Disability in Postsecondary STEM Learning Environments: What Faculty Focus Groups Reveal About Definitions and Obstacles to Effective Support

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Abstract

Students with disabilities lag behind their peers without disabilities in success outcomes related to access to, persistence within, and completion of postsecondary degree programs (National Center for Education Statistics [NCES], 2017). Faculty play a key role in shaping student success. To date, however, most of the work exploring faculty attitudes and behaviors has drawn from a broad sample (e.g., Buchanan, Charles, Rigler, & Hart, 2010; Kraska, 2003; Jensen, McCray, Krampe, & Cooper, 2004; Rao & Gartin, 2003), with only limited exploration of the attitudes and behaviors of science, technology, engineering, and mathematics [STEM] faculty (e.g., Milligan, 2010; Moon, Utschig, Todd, & Bozzorg, 2011). This study seeks to understand how STEM faculty think about and respond to students with disabilities in order to shape effective interventions. Data were collected through a series of four focus groups with 27 participants across 17 STEM majors including lecturers, pre- and post-tenure, and academic administrators. Key findings from the focus groups illuminated the impact of a formal accommodations process, individual approaches to providing support, and perceptions of the STEM climate towards students with disabilities. Recommendations for research and practice include strengthening support and training for faculty in STEM disciplines while continuing to explore these themes across institutional types.

Keywords: Students with disabilities, STEM, faculty, universal design for learning

Students with disabilities lag behind their peers without disabilities in success outcomes related to access to, persistence within, and completion of postsecondary degree programs (National Center for Education Statistics [NCES], 2017). These trends hold true across both disability diagnoses and institutional types (Manly, Wells, & Kimball, 2015). Empirical studies have consistently highlighted limitations in support and the prevalence of disability stigma on postsecondary campuses as among the most likely factors contributing to these gaps (Evans, Broido, Brown, & Wilke, 2017; Kimball, Wells, Ostiguy, Manly, & Lauterbach, 2016). Studies have also consistently suggested that faculty attitudes and behaviors contribute to the perceptions of both inadequate support and stigma (e.g., Baker, Boland, & Nowik, 2012; Schelly, Davies & Spooner, 2011). A growing evidence base has shown that intentionally-constructed interventions can modify faculty attitudes and behaviors in positive ways (e.g., Bongey, Cizadlo, & Kalnbach, 2010; Junco & Salter, 2004; Spooner, Baker, Harris, Ahlgrim-Delzell, & Browder, 2007).

To date, however, most of the work exploring faculty attitudes and behaviors has drawn from a broad sample (e.g., Buchanan, Charles, Rigler, & Hart, 2010; Jensen, McCray, Krampe, & Cooper, 2004; Kraska, 2003; Rao & Gartin, 2003), with only limited exploration of the attitudes and behaviors of science, technology, engineering, and mathematics [STEM] faculty (e.g., Milligan, 2010; Moon, Utschig, Todd, & Bozzorg, 2011). Nonetheless, work of this sort is vitally necessary given that students with disabilities face additional challenges in STEM fields (Dunn, Rabren, Taylor, & Dotson, 2012; Lee, 2011). For example, analyses of enrollment patterns show that students with disabilities face even more restricted success pathways in STEM degree programs than in other fields (Lee, 2011; National Science Foundation

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[NSF], 2017). Prior research has suggested that the effect of disciplinary cultures, the construction of faculty workload, and tacit pedagogical assumptions may contribute to this widened gap (e.g., Dunn et al., 2012; Moriarty, 2007).

Given the promising results of targeted interventions intended to modify problematic faculty attitudes and behaviors (e.g., Junco & Salter, 2004; Moon et al., 2011), a STEM-specific intervention may prove equally promising. At present, however, any such efforts would be hampered by a limited understanding of how STEM faculty members think about and respond to students with disabilities. As such, we ask: how do STEM faculty members describe students with disabilities and their faculty-student interactions in a postsecondary learning environment?

To answer this question, we utilize a series of four focus groups with STEM faculty members to explore both a range of individual opinions and group consensus. The data derived offer a more complete understanding of the reported attitudes and behaviors of STEM faculty members, which can help to structure evidence-based interventions toward more supportive and less stigma-laden postsecondary learning environments for students with disabilities. In so doing, evidence from this study contributes to the reduction of discrepancies between the STEM outcomes of students with disabilities and their peers without disabilities. The results of this study contribute to a growing literature base intended to address an outcomes gap that the NSF (2016) has described as diminishing the quality of the STEM workforce and scientific inquiry.

