely present as a result of social and environmental structures that restrict accessibility. For instance, the person who uses a wheelchair is disabled not because of the wheelchair, but because society does not always provide wheelchair *access*. That is to say, society disables individuals. This model is frequently used in disability justice frameworks to advocate for access. Briefly, limitations of this model include individuals with health conditions that also include experiences of suffering (e.g., pain, premature death) for which the disabled individual desires medical intervention. Others have created various models to attempt to bridge gaps in the medical and social models, such as the social/relational and political/relational models (Kafer, 2013; Thomas, 2004). These models position disability as caused by society but offer recognition of the psycho-emotional experiences of living with disability and for medical interventions when desired by empowered disabled individuals (as opposed to imposed by medical professionals or society wielding power over disabled individuals). This report, given the setting in workplaces that are currently creating and imposing disability, predominantly relies on the social model to frame observations, . However,

relational perspectives are emphasized in recommendations to center disabled people as experts on their own experiences, including in the medical sciences when addressing medical conditions causing disability and in the selection of the types of knowledge that are considered valid and valuable. Additional models of disability exist and persist in society (e.g., the moral/religious model) that are outside the scope of this report and therefore were not reviewed.

This paper employs both ableism and disablism to describe ways in which systems and individuals oppress individuals with disabilities. The differentiating factor of ableism and disablism is their focus, with ableism focused on ability in that it is the normalization of the superiority of ability to disability and disablism focused on disability, or the express inequitable treatment or discrimination against disabled people because of their disability (Goodley, 2014). The two concepts are interrelated, as ableism fosters an environment in which disablism can expand. The intention is to capture both the subtle (and sometimes not-so-subtle) belief in STEM that ability is superior to disability (ableism), as well as the historical and current active and intentional exclusion of disabled individuals from the STEM workforce (disablism).

This paper employs a mixture of so-called identity-first language (e.g., “disabled person”) and person-first language (e.g., “person with a disability”) in order to represent two common preferences in the disability community. Some individuals also use the word “impairment” to describe an alteration in function or ability of an organ or body part, while they use disability to describe the way in which these impairments interact with physical and social environments in ways that alter their access to daily life. In this framework, an individual might use the language “impairment” to describe a double amputation, but disability in reference to their need for wheelchair access—access that may not always be available due to systemic exclusions. However, not all individuals with disabilities claim the language impairment; for instance, some autistic individuals may not view autism as impairment, but may view society’s treatment of autism as disabling. Language choice of disabled individuals can reflect the surrounding sociocultural and oppressive structures (e.g., language choice may differ by country of origin), and language is likely to evolve over time as new concepts are generated and

structural ableism becomes better addressed. When existing applicable terminology (e.g., “crip tax,” “cripistemologies”) in disability studies literature and disability justice circles uses the reclaimed slur “crip,” it is repeated in this paper. In these instances, crip (short for “cripple”) is a slur used to refer to disabled people that has been reclaimed as a term of empowerment by portions of the disability community in disability justice movements.

The term *organization* is used throughout this paper to denote any scientific workplace. Such a workplace could be for-profit corporations and businesses, nonprofit organizations, academic or nonacademic research institutes, other research enterprises, government organizations and institutes, scientific societies, scientific journals, health-care organizations, or any number of other workplaces that employ scientists, as all such workplaces contribute to the systemic exclusion of scientists with disabilities. The term *bodymind*, coined by Margaret Price, is employed to emphasize the inextricably connected, yet distinct, nature of the body and the mind, particularly as applied to the experiences of disability and ableism/disablism (Price, 2015). Universal design is used to refer to a framework in which environments are designed from the outset with the needs of all people in mind, including needs both related and unrelated to disability. For understandability, this paper uses the language “accommodations request,” under the common parlance of the ADA and thus most employers. However, this language is stigmatizing and othering to disabled individuals. As Krebs (2019) states, “‘Accommodations’ implies something given out of luxury or generosity not necessity.” Where possible, after establishment of concept, this paper switches to “(met/unmet) access needs” where the intention is clear to the reader. The term *allistic* is used to refer to non-autistic individuals, to avoid classifying them as “neurotypical,” when they may possess other neurotypes that are disabled by social structures (e.g., psychiatric disabilities).

## CRITERIA FOR EXAMINING ACCESS: WORKPLACE ACCESSIBILITY CONSIDERATIONS

### Infrastructure

*Infrastructure*—defined here as existing components of an organization’s established physical, computational, and organizational structures, resources, equipment, and facilities—establishes the grounds (literally and figuratively) on which access needs must be met. Organizations should make newly established infrastructure accessible from inception and modify existing infrastructure to be accessible. Infrastructure considerations for equitable access begin at employee point-of-entry and exist throughout the employment lifespan. Establishing broadly accessible infrastructure can also save time and resources over the organizational time frame, because building universally accessible infrastructure means that organizations do not have to create as many individualized solutions (frequently termed *accommodations*) for disabled employees. Finally, workplaces that have centered access in prominent ways will be more attractive to prospective employees with disabilities.

#### **Infrastructure: Pre-employment**

EEOC guidance for ADA compliance states that the job-hiring process should be accessible, up to and including provision of disability-related accommodations (EEOC, 2002).<sup>3</sup> While compliance with the law is important, it is even more critical to note that by neglecting access to the hiring process itself, employers exclude an entire class of STEM workers before they even enter the applicant pool.

#### *Pre-employment Infrastructure: Job Advertisements and Application Portals*

Starting at point-of-entry for a prospective employee, the accessibility of job advertisements in various media, external organization websites, online human resources (HR) portals for applications, and a request process for meeting access needs during job applications, interviews, and hiring are all critical considerations (EARN, n.d.). Job application web portals are often created by third-party vendors and may not be compatible with existing accessibility technology, such as screen readers, used by prospective employees with disabilities.

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<sup>3</sup> See Approach section for discussion of language choice and conceptual frameworks.



As an illustration, prospective employees who require screen-reader software may be excluded if the portal does not allow ready field navigation using this software, or if documents necessary to the application process are provided in formats with limited or no screen-reader access. Other considerations for web portals include, but are not limited to, adaptability and accessibility of visual layout, for example, customization options such as foreground/background color and font style/size accessibility. Application portals and other aspects of the pre-employment process must be evaluated for accessibility and updated proactively to create greater access. Further, while not all prospective employees may be willing to disclose a disability during the application and hiring process because of disclosure sensitivity, especially because of the potential negative consequences of doing so, an option to report access needs for the hiring process (e.g., captioning during a video conference interview) should be readily accessible, available, and visible during the application (EARN, n.d.).

#### *Infrastructure: Candidate Selection Processes and Procedures*

As artificial intelligence (AI) enters a new era, employers are increasingly deploying it in hiring practices. The most common use of AI is in candidate selection, but like the humans that created it, AI can be subject to bias. The EEOC and U.S. Department of Justice recently separately issued guidance (EEOC, 2022; U.S. Department of Justice, 2022) related to this potential adverse effect of AI under Title VII of the Civil Rights Act of 1964 (P.L. 88-352). This guidance includes stipulations for assessing whether AI causes a selection bias that favors or disfavors applicants or groups of applicants with certain demographic characteristics. Employers should critically consider whether AI is ready for deployment in this arena, and regularly evaluate whether AI may evolve in ways that may result in subtle, insidious discrimination against selection of disabled employees or employees with other marginalized identities.

#### *Infrastructure: Individual Access Needs during the Hiring Process*

For some prospective employees, individualized access needs must be met during the hiring process for full access. If a prospective employee with a disability is interviewed, the interview venue can affect accessibility. If the interview is to be onsite, the workplace site itself may be inaccessible (see [Built](#)

Environment section); if the interview is to be done remotely via teleworking software, such software will have accessibility considerations (see Software section). Common access requests, such as for closed captioning during virtual interviews, alternative interview formats, and accessible interview sites should be anticipated, and employers should restructure hiring processes to recruit a diverse applicant pool. Common criteria used to explicitly or implicitly assess candidates—such as ability to maintain a level of eye contact that is deemed socially appropriate, and ability to gauge conversational turn-taking—can result in elimination of disabled candidates on the basis of bodymind traits that are not, in fact, required for job performance. For example, blind and autistic individuals may not maintain a level of eye contact that equates to interview expectations derived from the dominant norm of an allistic, sighted bodymind; autistic people, people with speech-processing disabilities, and individuals who are deaf or hard of hearing do not adhere to the same conversational flow expectations as other bodyminds. Adjusting interview approaches to allow people to demonstrate various strengths—not just those traditionally associated with a successful interview—are needed to build greater inclusion and reduce explicit and implicit bias against disability at this stage. Such adjustments will also benefit a diverse applicant base because they will reduce biases against different cultural approaches to work and communication, an important consideration given that science is a global enterprise. Employers should provide a transparent and readily available process to address access needs during the hiring process. Providing a readily available access needs request form for the hiring process not only reduces potential for selection bias against prospective applicants that have unmet access needs, but it also signals a culture of disability inclusion. (See Box 1 for a summary of key considerations.)

## BOX 1

### Pre-employment Infrastructure: Examples of Key Considerations

- Jobs should be posted on accessible (including screen-reader accessible) venues (e.g., accessible online job boards).
- The application portal itself should be fully accessible, including to users of assistive technology.
- The candidate selection process, including the use of artificial intelligence or other screening algorithms, should be evaluated and corrected for bias against disabled applicants.
- There should be a prominent option for requesting additional access provisions in the application portal as well as later in the application process, such as prior to interview.
- Interviews should be conducted in accessible venues or using web conferencing software.
- Remote interviews should be an available option.
- Hiring criteria should be adjusted to remove ableist interview evaluation metrics (e.g., making eye contact) and require managers trained in reducing ableist bias.

### Infrastructure: Employee Access and Inclusion

Employees with disabilities face several infrastructure-related barriers within the workplace environment itself.

#### *Built Environment (Worksite, Workspace, and Equipment)*

The most frequently conceptualized accessibility need is architectural. Most ADA guidance is issued and documented around this central topic (U.S. Department of Justice, 2010). As such, many accessibility resources place heavy emphasis on architectural barriers to full participation in the workplace, such as the width of hallways and the availability of accessible parking, ramps, and bathrooms. These resources (see [Tools to Assess and Improve STEM Environments for Accessibility](#)), while laudable and broadly applicable to many

physical spaces, often do not cover the nuances of scientific workspaces, such as the laboratory and fieldwork. Further, they often do not extend far enough to cover true accessibility. For instance, when assessing architectural accessibility beyond a building itself, one must include access of the building site to the nearest public transportation access, parking access, distance of parking facilities from work facilities, and the streets and sidewalks between public transportation access points and parking facilities to the work facility itself. On campuses with parking garages, access from the parking garage to the worksite must be considered. Is the distance too far for someone with a physical disability who can only travel short distances? Are there curb cuts in sidewalks between the parking garage and the facility?

Unique architectural barriers encountered by STEM workforce members include access within laboratories, access to specialized equipment, and access during fieldwork. Considerations for laboratories include bench height, equipment height, access to fume hoods, accessible workplace signage (directive signage, warning signage about hazards, etc.), and space for maneuvering in the laboratory (Ellis, 2021). Additional access considerations include whether specialized equipment, such as pipettes, microscopes, and various other specific scientific implements are accessible. In the case of specialized equipment, creative adaptive solutions may be required. For field work or other scientific workspaces that include physical access in nonnormative workplaces, considerations include width of passageways, access to nearby accessible restrooms, places and ways to rest, ways for workers who have transportation access needs to reach the work site, and, again, accessible signage. The tools evaluated (see section) offer more detailed considerations related to laboratory and fieldwork access.

