Enabling Equal Access to Co-Curricular Activities

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Abstract

The benefits of co-curricular activities are well-documented, with improvements in academic and professional development. Unfortunately, while U.S. laws mandate equal access to co- and extracurricular activities for disabled students, participation of disabled students in co-curricular activities is lower than the participation of their non-disabled peers, and this critical part of engineering education is often inaccessible to disabled students. In this paper we review the documented benefits of co-curriculars for all students and make the case for increasing the research focus on co-curricular inclusion specifically for disabled students, who are minimally represented in the overall body of work on co-curricular activities.

CCS Concepts

• **Human-centered computing → Accessibility theory, concepts and paradigms**; **Accessibility design and evaluation methods**; • **Social and professional topics → People with disabilities**.

Keywords

Co-curricular, accessibility, IDEA, disability, equal access

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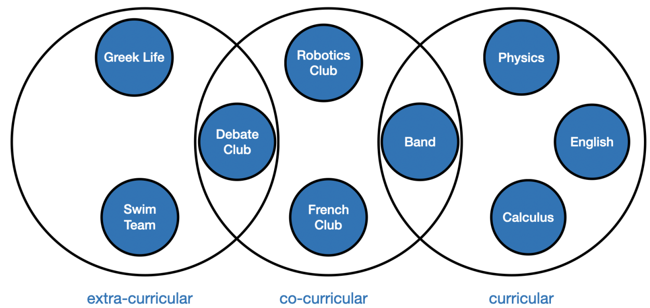

Figure 1: Examples of the relationship between co-curricular, extra-curricular, and curricular activities. We define extra-curricular activities which are unrelated to the academic curriculum. Co-curricular activities occur outside of the curriculum but use skills and techniques that apply to academics.

1 Introduction

The benefits of co-curricular and extra-curricular activities for engineering and computing students are well-documented, with improvements noted in academic performance, university retention, and professional development. Unfortunately, while the Individuals with Disabilities Education Act (IDEA) and Section 504 of the Rehabilitation Act mandate equal access to co- and extracurricular activities for disabled students, participation of disabled students in co-curricular activities is lower than the participation of their non-disabled peers. Disabled students represent a significant portion of the overall academic community: in 2022–23, the number of students ages 3–21 who received special education and/or related services under the Individuals with Disabilities Education Act (IDEA) was 7.5 million, or the equivalent of 15 percent of all public school students [23], so this non-participation represents a significant challenge to effective STEM education, at every level from elementary to graduate school. While substantial work has been done to document challenges for disabled students in STEM classrooms, and suggest improvements to mitigate those challenges, co-curricular activities have been comparatively neglected as a target for making STEM more accessible.

In this work, we review the literature identifying benefits of co-curricular activities for individual students and student communities, including quantifiable benefits to academic achievement, development of skills required for success in academia, networking opportunities, and benefits for college and graduate school admissions. We then discuss the societal benefits for the inclusion of disabled students in co-curricular activities: to research and design in assistive technologies and retain disabled students in STEM to ensure that high school, university, and graduate programs are keeping the most promising engineering and computer science students on-track to become the next generation of cutting-edge technologists. We outline some of the challenges to co-curricular inclusion, and identify areas of opportunity for research and action. Improving participation of disabled students in co-curricular activities, we argue, will empower students with and without disabilities to participate more fully in the scientific and engineering community at every level.

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2 Benefits of Co-Curricular Activities

2.1 Definitions

For our purposes, we define co-curricular activities as those outside the standard curriculum that use skills and techniques that are applicable to core academic pursuits. Fig.1 demonstrates this overlap and some examples of curricular, co-curricular, and extracurricular activities. We will focus on co-curricular activities that align with standard engineering and computer science curricula most directly, such as makerspaces, robotics or engineering challenge teams, coding clubs, and science clubs or competitions.

The definition of "disability" also changes depending on the defining document. While the Americans with Disabilities Act [2] and Section 504 of the Rehabilitation Act of 1973 [21] define disability broadly without a list of conditions, the Individuals with Disabilities Education Act (IDEA) more narrowly defines a specific list of eligibility criteria and further limits it to those children "who, by reason thereof, needs special education and related services" [53].

For our purposes we include as "disabled" people in any of these categories, as well as those who do not carry a disability diagnosis but experience barriers (whether physical, social, cultural, racial, socioeconomic, or other) which limit their access. While we give examples of co-curricular inclusion and exclusion relating to specific disabilities, many of these are generalizable. Further research is needed to identify where the differences in access needs due to disability may change the appropriate action for educators, society, and government.

2.2 Benefits for Individual Students and Student Communities

While the focus for STEM education is typically on classroom activities, multiple studies replicated across different countries, multiple decades, and at both the secondary and post-secondary level, have identified positive effects of participation in co-curricular activities on the academic achievement of students [42, 46, 51, 70]. Co-curricular participants have higher grade point averages (GPAs), higher retention and graduation rates [3, 6, 32], higher educational aspiration [29], and better performance even on individual exams [60] compared to their peers who do not participate in co-curricular activities. Co-curricular participation also encourages the development of group identity and feelings of belonging among participants [6], which research has shown is highly correlated with success in academic programs at the university level [33].