Literature Review

Three literature bases informed the data collection and analysis undertaken as part of this study. First, we reviewed literature related to the way that students with disabilities experience postsecondary learning environments. This literature highlights the roles that limitations in available support and disability stigma play in producing inequitable experiences for students with disabilities. Second, we reviewed literature focused on the ways in which faculty attitudes and behaviors shape the postsecondary experiences of students with disabilities. This literature demonstrates that, while faculty members may seek to be supportive of students with disabilities, they generally lack adequate preparation to provide this support. Finally, we reviewed literature on the STEM-specific experiences of students with disabilities. This literature establishes both that students with disabilities possess the capacity to be successful in STEM fields and that STEM learning environments may sometimes inhibit the realization of these success outcomes.

Postsecondary Learning Environment for Students with Disabilities

Students with disabilities entering postsecondary learning environments face an often unwelcoming, sometimes hostile climate (e.g., Beilke & Yssel, 1999; Hedrick, Dizen, Collins, Evans, & Grayson, 2010; Stodden, Brown, & Roberts, 2011; Vogel, Holt, Sligar, & Leake, 2008). Negative postsecondary experiences for students with disabilities often occur during the transition process and continue to compound over time. For example, Adams and Proctor (2010) documented significant differences between the transition experiences of students with and without disabilities—noting suppressed adaptation, social adjustment, and academic outcomes for students with disabilities. While students with disabilities frequently possess strong compensatory skills that allow them to utilize their own self-determination and self-advocacy skills to navigate the transition process (e.g., Chiba & Low, 2007; Garrison-Wade, 2012), limited and/or inconsistent institutional supports can suppress positive transition outcomes (Dowrick, Anderson, Heyer, & Acosta, 2005; Garrison-Wade, 2012).

Issues related to accommodations have consistently been cited as amongst the most problematic aspects of the transition process (e.g., Collins & Mowbray, 2008; Denhart, 2008; Lightner, Kipps-Vaughn, Schulte, & Trice, 2012; Marshak, Van Wieren, Ferrell, Swiss, & Dugan, 2010). For example, Lightner and colleagues (2012) found that most students who received postsecondary disability accommodations sought them only after encountering an academic crisis. Furthermore, their research indicated that the proactive pursuit of accommodations was related to student knowledge and perceptions of the process. These findings are echoed by additional studies that have shown that the decision to seek services is powerfully influenced by factors such as understanding of the accommodation process, perceived social stigma, and the nature of prior interactions with faculty members (e.g., Baker et al., 2012; Kranke, Jackson, Taylor, Anderson-Fye, & Floersch, 2013; Marshak et al, 2010).

This literature base has also demonstrated that students with disabilities and faculty members perceive postsecondary institutions differently—with the latter believing campuses to be more welcoming (Baker et al., 2012). As a result, students with disabilities express reluctance to disclose their disability status and often do so only under conditions of extreme need (e.g., Collins & Mowbray, 2008; Denhart, 2008; Kranke et al., 2013; Lightner et al., 2012). Notably, students with disabilities have reported that they would feel more welcome to disclose their disability status if they perceived faculty and staff to be

more supportive (e.g., Barnard-Brak, Paton, & Sulak, 2012; Burgstahler & Moore, 2009; Farone, Hall, & Costello, 1998).

Faculty Attitudes and Behaviors toward Students with Disabilities

Findings related to faculty attitudes demonstrate both the widespread presence of problematic beliefs and limited knowledge as well as the effectiveness of trainings in moderating these issues (e.g., Izzo, Murray, & Novak, 2008; Kraska, 2003; Lombardi, Murray, & Gerdes, 2011). For example, Brockleman (2011) revealed wide variability among faculty in their perceptions of effective accommodations. Some of that variability was explained by the differences between STEM and non-STEM faculty attitudes (Brockleman, 2011; Kraska, 2003; Lombardi et al., 2011). Studies have also shown that faculty members struggle to devise support strategies based on variations in learning environments (Gladhart, 2010; Rule, Stefanich, & Boody, 2011) and disability type (e.g., Bush et al., 2011; Cawthon & Cole, 2010; Chanock, Stevens, & Freeman, 2010; Jensen et al., 2004; Prevatt, Johnson, Allison, & Proctor, 2005). This inflexibility may pose particular challenges in STEM disciplines due to the wide variability in instructional practices—such as the combination of lectures, labs, and team-based project work—and varied ways that specific disabilities would need to be accommodated therein.

While the documented faculty attitudes described above are likely to prove problematic for some students with disabilities, they are also malleable (e.g., Izzo et al., 2008; Murray, Lombardi, Wren, & Keys, 2009; Rohland et al., 2003). Changing faculty attitudes can result in behavioral modifications, leading to more supportive learning environments for students with disabilities (e.g., Izzo et al., 2008; Murray et al., 2009). Particularly effective trainings have included the development of faculty learning communities (Cook et al., 2006; Murray et al, 2009; Rohland et al, 2003) and online components (Izzo et al., 2008; Junco & Salter, 2004). In contrast, disability simulations were shown to be ineffective mechanisms for challenging attitudes and behaviors (e.g., Nario-Redmond, Gospodinov, & Cobb, 2017; Silverman, Gwinn, & Van Boven, 2015). Instead, effective interventions for faculty provide both empirical information about students with disabilities and effective strategies for addressing support needs.