### *Computing and Web Resources and Other Information Technology*

Many STEM workplaces require standard word and data processing software, as well as field-specific software. Further, collaborations and work communications often require standard workplace telecommunications software of the 21st century. Additionally, workplaces often use online time-logging software and other internal web-based portals and software for human resources objectives, such as employee

evaluations, benefit selection, and employee profile updating (e.g., for emergency contacts and beneficiaries). But not all software centers access in its design. When choosing standardized software for word and data processing, telecommunications, and human resources objectives, workplaces must inquire whether their software choices meet common accessibility needs, such as live captioning, accessible and adaptable graphical user interfaces (e.g., adaptability of contrast, colors, and fonts to accessible formats), and screen-reader compatibility. For specialized scientific software, organizations must choose accessible software if available, and if not, creative solutions may be required for employees with certain disabilities, such as employing personal assistants or custom programming if software is open-source.

### *Training and Ongoing Career Development*

**Training and career development of STEM employees with disabilities.** Training and career development represent an important aspect of career mobility for STEM workforce members. Training often includes a combination of internal training and education alongside attending field-specific conferences. The EEOC offers clear guidance on accessibility of organization-sponsored trainings as a requirement for equal access (EEOC, 2002). Yet disabled individuals in the STEM workforce often encounter barriers around such access.

The simplest types of trainings offered are those required to keep certificates, and to keep current on internal policies and procedures, especially as they pertain to safety. However, many internally developed trainings fail to consider an access component, such as screen-reader accessibility, voice-over, captioning, and accessible venues/formats (e.g., are offered in-person only). It is critical for employers to extend access to these trainings, as well as any organization-sponsored continuing education in the field of interest.

Conferences and workshops represent a critical component of ongoing engagement with rapidly evolving and advancing STEM fields. With the co-evolution of social media and hashtags like #DisabledinSTEM, the lack of disability access at conferences has become more publicly discussed (@DisabledSTEM, 2023; @LiannGC, 2022; @PattiDickson, 2019). Issues such as lack of ramps to stages for

speakers who are wheelchair users, lack of closed captioning, and lack of reimbursement for needed travel assistance are just a few reported incidents. Organizations must consider disability access as a key component of conference planning when they are the host. If a disabled employee wishes to attend one of these conferences on behalf of the organization, they may face barriers when attempting to arrange to have access needs met within the conference venue, the airline or transportation company, or conference hotel block. When designing access to extramural training opportunities, organizations should be cognizant of the additional labor of arranging conference attendance when there are likely to be unmet access needs, the additional incurred cost of some access needs (e.g., using transportation services for distances that are considered walkable by their organization), and the additional health implications of travel on the disabled employee. Organizations should include assistance for disabled employees in navigating these barriers and should pressure conference hosts to design more accessible conferences.

Lastly, in STEM careers, mentors are often key to advancement. Disabled individuals in the STEM workforce need access to not only within-organization mentors but also disabled mentors, even if it means those mentors must come from outside the organization while greater diversity is established. STEM employers should evaluate the availability of those mentors within those organizations, and support employees in seeking networks of disabled STEM mentors (Peterson, 2021).

**Inclusivity training.** Workplaces need to consider whether they have any current training for managers and coworkers on creating accessible and inclusive workplaces and environments, and if such training is adequate. This training can include training for HR and managers on inclusive provision of disability access, training for information technology (IT) staff on inclusive web tools and software, training for all staff on creating accessible documents and figures, and training for all staff on navigating conversations around and interactions with disability in the work environment, including framing “disability accommodations” (equitable provision of disability access) in a positive light. Additional training aspects for inclusivity are discussed in [Employee resources for inclusion](#).

**Employee resources for inclusion.** Disability-based employee resource groups (ERGs) offer a gathering ground for individuals in STEM to explore barriers faced in their workplaces and brainstorm solutions, and serve as invaluable resources to workplace initiatives to improve accessibility and disability inclusion. They may coordinate training and outreach to ensure visibility of disabled employees and improve the culture of an organization. However, these organizations are often run on volunteer time of employees who already face disability-related marginalization. Diversity, equity, inclusion, and accessibility (DEIA) work represents an additional type of organizational service demand (Catalino et al., 2022); this additional organizational service has historically gone unpaid and unrecognized, though more colleges and universities are recognizing DEIA work as service work in their tenure criteria (Stewart, 2021; Catalino et al., 2022). When organizations continue to fail disabled individuals and then demand that ERG members (or other disabled employees on DEIA committees) put in more emotional labor to address institutional shortcomings, they expose disabled bodyminds to additional psycho-emotional trauma stemming from navigating ableism/disablism in the workplace; the outcome of such an approach is that the organization further disables the employee(s). Further, ERGs often are not provided adequate funds or administrative support by the organization to arrange activities and may demand financial contributions from members (Catalino et al., 2022). Organizations who establish ERGs with the expectation that ERGs perform DEIA labor on behalf of the organization should evaluate their funding and support structures for ERGs as well as ERG member time (Catalino et al., 2022). Employees who are reluctant to disclose their identities for fear of stigma or loss of advancement opportunities (Santuzzi and Waltz, 2016) may be similarly reluctant to join these groups for fear of “disclosure by association” and resulting social and/or career harms. This risk perception of ERG affiliation has been shown to be present in employees who are lesbian, gay, bisexual, and transgender (LGBT) identities, which—like many disabilities—are largely invisible (Beaver, 2023). All these barriers and additional marginalized identities can subtract from the potential positive effect of ERGs or even make ERG participation harmful to some individuals. As such, organizations must be cognizant of their own motivations for establishing ERGs, DEIA committees, and other similar

resources whose stated intent is to empower disabled employees. They must also be cognizant of their methods for supporting and utilizing these groups, to ensure that they do not perpetuate harms.

Employees also require adequate and knowledgeable management and human resources personnel regarding access needs (accommodations). Often, management is not fully aware of their legal responsibilities under the ADA. Some disabled individuals may also not be fully aware of their workplace rights. Managers (including entry-level and mid-level managers) need to be well trained to understand when an employee has declared a disability interfering with their ability to perform work under current conditions, even if they do not use the words “accommodation” or “disability” to do so, as people variably integrate “disability” into their identities (Santuzzi and Waltz, 2016). According to the EEOC, an individual may use layman’s terms to state an access need and need not refer directly to the ADA or the phrase “reasonable accommodation” to begin the interactive process for obtaining disability-related access (EEOC, 2002). As such, managers need adequate training in recognizing disability-related requests for access. They also must be trained regarding the importance of providing access—not just as it relates to compliance but also as it relates to employee inclusion and organizational values. Once an individual requests a change to meet an access need, knowledgeable HR personnel who are prepared to *supportively* engage the employee are required. Additional aspects related to the inclusivity of the access request (accommodations) process itself are covered separately, in Policies and Procedures.

**Employment-related health-care access, insurance and benefits.** Disability is often costly, with disabled individuals incurring hidden direct and indirect costs related to disability, sometimes referred to as the *crip tax*<sup>4</sup> during in-group speech (Loeppky, 2021; Hawthorne, 2021; Navarro, 2023). Estimates from the National Disability Institute put the average additional household cost per disabled adult at over \$17,000 in

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<sup>4</sup> See Approach section for discussion of language choice and conceptual frameworks.



2020 to achieve the same standard of living as equivalent households of nondisabled members (Goodman et al., 2020). In 2022, those rates rose to over \$18,000 (Morris et al., 2022).

Indirect costs are those incurred indirectly because of disability, such as loss of financial opportunities and loss of employment opportunities. Indirect costs of disability are elsewhere addressed in this paper in service of building a more inclusive STEM workplace environment to increase employment access to disabled employees. Direct costs are those costs incurred that are directly tied to disability-related needs, such as durable medical equipment (e.g., ramps, wheelchairs), assistance services, and additional health-care costs. These direct costs may affect position choice based on job position benefits (Goodman, 2020). It is often rare, for instance, that durable medical equipment like ramps and wheelchairs are fully, or even partially, covered by health insurance plans in the United States.

STEM positions are unequal in benefits provided; as an example, postdoctoral positions in the United States are woefully unequal in their insurance benefits (Smith, 2023; NPA, 2018), which can prevent disabled STEM workforce members from accessing the “traditional path” of doctorate and post doctorate training that is often an accepted norm. Worse still, postdoctoral scholars who obtain grant funding may lose access to employee status, which can result in loss of health insurance provided by their institution and paid sick leave and other benefits (Smith and Kimbis, 2023; NPA, 2018). This is a known issue that has been discussed by the NIH, with the NIH recommending uniform benefits for postdocs regardless of funding source in 2012 (NIH, 2012). However, over a decade later, postdoctoral researchers and university websites continue to report unequal benefits based on funding sources (Smith and Kimbis, 2023). Because scientists with disabilities often have a greater dependence on health insurance than their nondisabled peers, scientists with disabilities may be more reluctant to apply for career-advancing federal awards if such funds would jeopardize their ability to afford disability-related care and expenses. In the same vein, as many disabilities are inextricably tied to medical conditions requiring specialized health care, insurance must provide access to quality health care that is accessible within the region of residence of the disabled employee. The issue of adequate health care and

insurance coverage, like many others discussed in this article, is likely applicable to other key underrepresented groups in the sciences, such as women and primary caregivers of children or adult household members, and should be considered a key DEIA issue that institutions as well as funders include in ongoing efforts to evaluate postdoctoral decline (NIH, 2023) and overall equity in STEM.

Other benefits of import to disabled individuals may include life insurance tied to employment, access to nonmedical-related care benefits (e.g., in-home assistants), and strong retirement plans, which allow more accessible lives by offsetting the crib tax. Critically, the direct costs of disability affect individuals differently depending on intersections with other identities with their base financial privilege. Because of systemic discrimination, such as systemic racism, the significance of the crib tax on disabled communities of color and disabled individuals with additional marginalized identities is higher, making evaluating direct costs of disability influenced by organizational policies and benefits a critical aspect of DEIA initiatives (Testimony of Vilissa Thompson n.d.).

**Mental health and wellness resources.** Mental health–related disabilities represent one of the most stigmatized categories of disability. As a result, mental health disabilities can be some of the most difficult for employees to disclose and make their access needs known (i.e., request accommodations), yet they can be equally consequential for an employee’s wellness and inclusion in the workforce. Employers that provide robust mental health supports can offset some of this stigma (additional considerations related to stigma are addressed in the Culture section). Good mental health resources start with emergency programs such as Employee Assistance Programs (EAPs) that can provide limited mental health services quickly when an employee needs them (Doran, 2022). EAPs benefit the employer through increased job satisfaction, decreased work stress, and higher organizational commitment (Chen et al., 2021); EAPs have even been shown to help when an employee has an abusive supervisor (Wang et al., 2022). EAPs may be internal or external, and there are benefits and detractors to both options for employers and employees. EAPs should be equipped to help an employee

navigate outside referrals to adequate mental health resources that can support employee-specific needs on an ongoing basis.

Additional resources include adequate therapy coverage on employee health insurance plans that allow employees to access a variety of mental health resources and providers. Insurance does not always cover adult neuropsychiatric evaluations (ASHA, n.d.), which are needed for thorough evaluation and diagnosis of adults whose diagnoses of neurodivergent traits (e.g., attention-deficit/hyperactivity disorder [ADHD], autism, dyslexia) were missed in childhood. As such, to build and sustain a neurodiverse workforce, such insurance coverage is a necessary consideration. Where possible, access to wellness facilities, such as onsite gyms or sponsored wellness programs (e.g., access to mental health support phone apps), can offer additional support for employee mental health.

For disabled individuals, it is critical that employers ensure that wellness programs are not focused on goals and initiatives that are inherently disability exclusive. Goals to walk a particular distance using a step counter or to lose a particular amount of weight (which would discriminate against employees with eating disorders or low body weight due to chronic health conditions) are examples of frequently imposed employer goals tied to health benefits or cash incentives. Employers must be conscientious when designing programs aimed at the wellness of their overall workforce, without discriminating against a subset of the workforce, particularly those experiencing disability.