STEM Experiences of Students with Disabilities

While students with disabilities face unique challenges in STEM disciplines (e.g., Dunn et al., 2012; Lee, 2011; Moriarty, 2007), the empirical literature on modifying faculty attitudes and behaviors reviewed above suggests possible paths forward. Limited evidence from STEM-specific interventions indicates that they would prove effective in modifying faculty attitudes and behaviors (Rule et al., 2011). These interventions need to address both unique nature of STEM learning environments and the ways in which various disabilities manifest themselves in STEM disciplines. For example, students with disabilities generally have high STEM aspirations (Bittinger, Wells & Kimball, 2015). However, studies of their perceptions, as well as those of their parents and teachers, have shown that STEM fields are perceived as unwelcoming and unsuited for students with disabilities (Alston & Hampton, 2000; Bellman, Burgstahler, & Hinke, 2015). Additionally, the negative relationship between other minoritized identities and STEM participation is amplified by disability status (Cardoso et al., 2013; Lee, 2014)—that is, women and people of color with disabilities enroll in STEM fields at even lower rates than their peers without disabilities. Recent empirical findings suggest that these outcomes may also vary by disability status with positive associations between some types—most notably, autism—and STEM participation (Wei, Yu, Shattuck, McCracken, & Blackorby, 2013).

Data and Methods

This qualitative research project utilized focus groups to explore the way that participating STEM faculty members conceptualized disability and understood the support needs of students with disabilities. We utilized focus groups because they allow researchers to gain information on group opinions, perspectives, reactions, and responses (Guest, Namey, & Mitchell, 2013). By asking individual participants to respond within the context of a group conversation, focus groups help to illustrate: how shared understandings develop through interpersonal interaction; the consensus perception within and across groups; and the presence or absence of diverging opinions (Marshall & Rossman, 2006).

Sample Site and Participants

Our study took place between 2016 and 2017 with a total of 27 faculty participants ranging across 17 STEM majors. Participants held a variety of faculty positions at the university including lecturers, pre- and post-tenured faculty, and academic administrators. All participants were drawn from the same large public research institution located in the northeastern United States. At the time of the study, the

institution offered over 30 STEM majors for undergraduate students across three different colleges. While programmatic initiatives existed on campus to increase student representation within STEM disciplines, their missions operationalized diversity via efforts to promote the inclusion of women and underrepresented minority students. Support for students with disabilities was funneled through the disability services office on campus, a mid-sized office that offered resources for accommodation registration, exam proctoring, and individual consultation.

To recruit participants, we utilized maximum variation sampling to ensure a wide breadth of opinions, faculty roles, and disciplines (Morgan, 1996). We utilized three strategies to develop our sample. First, the disability services office on campus provided an initial list of faculty who represented a range of perspectives on working with students with disabilities and accommodations to serve as potential participants. Second, we sought referrals from experts in STEM fields and STEM education—again asking them to recommend faculty members representing diverse opinions about and awareness of disability support. Finally, we supplemented our other recruitment strategies by inviting small groups of STEM faculty from different disciplines until saturation was reached (between four to eight participants per group).

Data Collection

This study shares the results of four focus group semi-structured interviews, each lasting approximately one hour in length. The first two authors of the research team each led two focus groups. We utilized a loosely structured facilitation protocol (Morgan, 1996) consisting of seven questions, which were asked in slightly different sequence and phrasing based on the context of each individual focus group. Our protocol included questions such as (a) how welcoming do you feel that STEM fields are to students from diverse backgrounds? (b) how would you describe the support or guidance that you receive on working with students with disabilities? and (c) are there any specific strategies that you have found helpful in supporting students with disabilities in your classes? Focus groups were audio-recorded and transcribed.

Data Analysis

We utilized NVIVO software to assist in data management and analysis. After each focus group, memo writing was used to engage with preliminary findings (Saldaña, 2013). These memos were used to explore potential codes that would form categories and themes. The study used constant comparison analysis to look for similarities and differences within each group (Corbin & Strauss, 2008). In this analysis, conceptually similar incidents are organized within high-level descriptors. Subsequent comparisons illuminated the properties and dimensions of each category and theme as well as their differences. Here, comparisons were made across participants and focus groups. Negative cases were used to illuminate the boundaries of these descriptors (Patton, 2015).

The lead author conducted the preliminary data analysis, which was subsequently reviewed by the other coauthors. The entire research team then negotiated discrepancies in interpretation. Following this analysis, we engaged in member checking by sending preliminary analysis to participants to check the resultant findings and interpretations (Merriam, 2009). Conducting four groups allowed us to reach a point of saturation in which similar themes emerged across participants (Lincoln & Guba, 1985). In this case, we sought to provide sufficient description within our findings to help readers decide what concepts might have transferability to their specific contexts.

Positionality

The research team included people with varied personal and professional experiences related to disability. Genia Bettencourt grew up with a parent with a chronic health condition. She currently studies issues of access and persistence for marginalized student groups within postsecondary education, including conducting both research and teaching related to students with disabilities. Ezekiel Kimball is a person with a disability (obsessive-compulsive disorder). He has written extensively about disability in the higher education environment and worked previously at a postsecondary education program for young adults with developmental disabilities, served as the disability services coordinator for a small college, and as the director of institutional research at a college well-known for its work with students with learning disabilities. Ryan Wells focuses his research on equitable postsecondary access and success for students who are underserved and under-researched. The study of students with disabilities in college is, therefore, a natural extension of over a decade's worth of research. As the parent of a student with disabilities who is about to start transition planning and considering options beyond K-12 schooling, issues of disability and success in higher education are meaningful in personal ways as well. This mixture of experiences allowed us to approach our data collection and analysis with varied perspectives and to challenge one another to deepen our understanding of how STEM faculty perceived support for students with disabilities.

Limitations

Like all focus groups, the primary strength of our study is its ability to capture both group consensus and potential dissent from that consensus. However, focus groups can potentially be biased by the presence of strong opinions that suppress dissenting voices. As facilitators, we controlled for this potential through triangulation of findings across multiple focus groups and proactive facilitation techniques, but the risk cannot be mitigated entirely. Additionally, focus groups can be subject to strong outlier biases in sampling. In other words, the faculty who agreed to participate in our focus groups may be those who are already more aware of and purposeful in supporting students with disabilities. The range of opinions and espoused practices in our data suggests that our sampling frame adequately captured both positive and negative perceptions, but it is possible that the "average" STEM instructor is not full represented. Finally, in our focus on exploring instructor attitudes and behaviors in STEM fields, we acknowledge that we have compressed widely divergent disciplinary cultures and faculty social identities. Future work should look at variations in faculty attitudes and behaviors across fields. It should also explore how faculty members holding various minoritized social identities—including various types of disability—think about and respond to the learning needs of students with disabilities.

Findings

Key findings from the focus groups are divided into three sections below: (a) the impact of a formal accommodations process, (b) individual approaches to providing support, and (c) perceptions of the STEM climate towards students with disabilities.

Impact of a Formal Process

While multiple faculty members perceived disability accommodations to be a formalized process, this was particularly evident for senior members who reflected on their experiences over time. As opposed to working directly with faculty to address concerns, many recent students went through the institutional disability services office for accommodations. The functions provided by the office included formal documentation, overviews of accommodations, note takers, and standardized testing facilities to provide fewer distractions and additional time. In many ways, faculty perceived benefits associated with having a formal process. A centralized office created clear procedures to follow and provided resources that did not require additional faculty time or energy. A sentiment echoed by many participants, one individual elaborated on the benefit of the accommodations system:

> Even though the letter that you get [describing the accommodations for a student with a disability] isn't helpful in terms of exactly what the issue is that they're having, it is decently prescriptive as to what you should do. It's not vague, like "the student has a disability. You should talk with them to see what they might want." It's very much, "they need twice as much time to take a test in a distraction-free setting." That's explicit. I can do that.

However, participants also suggested numerous limitations of the formal system of accommodations. In some cases, accommodation letters arrived weeks into the term, and created situations in which faculty and students had to work retroactively to address a situation. Some types of accommodations available to students were irrelevant or difficult to implement, particularly for courses reliant on specific software programs, learning environments, or pedagogical designs (e.g., team-based learning). Additionally, several participants shared a concern that students might try to misuse the system of accommodations for personal gain. Having an intermediary, here the disabilities services office, as the defining agency on campus took the burden of responsibility from faculty in ways that could be both helpful and challenging. In one example, a faculty member shared a case in which it was unclear if a student with disabilities truly needed an accommodation, eventually deciding that the student's "been diagnosed through a process and I have no way of refuting that... I just have to go by what's on the accommodation letter." Overall, deferring to the disability services office provided a form of standardization across individuals but also limited instructor agency in structuring supports.