**Flexible and creative work models.** Many individuals with disabilities can work full-time, and their primary access barriers come at the expense of stigma and access barriers to their work. However, individuals with many types of disabilities (e.g., chronic mental and physical health disabilities) may either not be able to work full-time or experience a need for intermittent leave or extended leave related to disabilities. While the right to intermittent and extended leave related to disability is covered under the Family and Medical Leave Act of 1993 (FMLA; P.L. 103-3) in many cases, FMLA also has certain stipulations (such as establishing 1 year of employment), which disabled people may not be able to afford. Whether to move to institutions for upward

career mobility is thus additionally limited for individuals, who may include the anticipated possibility of an unforeseen medical leave in their decision-making. Employers who want to be inclusive must establish models (see policies and procedures section) for people with disabilities to access in the absence of earned FMLA (e.g., granting intermittent leave under the ADA until FMLA is earned; ensuring adequate staffing). Additionally, STEM needs new models for success that generate access to disabled individuals who may need part-time schedules that accommodate medical treatments or adequate rest (Sarju, 2021; Sang et al., 2022; see also [Tools Addressing Culture](#) section). Other flexible work models that are supportive of disability include remote work options, including hybrid work models and full-time remote work models. Even if a STEM employee needs onsite access (e.g., to equipment), many onsite employees still spend a lot of time working at a computer, (e.g., for writing, planning, data processing). Models where work that does not require onsite access may be accomplished remotely allow for disabled STEM employees to accomplish work from their homes, which may already serve their needs for access and will limit exposure to inaccessible systems outside the control of the employer (e.g., public transportation). Fully remote positions can allow disabled individuals more living options, and may provide them greater access to affordable accessible housing and health-care resources. (See Box 2 for examples of infrastructure considerations.)

## BOX 2

### Employment Infrastructure: Examples of Key Considerations

**Jobsite access:** Remote work should be an option for all work (e.g., computational work) that can be accomplished offsite; access to public transportation from the jobsite should be maximized; employee disabled parking spaces should be sufficiently close to the worksite and/or there should be accessible transportation from parking structures.

**Laboratories and field work:** There should be benches, equipment, and fume hoods that can accommodate mobility equipment and equipment arranged to allow sufficient space for maneuvering; there should be sufficient access to nearby accessible restrooms and places and ways to safely rest.

**Information technology:** Word and data processing, telecommunication, and any human relations (e.g., time logging, employment management) software should be vetted for accessibility prior to purchase; accessible options for specialized scientific software should be purchased if available; if accessible options do not exist, options for customizing open-source software or for hiring personal assistants should be explored.

**Training access:** Conferences hosted or sponsored by the organization should include disability access in conference planning; resources for access support should be provided to disabled employees to attend extramural conferences (e.g., to cover additional travel and equipment costs); support for accessing disabled mentors or mentorship networks should be provided.

**Workforce inclusivity:** Managers should be trained on inclusive team practices for disability access, including the accommodations process and procedures; IT staff should be trained on accessible IT procurements and development; staff should be trained in creating accessible documents and figures; managers and staff should be trained to interact inclusively with disability accommodations; employers should sponsor affinity groups and adequately compensate DEIA work, including that undertaken by employee affinity groups.

**Insurance and benefits:** Positions throughout the workplace, including those for postdoctoral scholars, should be equal in health insurance and other benefits (e.g., the funding source should not affect benefit receipt); employees should have health insurance options that include adequate health coverage for complex conditions; adequate life and disability insurance options should be offered; all employees, including postdoctoral scholars, should have access to retirement plans.

**Mental health and wellness resources:** Employees should have health insurance options that include adequate health coverage for complex conditions and psychiatric care, including psychotherapy, in- and out-

patient psychiatric treatment, and adult diagnosis of ADHD and autism; Employee Assistance Programs should be offered; additional wellness resources, such as access to gymnasiums, should be considered; employer-sponsored wellness programs should be revised to remove ableist incentives (e.g., they should not require employees to lose or maintain a certain weight for access to certain benefits, which could endanger employees with certain medical conditions).

**Work models:** Flexible scheduling and creative work models (e.g., hybrid work, remote work) should be available where possible; medical leave options prior to FMLA activation should be offered.

## **Policies and Procedures**

### **Policies and Procedures: Pre-employment**

#### *Job Listings and Advertisements*

Job descriptions often include, as essential requirements, particular physical abilities (e.g., visual or aural acuity, weight-bearing or lifting activity, driving requirements, and walking or standing requirements) that are nonessential functions for the position (Lu, 2019); for example, weight-bearing and standing requirements may be included in the description of an entirely sedentary position. These listings are, as if by design, explicitly excluding disabled individuals (Procknow and Rocco, 2016). Though the phenomenon is not unique to STEM, it is a contributor to STEM pre-employment discrimination. Organizations must critically evaluate what physical, sensory, or mental capabilities are truly essential job functions prior to posting a new listing (Procknow and Rocco, 2016). It is probable that they will need to engage disabled individuals in the field to determine if a capability is a requirement because of what Procknow and Rocco (2016) term “a lack of will to imagine work in other ways”—but which this author asserts is also sometimes due to lack of creativity or ignorance of knowledge inherent to disability experience (see [On Reimagination of a More Just Scientific Enterprise](#) section). For instance, even though there are blind chemists (Koone et al., 2022), a chemistry manager might believe that chemistry work requires sight, simply because *they* cannot imagine how they would perform their job as a blind person. Additionally, academic managers have indicated that they do not have

practical knowledge of how to provide access under stated and granted accommodations in academic settings (Remnant et al., 2023).

If ignorance goes unchallenged, managers may provide job descriptions that indicate such functions are unmodifiable to meet access needs. Further, organizations must examine their policies for job listings and the hiring process and ensure they apply organization-wide, to give individual hiring managers clear guidance on creating accurate and accessible job descriptions (Procknow and Rocco, 2016). Any provisioned templates should avoid inclusion of unnecessary requirements. Because hiring managers in STEM fields are often principal investigators, it may be necessary to implement screening procedures to remove discriminatory requirements prior to posting. Extrapolating to technology, similar policy review regarding advertisement host accessibility is required.

#### *Access Provision (Accommodations) Policies and Procedures: Pre-employment*

Most employers do not have a readily available hiring process access provision (accommodations) request procedure, which leaves disabled people wondering whether and how to disclose any disability that might affect the hiring process or their decision process (e.g., because it creates an access need that may be unaccounted for by an organization's hiring process) (Ameri and Kurtzberg, 2022). Additionally, disabled individuals have reported difficulty navigating the disclosure process that is often an aspect of an access request (Procknow and Rocco, 2016). Normalizing pre-employment access requests prior to application or interview provides employees with an impersonal and potentially less anxiety-producing option to request access. Further, it normalizes disability and access provision for hiring managers. There is proven discrimination by managers against submitted applications where disability is disclosed or access is requested (Ameri et al., 2018). Employers must regularly evaluate whether managers' hiring practice are appropriately reviewed for such discriminatory behavior (alongside review for other types of discriminatory behavior). One option to address such behavior is to decouple access request procedures from hiring decision-makers where possible, such that the hiring decision-makers are not privy to the access request or provision of access. This is not

always possible, where disability is visible or the aspects of meeting access needs are visible (e.g., provision of an American Sign Language interpreter). Addressing ableist/disablist policies and workplace culture (see section) are other required components of addressing inequitable hiring. (See Box 3 for examples of pre-employment considerations.)

### **BOX 3**

#### **Pre-employment Policies/Procedures: Examples of Key Considerations**

- Job listings should be revised to remove any nonessential physical/sensory requirements (e.g., requirements for visual acuity, hearing, standing, lifting); disabled individuals working in the field should be consulted to ensure that unnecessary requirements are not maintained due to lack of disability knowledge.
- Procedures should be enacted to review new job descriptions for nonessential requirements.
- Clear policies should be created that ensure job listings and selected job-listing distribution sites are accessible.
- Clear policies and procedures for requesting and providing disability accommodations in the application and hiring process should be created.
- Access request processes and procedures should be decoupled from hiring decision-makers.
- Hiring practices should be regularly reviewed for signs of discrimination.

### **Policies and Procedures: Employee Access and Inclusion**

#### *Policies*

To make an argument for the capitalist value of disabled bodies runs counter to the core principles of the disability justice movement (Piepzna-Samarasinha, 2018; Sins Invalid, 2015). However, in the context of workplace finance, it is necessary to counter those common—and false—narratives of the disabled person as an



unwanted legal requirement and cost, narratives that frame “access as excess” (Williamson, 2019). For example, counter to the belief that disability will reduce productivity, experiments in manufacturing teams have found that enriching teams with a moderate amount of disability actually *increases* productivity (Narayanan and Terris, 2020); other studies have shown that providing accommodations to disabled employees boosts creativity of both the disabled and nondisabled members (Man et al., 2020). Many disabled individuals are uniquely creative as a direct result of disability (Holly and Priti, 2006; Jones, 2022; Pennisi et al., 2021); others have innovated solutions to overcome access barriers that provide them new ways to look at interesting and difficult STEM problems (Jones, 2022).

Though accommodations are often assumed to be costly to employers, analyses find most accommodations are low cost (many being *no cost*), and the benefit-cost ratio is high (Schartz et al., 2006). Employers in a large survey who provided accommodations reported accommodations had both direct (e.g., retaining a qualified employee, increasing their productivity) and indirect (e.g., improving company morale, increasing company productivity) benefits for their companies (Solovieva et al., 2011).

However, looking at disability only through the lens of cost devalues contributions that are not directly calculable under this framework, such as increased innovation (Remnant et al., 2023) and acts as a type of “gestural violence” against disabled people (Kuusisto, 2015). Kuusisto states:

Gestural violence happens in the academy whenever a disabled employee or student asks for an accommodation the school doesn’t know how to deliver, or fears will be expensive. [Gestural violence] is always the first response when non-disabled administrators or faculty are faced with bewildering disability related challenges. It works by deflection. It works by assumptions. If you were a better disabled person, you wouldn’t be bothering me. If you were less blind, you’d be easier to deal with. If only you had a better attitude about life. Gestural violence is automatic. It is invariably disgraceful, shockingly unacceptable, and yet, tied to dominance, it is widespread within higher education.

STEM fields are inevitably informed by the culture of higher education, and access (accommodations) requests are often met with the same gestural violence. Together, this evidence demonstrates that providing access (accommodations) rather than gatekeeping can save costs and boost productivity of both individuals with disabilities and their teams while minimizing harms from gestural violence to disabled individuals.

Partly out of mischaracterizations of disabled people as costly or “faking it” (Dolmage, 2018a), organizations set up their human resources or accommodations offices with a major focus of training, policy development, and policy adherence centered on legal compliance (Mattison et al., 2022). Kelsey Byers characterizes this “intent to avoid [organizational] liability” as setting them up to be “gatekeeping offices” (Powell, 2021)—that is to say, their primary function is to provide only the minimum access necessary under the law. Dolmage refers to this as the “liability model,” which pigeonholes accommodations into “*always and only*—the legal minimum accommodation” (Dolmage, 2018b). Because of perceived cost of disability, organizations often frame their compliance offices around provision of proof, which many argue creates unnecessary barriers and contributes to the medicalization of disability (Lu, 2023; Dolmage, 2018c; Saltes, 2020). Disability resource specialists in charge of adjudicating accommodations for students have themselves questioned whether the very existence of the accommodations process was ableist (Strimel et al., 2023). Such restrictions, which were designed to avoid liability by adhering to the letter of the law, work instead to constrain organizational imagination from enacting the spirit of the law. Ultimately these processes limit creative access and, simultaneously, the futures of disabled scientists. Advocates argue that HR offices must stop thinking about the ADA through a compliance lens and instead use a lens of equity in order to foster inclusion and employee success (Parisi, 2022a).

While compliance-based access approaches ultimately fail, employers *do* need to be able to take action against employees who create hostile workplaces for disabled employees—especially, though not limited to, when those other employees are managers or other individuals in positions of power over disabled people. To

ensure that they can enforce an inclusive culture, employers need transparent and enforceable policies for both provision of access (to ensure that managers will follow access policies and avoid denying access requests) and nondiscrimination. They must also not act as “policies in name only”—they should be enforced to eradicate workplace-constructed ableism/disablism. Policies should clarify a nondiscrimination policy against any type of disability or other status when provisioning access, including consequences for failure to abide by the policy.

Revision of access request policies and procedures (discussed in Tools Regarding Policies and Procedures section) to alter the approach from a compliance-centered accommodations approach to a proactive, access- and human-centered approach is necessary. To further address these issues, trainings on organizational values surrounding access and disability inclusion should be required by policy, as should trainings on broadening access. It is important that managers and HR personnel be adequately trained on organizational approach to access, especially given that it is likely their past experiences are focused on minimum legal compliance, medicalization of disability, and access denial.

### *Procedures*

Length of time to provision of access, lack of transparency about how to obtain access, lack of transparency and communication during the access request process, lack of inclusion in the process, lack of access options offered, lack of social support, and maltreatment have all been cited as key negative experiences for individuals going through existing accommodations processes (Kensbock et al., 2017; Sang et al., 2022). When accommodations procedures are designed as gatekeeping mechanisms, they set up a culture of “disbelief” of the disabled individual. This culture presumes that the majority of individuals claiming disability are not, in fact, disabled (Lu, 2023; Dolmage, 2018a). This results in unethical (and illegal) discrimination. For example, employers are more likely to deny provision of access (accommodations) to individuals with psychiatric disabilities because of lower perceived necessity (Telwatte et al., 2017), and reviews of factors influencing accommodation request denials showed that most factors influencing denials did not constitute legal reasons for doing so (Carpenter and Paetzold, 2013). Further, HR staff may construe disability as a performance

management issue, and protective processes need to be developed around performance assessment to address how access requests may contribute to bias (Remnant et al., 2023).

Accommodations processes have been reported to take months, with organizations delaying accommodations. Besides being ableist, such procedures do not align with evidence: employers actually save costs when an access need is addressed earlier (Bonaccio et al., 2020). Additionally, current procedures include several costs to disabled people in terms of time, trauma, and money. First, disabled individuals may have to have their doctor fill out worksite-specific forms. This requires a medical visit *specific* to the disability accommodations request, which Krebs refers to as “the cost of accommodations” (Krebs, 2019) in the form of time and money. Having already established that health insurance coverage can be inadequate, it is also important to note that not every position comes with insurance that is effective from the first day of employment. Even if they are insured, disabled people may be in the process of establishing care with new providers, which takes time and energy (and may mean a wait for a scheduling opening), and they may need to reserve their medical visits for pressing medical issues. To complicate matters, disabled individuals may struggle to find doctors that are knowledgeable and unbiased about access request processes. Doctors hold biased views about disabled patients and feel unprepared to care for them, and their biases also extend to their disabled colleagues and trainees (Iezzoni et al., 2021; Jain, 2022; Roy-O’Reilly and Salles, 2023; Aulagnier et al., 2005). Ableism persists in medicine and medical education. Residents and doctors fear requesting accommodations and report experiencing bias from colleagues (Roy-O’Reilly and Salles, 2023; Pereira-Lima et al., 2023). Not only does this affect an important part of the health science workforce, but it also affects all disabled STEM individuals who need access to a doctor who supports their access request. This culture can make it difficult for disabled patients to establish trusting relationships with their providers and obtain medical documentation for employers.

The more time it takes and barriers to overcome to complete the documentation request and the accommodations process, the longer the person with a disability works with an unmet access need. The

advocacy required to establish their medical need contributes to what Konrad (2021) calls “access fatigue,”<sup>5</sup> which results in further disablement (Sang et al., 2022). Further, these processes often require extensive justification of why an accommodation is required. Mia Mingus (2017) describes this humiliating process of sharing deeply personal details to achieve “*basic* access” as a form of “forced intimacy.” Others have pointed out that accommodations processes are themselves disabling when they are exhausting, overwhelming, and time-consuming (Sang et al., 2022). This social disabling affects all disabled individuals but may disproportionately affect those with certain types of disabilities that are triggered by stress, such as autoimmune conditions and psychiatric conditions, and individuals who are experiencing other types of oppression. Macfarlane has recently challenged the legality of the process of medical documentation of disability, comparing and contrasting religious and disability accommodations under the law, whereby an assertion of religious belief is typically not meaningfully questioned by employers or courts and documentation is rarely required (Macfarlane, 2021). Macfarlane argues that the interactive process, especially where medical documentation is concerned, does not function as intended, calling it “exhausting” rather than “empowering.” Macfarlane suggests that a “hands off” model of accommodations similar to that of religious accommodations should be undertaken and asserts that the EEOC’s medical documentation framework contradicts the legislative intent of the ADA.

As summarized above, the current accommodations model is a lengthy, expensive procedure, potentially compounded by exposure to medical trauma (Lu, 2023). As such, it is more consequential for individuals with disabilities who also have another marginalization that negatively affects their financial well-being or results in health-care discrimination (Krebs, 2019), making such procedures antithetical to DEIA work. Further, the daunting aspect of seeking accommodations at new workplaces contributes to the reduced career mobility of disabled individuals in STEM fields. The end result is ableist and disablist (and often illegal) discrimination

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<sup>5</sup> Konrad defines *access fatigue* as “the everyday pattern of constantly needing to help others participate in access, a demand so taxing and so relentless that, at times, it makes access simply not worth the effort” (see Konrad, 2021).

against disabled people. To truly achieve equity, accommodations procedures must be completely restructured, with medical documentation requirements that act as gatekeepers reduced or eliminated in all possible instances. (See Box 4 for examples of considerations in policies and procedures supporting employee access and inclusion.)

#### **BOX 4**

##### **Policies/Procedures to Support Employee Access and Inclusion: Examples of Key Considerations**

- Disability access (accommodations) policies should be redesigned to promote access rather than “compliance” and to remove “minimum legal compliance” as a policy focus.
- Access provision procedures should be revised to reduce gatekeeping via medical documentation requirements; organizations should remove barriers designed around proof of being “truly disabled” (especially for, though not limited to, low-cost accommodations).
- If medical documentation is required, it should be (a) minimal, (b) easy to obtain by most types of providers, (c) noninvasive (e.g., not requiring specific diagnoses, not requiring intimate details), and (d) only viewable by individuals who will not be evaluating performance; medical privacy should be sufficiently protected; any associated medical visits should be covered immediately under employer insurance or other employer funds; where possible, medical documentation requirements should be eliminated.
- Policies should be redesigned to ensure that disability is not framed as costly, either explicitly or implicitly.
- Trainings should be provided to managers and other workers to reframe accommodations as positive.
- Nondiscrimination and access provision policies should be enforceable; disciplinary actions should be taken against managers and others who do not abide by inclusive policies.
- Access request and granting procedures should be readily accessible, clear, and transparent.

- All access request procedures should be designed for expedient granting of access.
- Policies and procedures should ensure accommodations will not be unnecessarily denied; when a requested accommodation cannot be provided, clear alternatives should be supported by the organizations; policies and procedures should ensure equal treatment of all types of disabilities, including those with greater attached stigma such as psychiatric disability and other invisible disabilities.
- Protective policies and procedures should be implemented to ensure access requests do not negatively affect performance assessment through managerial bias.

### **Other Policy- and Procedure-Related Considerations**

Additional policy- and procedure-related considerations are vast, but employers should consider several aspects documented in the literature. Because of fear of negative consequences from disability disclosure, employers should anticipate “late disclosure” of and requests for unmet access needs; this does not mean an individual was coping well without an accommodation prior to disclosure (Santuzzi and Waltz, 2016). STEM has a number of industry-specific employment arrangements (e.g., adjunct faculty, other non-tenure-track faculty, postdoctoral workers, contract) that have lower job security; in nonstandard and precarious employment arrangements, employees are more likely to have unmet access needs (Shuey and Jovic, 2013). Presumably, this could arise from fears associated with greater susceptibility to termination in the event of disclosure or from lack of management willingness to meet the access needs of these employees. Policies and practices must be reviewed to ensure inclusion of all STEM contributors, regardless of employment status type.

### **Culture**

Deeply ingrained and insidious stigma and bias against disabilities persist in our current culture, including within STEM (Jun, 2018). At times, organizations are not even meeting their minimum obligations under current law (Carlson, n.d.). According to the EEOC, disability discrimination has remained the basis of

one of the most common EEOC suits filed over the last 4 years (EEOC, 2023). Academic workplaces are not immune to these problems. Data from disabled faculty and staff at a large public university in the United States that also included non-STEM disciplines show that 1 in 4 report experiencing disability-related discrimination, and 1 in 5 report experiencing disability-related harassment on campus (Shigaki et al., 2012). Academics with disabilities also face oppression, discrimination, and bullying (Procknow and Rocco, 2016).

The culture of the workplace is inextricably tied to an individual's comfort with their disability identity in the workplace, comfort with disclosure, and likelihood of making formal access needs requests (Santuzzi and Waltz, 2016). A perceived pressure to conceal their identity or an ableist/disablist workplace culture could lead to negative psychological outcomes and lower job satisfaction for the individual, as well as higher turnover (Santuzzi and Waltz, 2016).

Individuals with multiple marginalized identities experience overlapping and intersecting discrimination (Crenshaw, 1989).<sup>6</sup> Disabled people of color experience what Mireles calls “racist ableism”—ableism that interacts with racism to characterize Black and brown people with disabilities as lazy, unproductive, deviant, unintelligent, and less academically capable (Mireles, 2022)—stereotyped pathologizations of both communities that are compounded and multiplied by intersectionality (Piepzna-Samarasinha, 2018). Others have described an intersection of gender-based discrimination and ableism in workplace environments (Chowdhury et al., 2022). Individuals who are otherwise multiply marginalized face similar exclusions and harms (e.g., LGBTQ+ individuals with disabilities,<sup>7</sup> veterans with disabilities). The concept of intersectionality is applicable here because, for example, a Black disabled woman will experience different and compounded oppressions in STEM relative to a White disabled man. As an individual can hold any of a factorial number of intersectional marginalized identities or backgrounds, each person's set of identities creates a complex set of

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<sup>6</sup> The concept of intersectionality was coined in the context of critical race legal scholarship by Kimberlé Crenshaw to describe the way in which Black women experience oppressions that are due to the compounded effects of race and sex and to critique the ways in which scholarship often focuses on a single axis of discrimination and chooses to uplift the most privileged members of a marginalized group.

<sup>7</sup> LGBTQ+ is the abbreviation for lesbian, gay, bisexual, transgender, queer or questioning, intersex, asexual, and more.



lived experiences of ableism that cannot be accounted for in single theories. To be truly successful, then, anti-ableist culture work must also be undertaken in the context of, and be informed by, parallel and intersectional work to disrupt other oppressions, such as racism and sexism.

### **Considerations of Scientific and Academic Culture and Values**

STEM has unique and deeply ingrained cultural notions that must be disrupted to build a truly inclusive environment for STEM contributors with disabilities. The culture of the STEM workplace is shaped by the culture of scientific approach, assumptions, and scientific values, including the present values surrounding the *medical model of disability*, an *assumption of objectivity*, and values of *productivity*, and *independence*. These values are frequently distinctly acted out in opposition to disability inclusion and disability justice. Further, mainstream approaches assume these values will lead to the best science. From a disability justice lens, mainstream scientific culture dismisses the value of team science (interdependence) to the detriment of individual scientists, scientific teams, and science as a whole. The alternative model of a disability justice-driven scientific value set might thereby challenge medical models of disability, examine positionality as contributing to scientific design and interpretation, and value impact of work over productivity and interdependence over independence.