As a result, the formal process was sometimes viewed as a barrier for faculty seeking to directly connect with students, instead creating a one-directional process of receiving information with minimal follow-up. The disabilities services office was primarily seen as having an administrative function rather than serving as a space to dialogue about how to best serve students or to navigate challenges of providing certain accommodations. In one example, a participant noted, "I want to help but, for example, with [the disability services office], they don't give you more information. It's just … send the exam here. That's all I can do without interacting with them." There were cases where the disability services office responded to faculty concerns and provided feedback on specific plans for accommodations, but these were often

seen as the exception. The uneven nature of responses made it difficult to anticipate what types of support were available. A positive past interaction was no guarantee of future support, a challenge exacerbated by a universal perception of the disability services office as understaffed on campus.

The lack of a relationship with the disability services office connected to a broader faculty experience of supporting students with disabilities with few resources. Participants voiced that they did not receive any formal preparation to support students with disabilities at any point during their academic training. The lone exceptions were those faculty coming from elementary and secondary teaching backgrounds, in which facilitating individualized education plans (IEPs) provided exposure to several key ideas. In higher education, supporting students with disabilities did not come up until one was a lead instructor, often late in a graduate program if at all. Without this background, faculty relied on trial and error and on-the-job learning. Another complication was participants' sense of an increasing numbers of students with disabilities within higher education. As one participant shared, "the sheer numbers of students now that are getting accommodations is exploding. When I started here, I had three to four kids in my class with accommodations. I now have 25 to 30." These numbers create new demands on the educational system and on faculty without prior preparation.

Individual Approaches

Although participants had little guidance around how to support students, they found effective ways to do so. Strategies of support fell into four categories: (1) referrals to campus resources, (2) use of empathy and personal attention, (3) development of relationships, and (4) adaptations to course structures. Participants largely saw their ability to use these approaches as dependent on their other instructional commitments, including time and class size. As such, it was important for students to self-advocate and proactively communicate.

Participants viewed referrals to campus services as a particularly effective way of supporting students with disabilities. Most frequently, participants connected students with the disabilities services office to obtain formal accommodations. Beyond this resource, other entities included the health center and the counseling center. One participant described an example of using the latter:

> I certainly walk two or three people to the counseling services every semester…I think many just assume that it will be easy, that this is what they're good at, and it should be easy. I counsel a lot of people that, no, the right major should be challenging without being overwhelming, and that it's okay to be frustrated.

More broadly, participants also described learning resources as a form of referral as well. For example, undergraduate teaching assistants offered support within academic disciplines. Others made referrals to campus tutoring services.

While not all participants were able to do so, faculty members that provided individual support to students with disabilities often drew upon their own past experiences. One participant shared, "I had a student that I was sure was dyslexic and for me it was easy to point out or to see because I'm dyslexic myself." Multiple individuals framed their understanding of disability through family members and their use of accommodations. For others, individual investment was based on a personal commitment and empathy. One participant shared an example of supporting an individual student to seek out accommodation:

> I have one student, it took me two years to get him to disability services. When I finally got that, his mother basically said, "There is nothing wrong with his brain." That was her attitude. She still has that attitude. The dad is more willing to work with it. It turns out his processing speed is very slow. He understands, he solves problems correctly, he just does it very slowly.

Large class sizes made this sort of personal attention more difficult. However, when possible, the result was usually a more rewarding relationship with students.

Multiple participants valued students coming to them with specific needs, building relationships that helped to provide better accommodations within the classroom. Examples of these collaborations included a student with a visual impairment explaining to a faculty member how to describe images in detail, one with anxiety sharing that she needed to have a panic attack prior to being able to complete exams, and one with colorblindness asking for alternate colors instead of red and green content on PowerPoint slides. Although faculty were receptive to these modifications, students with disabilities needed to proactively express their needs. This was particularly crucial with the rapid pace of the academic term, in which students that fell behind were often unable to catch up. One participant noted that, "If [students] talk to me, I can do something. If they show up at the end of the semester and say, 'Oh, by the way,' at that point, it's too late." In this regard, the highly sequenced

nature of many STEM curricula may pose a unique challenge for students with disabilities whose accommodations include modifications to course timelines. These STEM-specific challenges are described in depth in the following section.

Outside of building individual relationships rooted in care, understanding, and empathy, some participants sought to support students with disabilities by adapting courses. Multiple participants echoed ideas consistent with theory that disability is socially constructed, noting that the environment created barriers for students. One participant shared that "nine times out of ten, [students with disabilities] could learn the material, but learn in a different way and that's not offered." Several faculty members utilized accommodations beneficial for all students, an approach known as universal design for learning (UDL), though not always explicitly labeled as such by participants. Specific strategies included allowing extra or time on exams, posting notes for classes, and rearranging course content so that certain content could be done in homework rather than as a test. These techniques benefitted students with disabilities, but also the general course population. One participant shared that while "Maybe not every assignment has a modification, but within the classroom, there are lots of different types of products…or lecture or video or interactive styles to speak to different strengths that the students have." Overall, these modifications provided symbiotic benefits for students and faculty, and allowed the latter group to focus their attention on situations that required more specific support.