Persistent models of disability in Darwinian, medical frameworks contribute to implicit and explicit bias against STEM workforce members with disability (Schwarz and Zetkovic, 2019). In Darwinian frameworks, disability is viewed as inherently inferior—a trait that would impede an individual’s success and survival. These frameworks underlie the medical model of disability, which positions disability as a defect to be cured (Kafer, 2013). The medical model of disability, as the currently predominant model in health research, permeates the broader culture within the STEM enterprise as well as academia (Dolmage, 2018a; Jimmons, 2022), contributing to a perception of the disabled colleague as less than, a burden. Researchers and scientists must then be conscientious in how they are framing disability in their own work. For instance, autistic researchers have recently pointed to problematic framing of autism research from non-autistic researchers (Botha, 2021),

and greater medicalization of autism has been shown to be associated with greater presence of ableist cues in research construction of autism (Botha and Cage, 2022).

Further, scientists often fall back on an assumption of scientific objectivity in their approach to research—an assumption that their own social positioning could not affect their hypothesis generation or data interpretation and a norm that has supported continued proliferation of contemporary scientific racism (Cerdena, 2021). Not dissimilarly, ableist lenses have shaped disability research in medicine and the sciences, leading to the medical model discussed above, as well as the potential to assume objectivity when approaching a disabled STEM workforce through an ableist lens (Hammel, 2006). Leaders must also be conscientious when evaluating reports of ableism and discrimination of their own social positionality, and how that may influence their interpretation and biases.

Next, STEM culture—and indeed all academia—presently values productivity (e.g., number of publications, number of grants) over quality, impactful work (Dolmage, 2018a; Brown, 2020), with issues of work hours in academia being an oft-cited reason for disability incompatibility by both disabled (Sang et al., 2022) and nondisabled (Remnant et al., 2023) individuals alike. A perception of multiple disabled academics in a qualitative interview study set in the United Kingdom (Sang et al., 2022) was that academic culture requires inflexible and long work hours, and a high degree of productivity with publications and funding applications that would be incompatible with part-time work—a construction of a STEM performance model that could readily apply to the U.S. STEM academic (and perhaps even private sector) environment. One interviewee noted that STEM culture is inherently inaccessible: “I’m aware that having a sparser publication record just because I’m not able to work full-time, let alone the ridiculous 60-hour weeks that a lot of academics do, is inevitably going to have a negative impact on me” (Sang et al., 2022). At least in academia, there is little room for advancement in nontraditional career paths and no availability of part-time tenure-track options for principal investigators, which may prohibit disabled individuals from being lead investigators, and partially explain the massive funding applicant disparities observed in both NSF and NIH data (NSF, 2023; Swenor et al., 2020).

This is, in part, based on the value of productivity required for funding ascertainment from federal and other sources, with little consideration in evaluation given to aspects of life that could affect productivity (NIH does allow for requests to extend the “early-stage investigator status” for special circumstances [NIH, 2008]).

To move toward disability justice in STEM, organizations and funders can explore ways to support accessible roles that still give disabled people who need more flexible work schedules a chance to strive for upward career mobility and a chance—if desired—to serve as lead investigators (Brown, 2023; Mattison et al., 2022; Sarju, 2021). They can also consider whether “part-time” or “extended-clock” tenured positions could be created and funded. Senior staff positions (full- and part-time) that are permitted to apply for R01-level funding to cover a portion of full-time equivalent could be another solution. Further, funding agencies should consider evaluating their review policies to encourage funding of a more diverse array of investigators and work models, and to emphasize past work as having greater importance than current work. Early-stage investigator classifications could be extended for those with disabilities that require additional time away from scientific progress and/or part-time work. This reimagining of scientific success and of role structure can benefit more than just disabled individuals, but could also address other equity challenges, such as those faced by primary caretakers or by first-generation students.

Finally, and in relation to productivity, STEM presently values the “independent investigator.” This framing of independence firstly minimizes the contributions of “nonindependent” members of STEM and suggests that independent investigators operate without the assistance of those other team members. Secondly, it holds independence as a core value and pinnacle achievement. While it may seem like mere semantics, all individuals are dependent, to some degree; for example, the principal investigator is dependent upon laboratory staff, students, administrative assistants, and/or collaborators. They are dependent on grant services offices, and other key contributors to a successful STEM enterprise. As such, the cultural focus on independence favors a hierarchical structure with majority credit being received by principal investigators. The current cultural value of independence also directly contributes to negative stereotypes of interdependence and dependence,

enhancing disablism and ableism in academia by stigmatizing access needs as “dependencies.” Secondly, naming some people as independent (of others)—and subsequently, those people as the pinnacle of success—devalues both team science and the contributions of others, resulting in lower incentives for collaboration, interdependence, and shared creativity. This perspective is reflected in the fact that scientists themselves often believe disabled people are not able to engage in careers in their field (Atchison and Libarkin, 2016), a bias which must be challenged.

Conversely *interdependence* is a key component of disability justice frameworks (Sins Invalid, 2015; Piepzna-Samarasinha, 2018). Reframing STEM values through a lens of disability justice (a lens of interdependence) will alternatively foster collaborative and multidisciplinary components of the scientific enterprise driving new innovation through team science with leaders and team members who engage in shared responsibility and shared creativity. In the human-focused sciences such as medicine, disability justice frameworks would reimagine research participants as a key contributor to scientific research and emphasize participatory research, an ethical reframing that—in light of ongoing health equity crises for disabled communities (Kennedy and Swenor, 2023; Swenor and Deal, 2022; Valdez and Swenor, 2023)—is sorely needed.

### **Cultural Norms and Disability: Additional Considerations**

One aspect of workplace culture that reinforces multiple types of oppression, including disability oppression, centers on communication and presentation (e.g., dress) values that favor a White (in the context of this report, American), allistic, cisgender point of view. These include social niceties expected in the workplaces, small talk, introduction and icebreaker activities, the way that constructive feedback is expected to be communicated and received, and expectations related to what might qualify as “business” dress (which may not be possible with certain disabilities) and other types of appearance presentation (e.g., hairstyles).

Some types of communication expectations explicitly affect disabled people and reinforce discomfort in the workplace. For instance, broadly speaking, individuals are often uncomfortable with explicit discussions of

illness or disability experience, and such discussions may be assessed as “unprofessional,” even though they are a very real and important part of most disabled people’s lives. Communication courses often emphasize that characteristics of leadership include particular communication aspects such as reading body language, rather than how to work successfully with people from different communication backgrounds to foster growth of a diverse team, which can directly affect autistic and other neurodivergent individuals. Rather than asking these individual team members to conform to a communication norm and promoting one communication norm as “good leadership,” it is important to normalize different communication styles—and sharing information about communication access needs (e.g., direct and literal communication, instant messaging versus face to face). This can help all individuals in the workplace succeed, not just neurodivergent ones or ones with communication-related disabilities. Workplaces can also normalize wearing headphones around distractions and being allowed to stand or use a fidget during meetings (Parisi, 2022b). People with other types of learning disabilities may face similar biases, and additional stereotypes about their capacities, yet learning disabilities can give individuals unique approaches to inquiry in STEM (Diedrich, 2017). Unfortunately, little research exists on the experiences of postgraduate STEM scholars with neurodivergence (Kolodkin-Gal, 2023). (See Box 5 for examples of workplace culture considerations.)

#### **BOX 5**

##### **STEM and STEM Workplace Culture: Examples of Key Considerations**

- Workplace cultures should support openness about and comfort with discussing disability and illness.
- Workplace cultures should support multiple communication styles and workplace presentation that are multicultural and disability friendly.
- Health-related researchers at the organization should be challenged to view disability through lenses outside of the medical model of disability.

- Employees should be challenged to examine how their positionality may affect their work and challenged to re-examine their objectivity (e.g., how being nondisabled might influence scientific interpretation of a result).
- Quality and impact of work should be valued more than quantity in employee assessment; narratives that value specific work hours and outputs should be challenged in workplace culture.
- Positions should be created that allow alternative work schedules and outputs, such as part-time and extended-clock tenure investigator positions.
- Funding organizations should consider supporting the creation of part-time principle investigator roles and evaluation metrics; funding organizations should support opportunities that allow nonfaculty and non-tenure-track researchers to act as principal investigator (or field equivalent).
- Team science, collaboration, and *interdependence* should be emphasized over *independence* and individual achievement.
- Cultural norms around presentation and communication should be explicitly anti-ableist and opposed to other types of oppression, such as racism and cultural discrimination; for example, expectations for workplace dress, hairstyle, body language, eye contact, and directness should be framed from disability justice lenses.
- Organizations should engage in ongoing efforts to challenge external societal values that are ableist.

### **Addressing Individual Access Needs**

There are several considerations regarding the specific aspects of addressing the access needs of the individual (frequently referred to as workplace accommodations). The disabled STEM workforce is not a monolith, and every disability or set of disabilities comes with a unique set of access needs. While the goal of the infrastructure, policy and procedure, and culture considerations above is to strive for a universal workplace design that works well for all employees regardless of disability status, there will inevitably be employees who do not fit the mold of anticipated access needs. For instance, even a perfectly wheelchair accessible lab may still

require a personal or technical assistant—or a technological, robotic update—to permit access to conducting certain experiments for an individual with limited upper limb mobility. A redesign of workloads or hiring of new staff may be necessary to facilitate this access.

Because of the way many scientific positions are funded in the academic and nonprofit research industry—funding for pursuit of specific scientific projects—institutions may adopt different policies regarding the responsibility to *pay for* an accommodation when there is a cost to retrofit or alter an inaccessible environment (Peterson, 2021). Some may pay for accommodations out of institutional or departmental funds (including funds from “indirect funding” granted by federal support), while others may require principal investigators to pay for accommodations for themselves or for their staff and trainees (Duerstock et al., 2023). This means that young investigators are less capable of training and supporting individuals with disabilities and are less capable of sustaining their own careers if they are or become disabled. Further, it means that access solutions are more likely to be temporary retrofits (see below), rather than long-term access solutions that support permanently increasing the accessibility of the environment. Federal funding bodies could adopt policies that designate access needs requests as under the purview of the institutional funds (i.e., funded by indirect or other institutional funding sources, not direct project funds). Funding bodies could also strengthen their support for access in STEM by imposing similar rules and regulations for disability-related discrimination and lack of access provision as the NIH and the NSF have done in an effort to reduce harassment in STEM workplaces receiving NIH or NSF funding, respectively (Lauer and Bernard, 2022; NSF, n.d.). (See Box 6 for examples of considerations for individual access needs.)

#### **BOX 6**

##### **Individual Access Needs: Example Key Considerations**

- The onus should be removed from individual investigators or workgroups to pay for an accommodation and should instead be centralized organizationally, to reduce unequal access.

- Organizational efforts should be undertaken to ensure access solutions are scalable and sustainable beyond the needs and tenure of a single disabled individual.
- Funding bodies should adopt policies that require organizations to pay for access solutions from indirect or other centralized funds.
- Funding bodies and other large organizations such as STEM societies should adopt enforcement policies for organizations that engage in disability discrimination.

### **TOOLS TO ASSESS AND IMPROVE STEM ENVIRONMENTS FOR ACCESSIBILITY**

In many cases, access needs are met with a solution that cannot be carried forward to other individuals with the same access need, is not readily adaptable to other worksites or scenarios, and is temporary in nature. Identifying new access needs of individuals should be viewed as an opportunity not to retrofit an environment to an individual, but instead as an opportunity to reassess accessibility of the workplace and to redesign spaces to be more permanently accessible. The negative consequences of (only) retrofitting cannot be understated (Dali, 2018; Dolmage, 2018a; Williamson, 2019). It creates two major problems: (1) it puts the onus on the disabled individual to do something differently to adapt to an inaccessible environment rather than on the organization for creating that environment (Dali, 2018), and (2) these retrofitted, “duct-tape” solutions can further stigmatize and isolate the disabled individual (Williamson, 2019). The process of retrofitting, as it stands, is in itself a type of structural ableism, as Dolmage (2018c) writes in *Academic Ableism: Disability and Higher Education*:

Retrofits address inequities and inaccessibility, but do so in ways that reinforce ableism, turning disabled people into charity cases or villains, while situating teachers, administrators—and even presidents—as heroes.



As opposed to narrow retrofits intended to address an access need brought by a single individual, larger infrastructure changes can benefit more than a single person. Infrastructure establishment also helps individuals with other disabilities, nondisabled employees, and future employees. For instance, the choice of communications and web conferencing software that provides automated captioning and transcription is an example of an infrastructure modification that is often conceptualized as an access need only for employees with access needs related to speech.<sup>8</sup> However, this option can also aid employees with other disabilities who may not have requested it. As an example, employees with physical disabilities that affect typing could utilize automated transcription to improve note-taking. Based on results from a large national survey of students about captioning lectures (Linder, 2016), it is also likely that nondisabled employees will find captioning and transcription features helpful. Nondisabled students reported that captions aid understanding (including of English as a second language) and focus, allow for attendance in sound-sensitive environments, and overcome poor audio quality (Linder, 2016). Captions that are also recorded as transcripts allow convenient transfer of complex concepts covered quickly in meetings to notes and allow for revising complex topics and discussion. Many such aspects of universal design are similarly utilitarian for individuals without disabilities, making them beneficial to most employees in an organization.

A limitation of many of the tools and approaches (reviewed in that section) is that they sometimes position the retrofit as the obvious access solution, and many are developed under the current “accommodations as compliance” framework, which does not meet the needs of disabled individuals. As readers explore these tools, they should continue to reimagine applications to permanently expand access.

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<sup>8</sup> Note that automated captioning is not the same as closed captioning and, in itself, provides insufficient access for many deaf and hard-of-hearing people, though it is sufficient for some individuals with mild hearing loss or other disabilities related to speech processing.

## **Tools That Cover Broad Multiple Aspects of Accessible Work Environments**

The simplest measure of workplace performance over time is the representation and retention of employees with disabilities, which requires collecting this data. To encourage disclosure, Swenor and Meeks have advised that employers commit to collecting this data in a secure way, report it only in large aggregates to prevent identifiability, and store the data separately from employee data that is tied to managerial records and performance evaluations (Swenor and Meeks, 2019).

The EEOC enforcement guidance (EEOC, 2002) on the ADA offers guidance on common questions related to implementation of the ADA, including questions on making job training accessible, making the application process accessible, and other aspects of workplace inclusion that are often overlooked. However, this guidance was issued in 2002, prior to the passage of the ADAAA of 2008, and is limited to what constitutes compliance, rather than how to enact compliance (e.g., it states that job trainings must be made accessible to disabled employees or accommodations applied, but it does not provide specific guidance for deploying specific accommodations). This document is useful for employers who are just beginning to understand their requirements to create access (as long as they also understand that compliance is a bare minimum and does not equate with access). It is also useful for disabled employees with questions about the rights they have in the workplace, as long as they understand that their rights were expanded after this guidance was written, by the ADAAA. An additional fact sheet as well as two question-and-answer documents provide some lay language clarification about the EEOC's final regulations regarding the ADAAA of 2008 (EEOC, 2011a, 2011b, 2011c, 2011d). Further, employers should note disability justice narratives that challenge EEOC guidance on medical documentation, especially those that challenge medical documentation requirement as contradictory to legislative intent (Macfarlane, 2021).

The Employer Assistance and Resource Network on Disability Inclusion (EARN) offers resources geared toward employers that cover many aspects under the employment umbrella for people with disabilities, including recruitment, hiring, workplace culture, making disability disclosure safe and encouraged, and

accommodations (EARN, n.d.). Additionally, EARN offers free short video trainings from their Inclusion@Work coursework, which include specific strategies for achieving accessibility goals. Other free trainings offered by EARN include a titled *Creating a Mental Health-Friendly Workplace*. As with all trainings, AskEARN trainings have some limitations, as language around disability can change over time, and they are only short, nonintensive, self-paced courses that do not provide interactive learning environments. However, for organizations who are new to building accessibility into their DEIA plans, they represent an excellent starting place.

Geared toward faculty who design and teach the sciences in a postsecondary setting, *Creating a Culture of Accessibility in the Sciences* (Sukhai and Mohler, 2017) offers a high-level overview of several science-specific topics. While several chapters are geared directly toward educational settings, they can still be useful in designing accessible workplace training and career development opportunities. Additionally, it offers guidance on STEM-specific access solutions, such as the chapter “Assistive Technology for the Lab.” While not a thorough guide on building accessible laboratory spaces, aspects of this text can supplement access checklists described below for building accessible labs. Similarly, while it covers technical assistants in relation to laboratory coursework, it nonetheless rebuts myths about personal assistants, such as their expense, and as such can address negative stereotypes that managers, leadership, and even coworkers may have about disabled colleagues who require this access solution. The best workplace use of this text is not in a point-by-point list of all the steps to take when making a workplace accessible. However, it can serve as a foundational text to challenge stereotypes, address commonly held biases, and raise awareness of specific considerations for accessing scientific workspaces and scientific equipment.

The University of Washington’s Disabilities, Opportunities, Internetworking, and Technology (DO-IT) Center maintains the AccessSTEM database, which collates more than 700 case reports, promising practices, and question-and-answer articles that may offer solutions to specific unmet STEM access needs (DO-IT, n.d.-b). Also at the University of Washington, the Center for Sensorimotor Neural Engineering (CSNE) has reported

on their methodology for increasing accessibility and inclusivity for students and faculty with disabilities alongside preliminary results from the first 3 years. This report can create a roadmap to begin to address access and inclusion barriers for individuals with disabilities in STEM (Bellman et al., 2018).

Though specific to neurodiversity, *Workplace Neurodiversity Rising* is a text aimed at organizational leaders to guide specific changes to workplace policy and culture to build a more inclusive environment for a neurodiverse workforce (Rivera, 2022). The book is highly actionable and uses common business management and human resources parlance, making it accessible to leaders accustomed to addressing workplace change under this lexicon. It includes a section on hiring process—explaining that the common practice for hiring is centered on personality-, traits-, and/or “cultural fit-” based hiring, while an inclusive hiring practice would center on values-based hiring. This workplace guide to adjusting culture can guide managers as they work to address common biases in hiring, interview, and employee evaluation practices that devalue neurodivergence. Further, it can guide workplace and work-structure design practices that are more inclusive to neurodivergent employees—and employees with diverse cultural backgrounds or life circumstances.

### **Infrastructure-Related Tools**

#### **Built Environment (Worksite, Workspace, and Equipment)**

As many disabled individuals are keenly aware, the ADA is not an enforceable building code, and no governmental review for access compliance is conducted before a new building is opened for use. Building plans are devised by architects and contractors, and though many know about and are familiar with the ADA, these plans are not reviewed, nor are permits issued, under the ADA by any federal government agency or under federal building codes. Instead, the ADA is a civil rights law that is enforced on a complaint basis, which requires an individual to identify an access issue and file a complaint (U.S. Access Board, 2014). Under federal regulations, this largely means that ADA-covered entities are themselves responsible for ensuring ADA compliance of any new construction or renovation. However, some states have begun implementing their own accessibility building codes. As an example, Washington State governs building accessibility for persons with

disabilities and includes adoption of the International Building Code (IBC; 2018 code adopted through October 2023, with 2021 IBC going into effect thereafter) (SBCC, 2023, 2020).

Leaders of organizations with older buildings and in states without building accessibility codes should be particularly conscientious when ensuring contracts cover accessibility design requirements that, at minimum, meet the ADA requirements. All organizations should be entering into contractual agreements with architects and contractors who are knowledgeable of and enthusiastically support incorporation of the most recent ADA building guidelines (U.S. Department of Justice, 2010). Others have reviewed how difficult it can be to get architects to comply with these regulations, with architects emphasizing the aesthetic and normative-functional aspects of universal design over disability access (Williamson, 2019). Some commercial architecture entities specialize in accessible architecture design consulting and can work with existing contractors to ensure access requirements are met, especially in unique spaces such as laboratories, where the guides contained in the ADA may fall short. Another option may be paying existing employees or community groups to collaborate with architects and construction firms to ensure infrastructure is accessible.

#### *Tools for STEM-Specific Workspaces: Laboratories, Field Sites, and Equipment*

A growing number of resources guide accessible design and construction of STEM-specific workspaces, in particular laboratories, and multiple checklists offer a starting point when designing a new accessible lab-space or attempting to retrofit an existing lab space to be accessible to disabled scientists and engineers (DO-IT, 2012; Burgstahler, 2012; COU, 2014; Pagano, 2015). The checklist from the DO-IT Center on designing accessible laboratory spaces for students offers a series of excellent and extensive questions to ask when (re)designing an accessible laboratory space (DO-IT, 2012). These considerations are broadly applicable to lab workspaces for employees as well. However, this resource is limited in some places as it does not provide specific definitions of how one might address a particular question or provide definitions of what might be considered accessible. For instance, it asks, “Are all levels of the facility connected via an accessible route of travel?” but it does not further define what might be expected of this route of travel. An associated guide

(Burgstahler, 2012) from the same group provides more context in that it offers somewhat more concrete guidance for access needs related to various disabilities, but those who are unfamiliar with disabilities may still find they are unable to thoroughly evaluate their lab spaces using these two resources alone. A guide from the Canadian context (Ontario's Universities Accessible Campus) on the same topic provides more concrete and actionable steps that can act as a supplement to these questions (COU, 2014). For instance, it defines seven specific access steps for building an accessible route of travel, such as this example: "Avoid installing protruding objects (such as a fire extinguisher, sinks, signage, and equipment) from walls, ceilings, and other locations within paths of travel." As a result, a business may consider using wall-inset fire extinguisher placements (common in airports) to enhance accessibility. Together the DO-IT Center and the Ontario's Universities resources offer criteria for evaluating laboratory spaces for accessibility, and concrete action steps for creating that accessibility. *Teaching Chemistry to Students with Disabilities: A Manual For High Schools, Colleges, and Graduate Programs* (Pagano, 2015) is an open-access book designed to facilitate chemistry instruction to students in secondary and postsecondary programs and offers a third resource for laboratory evaluation. Chapters 5 and 7 look extensively at applying the principles of universal design to the laboratory, including web-based and digital chemistry teaching materials. While none of these resources individually offer a comprehensive architectural guide for making the built environment of a scientific laboratory accessible, and most are geared primarily to the education of students, they all offer critical insights into what a universally designed laboratory would look like. Organizations building or updating their laboratories for accessibility should consider sharing all of these resources with architects as expectations for meeting access needs.

Fieldwork poses particular barriers to accessible education and careers in STEM. It can be impossible to anticipate all potential scenarios encountered in the field, and some types of worksites may have certain environmental obstacles (e.g., environmental protection needs, access through tight spaces such as caves) for which presently no accessibility innovation exists. But that does not mean individuals who cannot access certain types of fieldwork will be unsuccessful or incapable scientists in those fields. By reimagining how students learn in the field, disabled students are now able to receive the skills they need to understand fieldwork, and by

employing a larger array of tools to access and process field data (e.g., off-road wheelchair technology, drone imaging, 3-D imaging), we can create ongoing workplace roles for scientists who may not, in present time, be able to access certain field sites (Chiarella and Vurro, 2020; Dzombak, 2020; Marshall and Thatcher, 2019). While not all possible needs and potential accommodations are included, the Royal Geographical Society (with the Institute of British Geographers), or RGS-IBG, continues to compile resources for accessible and inclusive fieldwork on its webpage (RGS-IBG, n.d.). A limitation of this collated set of resources is that it simply links to new resources and publications, rather than acting as a single, routinely updated, comprehensive guide. Though the website states the page is dynamic, it also is unclear how often the resource is updated. And, because the resource covers a variety of inclusivity situations (not just disability), some resources that are categorized under other interests in this paper (e.g., menstruating students in the field) are also applicable to certain disabilities (e.g., those that may require medical privacy or frequent bathroom trips) (Greene et al., 2020). However, one benefit is that the RGS-IBG web page offers categorized content that may help supervisors, HR and disability accommodations specialists, and disabled people who may be unfamiliar with existing access innovations in the field, and may collate additional resources in the future. As an example of resources this web page collates, one such resource is a guide for teaching accessibility in archeology (Phillips et al., 2007). While aimed at instructors so that they can meet the access needs of students, and unlikely to detail all field access needs in workplaces, it nevertheless offers an excellent high-level summary of unmet access needs and possible solutions across a wide range of disabilities, including physical, sensory, mental health, and learning disabilities. A limitation of this resource is its age (2007) and setting (England). New access innovations may now be available and the language used (e.g., deemphasizing “disability,” using “hearing impairment” instead of deaf/hard of hearing) may not align with disability identity as construed in current disability justice spaces in the United States.