Challenges of STEM Fields

Participants perceived STEM fields as rigorous and demanding in ways that created questions around which students were best served within these programs. One participant shared a sense that "the vast majority of faculty, even the most generous, helpful, high teaching evaluations don't always understand disabilities." Participants described both the overriding focus on research in their fields and their own educational successes as contributing to challenges in understanding the viewpoint of a student with a disability who might be struggling. As one participant described fellow faculty members, "They just imagine themselves. They went to class…You just make yourself do it. If this is important to you, you just do it." While it is likely the case that faculty members in all disciplines are predisposed to view their students through the lens of their own experiences, STEM disciplines have been widely shown to be particularly challenging environments for struggling learners. The challenges are amplified when students arrive on campus with varying degrees of secondary preparation and mismatched expectations of academic programs, creating tension between the perceptions of STEM fields and their realities.

The difficulty of STEM climates was amplified by the fact that the sample site was a large public research institution. A class size of 100 was considered small for many classes, and routinely went up to as large as 500. One participant expressed the barriers of the institution, confiding that "if I could be honest [with students with disabilities], I'd say, 'Go to a smaller college where there are smaller classrooms.' I don't think I could say that, but that's what I'd be thinking." Even minor accommodations created time restraints, such as trying to reschedule or create new tests when someone missed an exam date. One participant shared an example, stating:

> Those are really problematic when we run a lab with 380 students because you have a student who says, "Due to my disability, I wasn't able to come to class today." You're not supposed to say anything and then, all of a sudden, it's five, six weeks in and they've missed four labs. How do you help that student?

One participant described the struggle to navigate across these limitations, sharing that "I sometimes think, if I wind up taking a lot of time for whatever reason for one student, then I have less time for all the others." The tenure system also prioritized other aspects of faculty performance for many participants, rewarding research productivity over teaching. As one participant noted, "I would love to be a better teacher. I would love to have time to read pedagogy, but that's not happening." Growth in the technical craft of teaching required individual investment beyond the daily structures and demands of academic life.

At times, participants voiced ways in which they struggled with the degree of accommodations to make and how those might impact overall rigor within a course or students' ability to succeed post-graduation. One manifestation of this concern was the idea that accommodations within higher education may prevent students from learning the skills necessary to be successful in their careers. A participant voiced this as part of their personal approach, in which "I'm kind of cut and dry and I don't know how to pull your boots up, you're just going to have to work hard. You may have to work harder than somebody else." This was directly tied to success in the future, where "if you can't get up, you're not going to have a job." In these views, accommodations did not provide the right type of support to the students because they might

not prepare them for the career ahead. One participant noted that "our job is to produce people that will practice in the profession…This includes not only knowing some equations and thermodynamics and so forth, but it's showing up on time, getting your work in and things of this sort." The desire to appropriately prepare students for the environments they would encounter post-graduation was amplified by the nature of STEM fields themselves, in which individual limitations could result in widespread impacts to the general health and wellbeing of society. Here again, the unique nature of STEM fields likely plays a role: since STEM fields are almost universally high paradigm consensus, there is often a core knowledge that students must acquire to be successful not just in a particular course but in those that follow. In contrast, in low paradigm consensus fields, it may be possible to avoid some content entirely—for example, specializing in one area of history while not pursuing others.

Discussion

Our findings highlight the requisite complexity of supporting students with disabilities in postsecondary STEM learning environments. Faculty members must work to balance a formal accommodations process that at times seems ill-suited both to student needs and to the structure of learning experiences in their particular field. They do so while balancing the need to provide individual support to students with disabilities and very real obligations including large class sizes, research agendas, and service commitments. Participants also recognized that disability may have unique resonance within postsecondary STEM learning environments where disciplinary norms structure classroom and laboratory experiences in very specific ways. Each of these findings contributes to and extends existing dialogue within the growing literature base on the postsecondary experiences of students with disabilities.

The empirical literature on the campus climate for students with disabilities has previously suggested that students with disabilities frequently feel unwelcome in postsecondary learning environments (e.g., Stodden et al., 2011; Vogel et al., 2008). The work supporting this claim has focused primarily on students' reports of postsecondary learning environments, and our work highlights congruity between student and faculty perceptions. Given the importance of faculty members to the experience of postsecondary students with minoritized identities (Hurtado, Alvarez, Guillermo-Wann, Cuellar & Arellano, 2012), this commonality may be a beneficial place from which to work toward a more supportive campus climate for students with disabilities. Further, while our findings confirm the largely good intentions of STEM faculty members, they also suggest a widespread lack of training and experience regarding how best to support students with disabilities. Prior research has indicated that helping students to develop positive self-concept (e.g., Chiba & Low, 2007; Garrison-Wade, 2012) and to secure accommodations would be effective ways of addressing the support needs of students with disabilities in postsecondary STEM learning environments (e.g., Baker et al., 2012; Kranke et al., 2013; Marshak et al, 2010). Our findings reveal that more effective support for STEM faculty in working with students with disabilities would help to realize these positive outcomes; doing so would likely contribute to student perceptions of faculty support, a key measure in studies of several desirable outcomes (e.g., Barnard-Brak et al., 2012; Burgstahler & Moore, 2009).

While our findings did generally confirm the good intentions of STEM faculty, participants also had a wide range of views and opinions in describing their interactions with students with disabilities. Many of them genuinely seem to have the students' best interests at heart, and yet their understanding and awareness of disability often influenced the way this concern manifested itself. That finding challenges prior findings that indicate that STEM faculty held disproportionately negative perceptions of students with disabilities when compared to faculty as a whole (e.g., Brockleman, 2011; Lombardi et al., 2011). For example, some of our participants described walking students to counseling services due to their understanding of what was needed. This sort of individualized helping behavior is a key mechanism for support. Furthermore, other participants were concerned that helping students too much could in some way hamper their learning of the behaviors needed for future job success. That inconsistency echoes prior findings that document wide variability in faculty knowledge regarding the needs of students with disabilities and how best to support them (e.g., Bush et al., 2011; Cawthon & Cole, 2010; Prevatt et al., 2005).

While participants differed markedly in their opinions about how best to support students, they all suggested major systemic issues that could be addressed more centrally within the institution where we collected data. Many participants found the accommodations process to be problematic, illustrating that the STEM field matches the more general literature on student transitions (e.g., Collins & Mowbray, 2008; Denhart, 2008; Lightner et al., 2012; Marshak et al., 2010). There was widespread agreement that faculty are not trained or prepared well for understanding disability or how to provide appropriate ac-

commodations. Although not entirely surprising, this finding does mean that evidence-based interventions designed to help faculty members learn how to support students with disabilities have not fully made their way into practice (e.g., Cook et al., 2006; Junco & Salter, 2004; Rohland et al., 2003).

Perhaps even more tellingly, participants described navigating not only their own confusion over supporting students with disabilities, but also the unease of those same students. According to participants, they frequently encountered students with disabilities who feared that others would perceive them as receiving special treatment, were unable to access timely and effective accommodations, and struggled to conceptualize their present support needs in the context of perceived expectations in rigorous STEM careers. These findings echo prior literature on student experience (Lyman et al., 2016; Marshak et al., 2010). The similar concerns may be a place from which to advance the conversation between faculty and students on these topics, and yet they can also serve as sources of tension and apprehension. That work is particularly needed given the complex relationship between disability and STEM education previously documented (e.g., Bittinger et al., 2015; Cardoso et al., 2013; Lee, 2014; Wei et al., 2013).

Conclusions and Implications

Our findings confirm, extend, or complicate prior work on the experiences of students with disabilities generally and in STEM fields specifically. Faculty participants in a series of focus groups described the often-problematic influence of formal accommodation structures on the experiences of students with disabilities. They also espoused a wide range of opinions regarding how best to support students with disabilities in STEM as well as the likelihood of their success in postsecondary STEM learning environments. Our findings connect with prior literature that suggests that these attitudes contribute to faculty behaviors, which are malleable through evidence-based interventions (e.g., Cook et al., 2006; Junco & Salter, 2004; Rohland et al, 2003). Finally, our findings suggest that STEM faculty members, like students with disabilities, understand that postsecondary learning environments can be unwelcoming and invite support in addressing the factors creating this problem.

Implications for Practice

The views and opinions shared by STEM faculty lead to several considerations for faculty development. Two implications for practice emerged from the participants themselves. The first focused on strengthening relationships with disabilities services administrators to provide ongoing support and resources. Rather than receiving a letter about accommodations without follow up, faculty expressed a desire to consult with disability services staff around decision making. Moreover, as STEM learning environments differ appreciably from other postsecondary learning environments, having in-depth knowledge of STEM fields is particularly important in navigating unique challenges related to content, classroom structures, and technology. Faculty suggested developing specialized STEM liaisons to consult regarding disability accommodations within their disciplines. However, these partnerships would require a greater commitment to support students with disabilities at the institutional level, as disability services offices are often understaffed and under-resourced. Our sample site provided an example of limited resources, as an office with fewer than 20 individuals was responsible for overseeing accommodations and support for a student population of almost 30,000.