Because of the uniqueness of some scientific instruments, innovation may be required. However, this is not without precedent in STEM. Individuals in STEM have been using 3D printing to create bespoke laboratory equipment in many fields (Capel et al., 2018). Similar efforts exist in the disabled community to create bespoke

prosthetics and devices (e-NABLE, 2023). Katharine Hubert (@cripple\_vs\_stem, 2021) began, and now others have adopted ( Hubert et al., n.d.), a Twitter hashtag (#labadaptations) under which to share access solutions for laboratory equipment and tasks. Hubert now maintains an encyclopedia version of her own creative access solutions, which are designed for joint hypermobility and pain, but may also work for other access needs (Hubert, 2023). When Bradley Duerstock encountered a need to do microscopy to pursue his desired research field, he was unable to access the microscopes available to him, because he had a spinal cord injury causing tetraplegia (Duerstock et al., 2023). He engineered and iteratively improved accessible light microscopy using computationally directed control for individuals with visual and upper limb mobility disabilities (Duerstock, 2006; Duerstock et al., 2010). Technologies supporting computational control of microscopes have since been adopted and are widely available in microscopes from most major vendors and are essential features of advanced microscopes such as cryo-electron microscopes. He has continued to develop access solutions for individuals with disabilities to access STEM education and careers in the fields of engineering and robotics, such as tactile graphics for blind scientists and accessible robotic arm control for individuals with upper limb mobility impairments (Jiang, Wachs et al., 2013; Jiang, Wachs, Pendergast et al., 2013; Williams et al., 2014). Many of these examples relate to individually engineered solutions and are provided here as a demonstration of possibility; when individuals request access and a solution cannot be immediately imagined by management, the request for access is often rapidly dismissed as impossible. These examples demonstrate that disabled innovation persists in spite of continued creation of inaccessible equipment; instead of rapid dismissal, managers can be co-innovators—seeking and developing novel solutions for access. Employers with access to 3D printers, engineering departments and students, design students, and others with manufacturing and design expertise could encourage and explore similarly creative solutions to unmet laboratory access needs. At the same time, scientific companies must recognize that, as with Duerstock’s microscope, accessible design can benefit more than those with disabilities; as such, they must continue to explore application of universal design principles to the development of next-generation scientific devices and laboratory equipment.



New investments in technologies, such as in the creation of cloud labs, where almost all experiments are performed by robots controlled via computer interfaces (Arnold, 2022), are one approach to reducing the number of needed individualized adaptations. These labs are not only more accessible to scientists with disabilities, but they also greatly reduce the amount of time to conduct experiments. In one example, a researcher was able to reproduce years of his research in mere weeks within a cloud lab (Arnold, 2022). Continued investment in accessible technological solutions for conducting laboratory and fieldwork will allow scientists to increase productivity, advance diversity, and potentially reach and research field sites in novel ways that are less disruptive to local ecosystems. These investments are not just good for disabled researchers, they are good for science.

### *Other Resources for Built Environment*

Hamraie's Mapping Access project is a collective effort to examine environmental access beyond code compliance (Hamraie, 2018). Hamraie also provides a free Mapping Access Toolkit (Hamraie and Critical Design Lab, 2020) geared toward student exercises for critically examining environments for accessibility, and which is grounded in disability justice theory with specific recommendations for performing these exercises in nonharmful ways (for instance, avoiding disability simulations). This toolkit could be used by organizations to evaluate their campuses for accessibility.

### **Tools for Accessible Software, Websites, and Other Digital Products**

The Partnership on Employment & Accessible Technology (PEAT) offers a set of toolkits geared toward employers that focus on integration of accessible digital technology (PEAT, n.d.). These toolkits are extensive, and they cover everything from inclusive AI to procurement to telework and hybrid workplaces. These toolkits offer play-by-plays intended to walk employers through each step. For instance, one of the AI toolkits offered is the AI Disability Inclusion Toolkit, which covers the basics of AI, risks of AI, and equitable AI, and offers a guide for equitable use of AI in the workplace. Each toolkit is short and takes little time to complete and is best directed not at the specific technical aspects but rather at managerial staff.

The World Wide Web Consortium's (W3C) Web Accessibility Initiative has created, and maintains updates to, a set of guidelines called the Web Content Accessibility Guidelines, which are geared toward building accessible websites and accessible web content creation (W3C, 2023). These guidelines, now in version 2.1 with the drafts of version 2.2 as well as version 3 available, offer the most comprehensive set of guidelines that also offer success criteria. The guidelines are being continuously revised, and the pace is often slightly behind the needs of the community based on processes. However, they offer the best starting point to set requirements for web developers at an organization. Federal rulings have now established that web accessibility is required, using these guidelines.

Web content should be reviewed for accessibility after creation. There are free automated web tools that can assist; however, they are not usually very successful, as they only assess basic features like the presence of alt text on all image content—they do not assess the content of the alt text to determine if it is adequate. W3C offers a list of vendor-provided and open software for accessibility evaluation, which is currently undergoing an update (W3C, 2006). The best approach is manual testing with consultants who are accessibility experts in web development.

It is important for disabled STEM employees to fully integrate with their colleagues by attending the same meetings, sharing the same documents, and exchanging the same information. Several resources aim to help achieve this: the Content Creation page of Section508.gov offers a list of guides that includes guides for creating accessible documents, presentations, video and mixed media, and meetings. Its primary limitation is that it is specific to government agencies that fall under Section 508 regulations (regulations about accessibility that apply to the federal government) of the Rehabilitation Act of 1973 (Pub. L. 93-112), meaning some references to available resources are applicable only to government employees (GSA, n.d.). Mentioned previously, the DO-IT Center offers a similar set of guides, this time geared toward a more general audience (DO-IT, n.d.-a, n.d.-c). Similarly, equitable data sharing and access is a key consideration of accessibility in science. Much of STEM communication involves sharing data through visuals, which are completely

inaccessible to blind members of the STEM workforce as well as people with other visual disabilities; for instance, even people without impaired visual acuity but who have colorblindness (which includes approximately 8 percent of people with XY chromosomes) might find images that utilize color to communicate inaccessible. However, there are many resources to aid in creating colorblind-friendly visuals (Tol, 2021; Summerbell, 2019; Swan, 2019; Katsnelson, 2021; Brewer et al., 2013; Ferreira, 2020), which are simple to follow and implement. Similarly, many individuals and groups have created resources dedicated to writing image descriptions for scientific figures (DAISY Consortium, n.d.; Chiarella et al., 2020; NCAM and DIAGRAM Center, 2019; SIGACCESS, 2019b; AccessiblePublishing.ca., n.d.). Image descriptions and explanatory text describe the information conveyed in the figure—simple alt text that says something akin to the figure title is not accessible, and image description development does require training and practice. However, making visualizations accessible through image descriptions is an important toolkit that can also improve scientific communication skill sets by honing the ability to succinctly and clearly describe data.

Beyond creating images that are more accessible visually and including appropriately detailed image descriptions, STEM needs new ways beyond the visual sense to conceptualize, represent, and communicate data. In the field of astronomy, a growing field of individuals are working to use sonification to “show” data through auditory senses, instead of visual ones (Harrison et al., 2022). Not only is this sonification of data useful to blind astronomers and astronomers with other visual and visual processing disabilities, but it is also useful to astronomy as a whole, offering new ways to represent and communicate data about matter that does not produce light. Tactile graphics are another means to communicate visual data in accessible formats that have been explored using 3D printing as well as using lithophane (Koone et al., 2022; Williams et al., 2014). It is likely that both of these approaches to data representation for alternate senses will expand the ability of scientists to think about, conceptualize, and communicate data—be they disabled or not. Continued innovation through these and other formats is needed to ensure universal accessibility of scientific data.

## **Training and Ongoing Career Development**

In response to experiences of conference inaccessibility, Mittendorf and Jimmons (2022) co-authored a guide to planning accessible conferences that is freely available on the web. This guide is noncomprehensive but offers a series of steps for inclusive conference planning alongside explanations for *why* such a modification to traditional conference plans is necessary.

Focused on individuals who have vision impairment, Wu, Martinello, and Swenor (2022) authored a description of building a more accessible conferences that includes clear descriptions of common access barriers at in-person and at virtual conferences. For a thorough review of making conferences accessible to blind, low-vision, and visually impaired individuals in either format, conference planners will find this guide helpful.

Perhaps the most comprehensive set of guides, with step-by-step criteria for assessment of accessibility of the conference plan is the set of guides (one for in-person and one for virtual conferences) authored by the Special Interest Group on Accessible Computing (SIGACCESS, 2019a, 2020). For conference planners in large societies who regularly host conferences, these guides present the ideal series of questions to ask during planning as well as in finalization stages.

## **Tools Regarding Policies and Procedures**

This author (Mittendorf, 2022) and others (Dolmage, 2018a; Clarke, 2023; Macfarlane, 2021) have proposed variations of a reimagination of the accommodations process whereby access needs are met from day one of request wherever feasible (obviously to meet some access needs requires procurement) with medical documentation requirements minimized or eliminated; models that propose minimization of documentation suggest it be accepted as a formality for any legal reporting and compliance purposes if necessary, but not be used to gatekeep access provision. Macfarlane specifically argues for elimination of documentation—both challenging the legal grounds under which this guidance has been issued and upheld (see above, in Policies and Procedures: Employee Access and Inclusion) and outlining a model for “disability with documentation”

grounded in models for workplace accommodation of religious belief (Macfarlane, 2021). Establishing belief, rather than disbelief, is a central feature of these processes, designed to meet access needs, not prevent liability. Even if an exact accommodation cannot be granted from the initial request, the interactive process must include working together to come to an access solution.

### **Tools Addressing Culture**

DEIA initiatives have become a commodity, and many “inclusion metrics” or “inclusion indices” are a marketplace item, with proprietary studies and validations sponsored by the owner of the metric, and the metrics themselves unavailable for preview by noncorporate entities. As a result, it was difficult to evaluate the many available metrics and indices on the market.

In terms of academically developed metrics for disability inclusion, this review evaluated a single, noncommercial, validated 41-item measure for measuring social support for workers with disabilities, which measures supervisor, co-worker, and non-work-based social supports for these employees, which they posit could have utility to evaluate the social support climate for disability in workplaces (Lysaght et al., 2012). This scale has the advantage of being specific to disability and for managing both supervisor and co-worker dimensions, and for having been validated, albeit in a small cohort of individuals. In addition to being untested in real-world implementation studies, this study used a small cohort for validation, was set in a Canadian context, and the cohort underrepresented mental health disabilities and small workplaces; a literature review did not identify additional validation studies. It is also intended to be used by the disabled employees themselves. While disabled individuals are best equipped to speak to the support they experience from their workplaces, in the context of very small workplaces, it may be difficult to anonymize responses, and larger workplaces may have more power to comprehensively assess culture.