The second recommendation focused on the need for more training for STEM faculty regarding how to support students with disabilities within their disciplines. Since no participants reported receiving this training as part of their graduate programs, STEM faculty often were forced to learn about these accommodations during their career in informal or unstructured ways. These types of learning are more likely to result in inappropriate approaches or simply a lack of awareness of the options available (Kimball, Vaccaro, & Vargas, 2016). While trainings were offered, they often required faculty to invest time and energy outside of their daily responsibilities and were not rewarded within institutional measures of productivity. Instead, a more effective support structure would integrate trainings into existing requirements of faculty life, such as having guest speakers at faculty meetings. Additionally, as graduate education provides an important role in socializing students to the norms of academia (Weidman & Stein, 2003), working to incorporate such education into early teaching experiences may provide a foundation for future pedagogy. For example, graduate teaching assistants could be required to attend workshops on supporting students with disabilities, adapting course content, and providing accommodations. Creating multiple opportunities for trainings across levels would create an internal infrastructure in which academic units could better develop internal capacity to support students with disabilities beyond a sole reliance on disability services providers.

An extension of this recommendation for better training generally is to provide training in UDL

principles and design specifically. While some faculty were already adapting courses in ways that were likely to benefit a wide range of students (though not using the UDL label), other faculty were fairly convinced that their discipline's courses were unlikely to be able to be modified in appropriate ways. Both groups could benefit from formal training in UDL principles and design. Those who are already de facto doing some form of this would benefit from finding support for their individual efforts and learning how to improve more formally. Those who do not understand how courses can be made more universally accessible would benefit from a basic understanding of the ways this can be achieved and the benefits that accrue from use. This is a way to potentially overcome resistance to such changes, or at least to move away from potentially problematic tacit pedagogical assumptions (e.g., Bongey et al., 2010; Junco & Salter, 2004; Spooner et al., 2007).

Moreover, specific support measures can be used to help support students. Many disciplinary STEM initiatives have successfully sought to change the climate and culture in specific fields for students of color and/or women. For example, the BRAID (Building Recruiting and Inclusion for Diversity) initiative focuses on the inclusion of women and underrepresented minority students in computer science. There could be similar effort across STEM disciplines to provide support for students with disabilities. As NSF explicitly includes this group as a focus in its grant funding, there may be viable funding mechanisms to support such efforts. These organizations could also include advisory positions for students to provide input into their STEM learning environments. These types of opportunities would not only be beneficial to providing faculty with resources for how to provide accommodations, but would provide students with disabilities with an opportunity for self-advocacy beneficial to their larger sense of belonging on campus (Vaccaro, Daly-Cano, & Newman, 2015).

Across these implications, there is clear evidence that education at the individual level needs to be supported at the institutional level. The academic climate, particularly for research intensive institutions, prioritizes peer-reviewed publications as the benchmark of success for job rewards, including tenure (Slaughter & Rhoads, 2004; Weber, 2011). This system provides little incentive for faculty to focus on their teaching, a challenge amplified students with disabilities represent a heterogeneous group where needs may vary (Kimball et al., 2015). The development of clear training, communications, and rewards structures may enhance the ways that STEM faculty develop to provide support to students with disabilities. These strategies would also support the development of modifications within specific STEM learning environments in ways that provided support for both students and faculty, aligning with key goals to increase diversity across STEM fields (NSF, 2017).

Implications for Further Research

While changes in practice are likely be most directly beneficial to students, additional research is also needed given the relatively small body of literature related to STEM faculty and disability. Exploring similar questions at different types of institutions would be useful, as one may assume that these issues play out differently at smaller colleges than at large research institutions. One faculty member even referred to this, assuming that students with disabilities should "Go to a smaller college where there are smaller classrooms." As yet, however, we lack even the empirical literature to determine whether this assumption is valid. Students with disabilities disproportionately attend community colleges (NCES, 2017), which tend to be smaller than research universities but are also notoriously under-resourced. In that regard, they mirror the comparative resource poverty of many smaller, less selective institutions. Small, non-selective institutions other than community colleges present even more questions that are currently not address in the literature regarding STEM education. As such, a useful study might ask about the intersection between disability, institutional type, and STEM outcomes.

In order for researchers to approach the role of faculty in the experiences of students with disabilities in STEM, common models or frameworks would be useful. Existing models such as the Multi-Contextual Model for Diverse Learning Environments (DLE; Hurtado et al., 2012) acknowledge the role of faculty in the student experience broadly. However, there are unique aspects to students with disabilities as participants in a diverse learning community and to STEM fields that go unacknowledged in the DLE (Kimball et al., 2015). The important connection between faculty and the disability services offices is also integral to this learning, as participants in this study made clear. A model that includes these specific pieces, likely bridging curricular and co-curricular aspects of a campus, could help the field to systematically develop knowledge that would be useful to improving the system on behalf of students with disabilities.

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