## Tools for Addressing Individual Access Needs

### Existing Resources: Utility and Limitations

The Job Accommodation Network (JAN)<sup>9</sup> is perhaps one of the most useful resources for many employees seeking accommodations who are newly disabled and may offer new access solutions even to employees with disabilities who are accustomed to the process (JAN, n.d.). This resource also offers managers and HR department solutions and ideas about reasonable accommodations for specific disabilities and health conditions. As an example, selecting “lupus”<sup>10</sup> from the list of the resources offers an extensive list of possible aspects of lupus that may create a workplace access need, such as “Attentiveness/Concentration” and “Balancing.” It is possible that an employee with lupus could have access needs around neither, only one, or both of these for their job functions. Employees and employers can readily navigate between ideas for access solutions for each of these traits, such as “noise-cancelling headsets” and “grab bars” as well as sample vendors of each type of access solution, where a purchase is applicable. JAN can also be filtered by what it terms “limitation” (which might be likened to “impairment” in the model discussed in the [Approach](#) section); for instance, a manager or employer need not know that someone has a specific medical condition (in this case, lupus) that leads to their access need related to balancing, only that they *do* have an access need around balance. This limits the amount of “forced intimacy” needed for management/HR to engage in imagining possible access solutions. Filtering by limitations allows one to immediately peruse solutions for balance. JAN also has filters with similar levels of detail for “workplace functions” where an employee may encounter an access need (e.g., “noise” and “work site access”) and rights and responsibilities for specific requested accommodations or entire fields of work (e.g., “modified schedule” or “healthcare,” respectively). JAN is not a comprehensive resource of all possible disabilities, health conditions, access needs, and accommodations. However, it offers one of the most comprehensive databases available that is geared for both employers and employees, and covers a broad

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<sup>9</sup> JAN is a service of the U.S. Department of Labor’s Office of Disability Employment Policy/ODEP (#OD-38028-22-75-4-54).

<sup>10</sup> Selected for the author’s experiential knowledge of lupus, and for its many possible manifestations, for the reader interested in exploring JAN from an HR/management perspective using an example.

array of work types, including specific job functions that could be used as resources for STEM tasks. While some access innovation may still be required, JAN offers an excellent starting point for both employees and employers when an unmet access need arises and a guide of possible access solutions would be helpful.

## **Additional Tools**

### **Short Personal Narratives**

In short trainings, it may be useful to supply personal narratives that are also tied to actionable recommendations or examples of what to do—and what not to do—to support disabled STEM employees. While not offering a comprehensive set of recommendations, these short trainings could be designed to start the conversation about ableism in STEM organizations, and geared toward organizational leadership, managers, and human resources staff. By connecting recommendations with personal narratives, such trainings could help personalize the real-life consequences of ableism in academia for disabled individuals in STEM.

Julia Sarju has provided several key recommendations and reflections for continuing progress in accessibility in the sciences post pandemic, including options for flexible and remote working (including part-time work), greater involvement of disabled staff in decision-making, increased web and software accessibility, and virtual conference attendance, and positive cultures that encourage disability disclosure and visibility (Sarju, 2021). These calls for reevaluating science work culture are echoed in other personal narratives about ableism in academia (Brown, 2023). Cited previously, the *Nature* careers section recently offered a set of four personal narrative arcs covering experience of disability in the sciences that highlights both positive anti-ableist practices as well as experiences of disablism and ableism in the academic sciences (Powell, 2021).

### **Author's Perspective: On Reimagination of a More Just STEM Enterprise**

Taken more broadly, the fact that the price of access sits largely on the shoulders of disabled individuals results in exclusion from STEM. This exclusion contributes to systemic injustices and in circumspect ways to societal eugenics practices. Simon Newman, the president of Mount St. Mary's University in Maryland made this goal of exclusion—not access—more explicit in a statement about a questionnaire he planned to send

freshman college students with the alleged goal to dismiss 20–25 students who reported depression or other “warning signs” of likelihood to drop out before they could affect college rankings. “This is hard for you because you think of the students as cuddly bunnies, but you can’t,” the college newspaper reported that he stated to a concerned faculty member. “You just have to drown the bunnies ... put a Glock to their heads” (Schisler and Golden, 2016). If STEM workplaces want to recruit and retain a disabled workforce, they must confront their implicit contributions to what Newman allegedly made explicit about academia: that disabled individuals will confront a hostile environment where they are unlikely to succeed (not because—as many believe—of their disability, but because of their environment).

As STEM-by-trade and often STEM-by-identity, STEM managers and employers innately desire peer-reviewed empiric evidence for any intervention, such as for workplace changes to improve disability inclusion. But because disabled individuals have been systematically divested from the workplace, there is little empiric evidence on human resource development and disability to improve participation of people with disabilities in the workforce (Dwertmann, 2016; Jurado-Caraballo et al., 2022; Procknow and Rocco, 2016). Much of what does exist is cast through an ableist lens—or at the very least, one that involved no disabled perspectives (Procknow and Rocco, 2016). Scholarly work on disabled individuals that does not include disabled scholars can pose the hazard of what Zayhowski, Kim, and Jimmons (2023) recently termed “dangerous allyship”—work done with the goal of helping a marginalized community that ultimately harms this community. The authors poignantly note, “Proximity does not equal identity. Authorship does not equal embodiment.” Further, the realm of knowledge is not limited to “intervention” and “outcome” studies, or the scientific and human resources literature. As Hammel (2006) points out in *Perspectives on Disability & Rehabilitation: Contesting Assumptions; Challenging Practice*, epistemological considerations such as “Whose knowledge counts?” derive from an assumption that some types of knowledge are superior, and thus in the realm of disability knowledge, are intrinsically “issues of power.” In the context of individuals who have been historically excluded from generation of the presumed “superior knowledge” type, epistemic power is also an issue of epistemic justice.



In the humanities, there is a rich discourse related to disability justice, disablism, ableism, and reimagining social structures to include disabled individuals (Mulaney, 2019). Even so, disabled individuals' access to the academy in other disciplines still lags behind those in other employment sectors, since disabled individuals are most likely to work in service positions or be self-employed (FSC Majority Staff, 2022; Dolmage, 2018a). This “academy lock-out” leaves disability justice movements to generate their evidence in the margins—on blogs, in community organizations and movements, in online communities such as Twitter and Reddit. Knowledge is also generated individually and intrinsically, in each disabled person's interactions with their environment (Piepzna-Samarasinha, 2018). This type of knowledge has been termed *cripistemology*<sup>11</sup> and represents a disabled person's intrinsic body-knowledge and access-knowledge that can come only through lived experience (Johnson and McRuer, 2014). This knowledge offers resources, analyses of current patterns of ableism/disablism and disability inclusion, and strategies for system restructuring that address the access and inclusion imperative. These collective “anecdota” make up a body of community-led scholarship that is often discounted in academic and workplace settings as political discourse or nonscholarly (Mellifont et al., 2019; Peña-Guzmán and Reynolds, 2019; Botha and Cage, 2022). In the setting of individual access requests, such dismissal is used to other, exclude, and isolate individuals with access needs. Dismissing personal narratives of disabled individuals is a type of “testimonial injustice,” argue Peña-Guzmán and Reynolds (2019), that results in willful epistemic injustice.

It is not necessary to wait for scientifically sanctioned evidence generation on how to dismantle disablism and ableism (Mellifont et al., 2019). A reader who has accessed the citations to this article will notice that some are personal narratives and autoethnographies from other authors. For instance, the crip tax was best explained by individuals who were paying this tax. It may be easy for some to dismiss these as anecdotes; however, it is critical to remember that case studies form an important basis of hypothesis generation and

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<sup>11</sup> A portmanteau of “crip” and “epistemology.” In the cited text, Johnson and McRuer trace the origin of the word to Lisa Duggan, via personal communication.

intervention design, and that a large number of nearly identical case studies represents an evidence body in and of itself. Others have termed this the “ableism elephant in the academy” and contend that personal narratives serve as evidence of barriers and their solutions (Mellifont et al., 2019). To achieve disability justice within STEM, organizations and federal funders of STEM work need to incorporate the vast and untapped resource of community-led and humanities-based disability scholarship into their DEIA workshops, initiatives, and strategic plans.

In addition to allowing cripistemology to contribute to the reimagination of the STEM environment, cripistemology offers something directly to STEM. The unique ways disabled people adapt their environments to their access needs represents a realm of innovation that science has not fully explored. Examples of innovation driven by disabled STEM workforce members include the creation of background blurring (a now commonplace videoconferencing feature) originally developed to facilitate lip-reading for deaf individuals, touchscreen scrolling features that were originally developed for carpal-tunnel accessibility, and a collaboration between blind and sighted scientists to create tactile graphics accessible to both blind and sighted readers (Daehn and Croxson, 2021; Koone et al., 2022). Just as it has been argued that physicians with disabilities will better understand, empathize with, and treat their patients with disabilities and should be afforded a place in medicine (Iezzoni, 2016), disabled STEM workforce members will offer unique insights in fields as diverse as social sciences, climate science, bioethics, anthropology, public health, and biomedicine. These insights will ultimately improve our understanding of these fields and increase the positive influence of science on humanity.

Cripistemology also provides a window into how disability culture can reshape our scientific approach. In the personal essay collection *Uncharted: How Scientists Navigate Their Own Health, Research, and Experiences of Bias*, edited by Skylar Bayer and Gabi Serrato Marks (2023), many disabled scientists provide personal insights into the intersection of their disabled and scientific selves. One essayist, Glyn Everett, a manual wheelchair user, sociologist, and Bristol, England, native describes performing field work in Portland, Oregon, where he could rarely access front doors because they were often up several steps. To solve his access

problem, he paired with a Hong Kong native who was on the research trip but who had no specific role on the team. For most of the trip, his colleague's primary role was knocking on doors—until, that is, they arrived at the first accessible street, only for Everett to find the entire street occupied by non-English-speaking residents. They happened to speak Cantonese, his colleague's native language, and so his colleague was able to become interviewer, enriching the dataset with a perspective they otherwise would not have obtained. Everett expands the social model of disability to a “social model of exclusion” to show how normative assumptions exclude many individuals who are not represented by the dominant culture. This enriching tale explains the powerful effect of radical interdependence—a core tenant of disability justice—on this single study, emphasizing that STEM has much to learn from disability culture.

## **CONCLUSION AND OUTLOOK**

Once STEM degree recipients with disabilities enter the workforce, they face barriers when trying to find and retain, and advance in, employment, such as inaccessible hiring processes, inaccessible workplaces, poor processes for accommodations, lack of accessible continued education and training opportunities, and stigma and negative culture surrounding disabilities. Disabled individuals in STEM will face these barriers throughout their careers and at each career move—barriers so great that they can deter disabled individuals from continuing along their STEM career path or even lead to poor mental and physical health outcomes (Kennedy and Swenor, 2023; Branco et al., 2019; Cech, 2023; Watermeyer and Swartz, 2016).

The need to retain access to certain health or support resources may make disabled STEM workforce members less mobile, which can lock them out of certain career opportunities. New resources that have emerged to address disability exclusion in laboratory and field science spaces make clear that mere compliance with the law is insufficient, and the accommodations processes as they stand demonstrate that a focus on compliance is far removed from a focus on access. Access-focused reimagination of the STEM workplace and culture can benefit employees and employers, as well as STEM as a whole. Access culture, rather than accommodation or compliance culture, can reposition disabled people as fully valuable members of the

workplace and will reduce time and resources (on part of both employee and employer) dedicated to the accommodations process. The tools provided here serve as foundational building blocks to start reimagining access beyond compliance, but STEM must also reexamine and address values within STEM culture and the problematic ways disability is constructed in these values. There is much more work needed before STEM is truly an accessible career path; applying disability justice frameworks will be necessary to accomplish this work.

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<sup>12</sup> The author here has listed credentials of those in acknowledgments not as a way to differentiate individual contributors but to acknowledge the many types of professionals who contributed to the intellectual underpinnings of this work, and to acknowledge credentials that were obtained for many in the direct face of access barriers. The author notes that some individuals in this list were explicitly completely excluded from degree-necessary work for desired degrees because of their use of access equipment, halting degree pursuits. Their specific credentials make them no less of an expert.

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### **Positionality Statement**

The author is a White, disabled, chronically ill individual, whose personal disability experience includes physical (including mobility), sensory, and neuroprocessing disabilities. The author currently works in a fully remote job, but has previously worked in in-person workplace environments.

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