In addition to the direct academic benefits of co-curricular participation, it is a major factor in children's development of "non-cognitive" skills, such as "task persistence, independence, following instructions, working well within groups, dealing with authority figures, and fitting in with peers" [19]. In their 2010 work, Covay and Carbonaro [19] argue that co-curricular participation is a significant factor in gaps in educational outcomes observed between students with lower and higher socioeconomic status. These skills are notoriously difficult to teach within the academic curriculum [52], especially in STEM programs where there is also pressure to include more technical content [37]. These skills, however, are well-known to be critical to later academic and industry success—as far back as 1918, a Carnegie Foundation report suggested that only 15% of an engineer's success in industry is based on their academic preparation. More recent studies from Bangladesh [4], Hungary [38], Columbia [40], Europe [13], and the USA [34] all emphasize the importance of developing these skills for aspiring engineers, and that they are frequently lacking. Co-curricular activities provide an opportunity to bridge this gap by expanding the opportunities for the hands-on learning and teamwork that best build non-cognitive skills.

For high school students, extracurricular and co-curricular activity participation is also a boon to college admissions [26]. However, Park et al. [57] found that these advantages are distributed unequally across different types of extra-curriculars. In particular, they found that leadership of groups associated with a particular cultural group or identity contribute less to college admissions success [57] than co-curricular activities or athletics. For university students, co-curriculars like research experiences [62] and internships [36] both influence graduate admissions directly and provide students with mentors who can write letters of recommendation, which are frequently the most influential part of graduate admission packages [48].

Co-curricular activities also provide opportunities for networking with older students, students outside their immediate classes, with corporate sponsors or alumni, and with faculty [54]. Developing these professional relationships has both immediate benefits (such as making students more comfortable asking for help or attending office hours [18]) and longer-term benefits, such as faculty mentoring relationships [54]. In addition, the peer-leadership model of many co-curriculars provide opportunities for students to be mentored and, in turn, take on mentoring roles for other students, building both networks and skills that are critical to student success [31, 35].

Figure 2 illustrates how these academic and non-academic benefits of co-curricular activities combine with classroom activities to provide the necessary skills for research and industry careers. In addition to these benefits to individual students, there are benefits to society, the academic community broadly, and downstream effects from encouraging and enabling disabled students to participate in co-curricular activities.

2.3 Societal and Downstream Effects: Why Disabled Perspectives Matter to Everyone

A lack of access to resources like those provided by co-curricular programs can lead students away from professions in STEM, contributing to the "leaky STEM pipeline" [67]. This means that there are very few disabled mid- and late-career professionals in computer science or engineering [10]. Although 27% of adults in the US have some form of disability, they account for just 3% of the STEM workforce [66]. As of 2021, only 4% of American faculty members identified as disabled [64] and anecdotally, these numbers are even lower in STEM disciplines. This has trickle-down effects on both engineering broadly (especially in terms of mentoring and fostering feelings of belonging for members of underrepresented groups) and accessibility and assistive technology research in particular.

User-centered design methodology and movements like Disability Justice[39] argue that disabled voices need to be present in

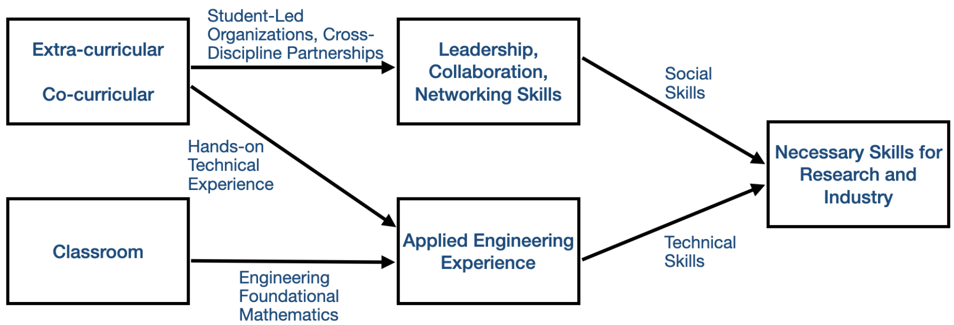

Figure 2: How extra-curricular and co-curricular activities combine with classroom education to prepare students for research and industry

assistive technology design. However, this is not always the reality [56]. Despite research conducted almost three decades ago [41] which recommended that accessibility research be conducted by mixed teams of disabled and non-disabled researchers, with consultations from other disabled community members for additional perspectives, the low prevalence of disabled researchers makes implementation of this model difficult. Although literature on the effects of the guidance of disabled PIs and research team members in implementing successful research is extremely limited, more limited user input is known to be correlated with end-user rejection of technology [11].

In addition, given that the vast majority of early research participants are taken from convenience samples [30], such as students doing co-curricular research on other projects in the same lab, the under-representation of disabled students in co-curricular research also reduces their representation and participation in the research findings and results. Supporting disabled students in research and supporting disabled faculty members seems to have compounding and self-reinforcing benefits for both the quality of the research and the personal and career development of the researchers.

3 Challenges in Co-Curricular Inclusion

Students with disabilities often face challenges when joining or participating in co-curricular activities. Although the Individuals with Disabilities Education Act (IDEA) and Section 504 of the Rehabilitation Act both mandate equal access to co- and extracurricular activities for disabled students, full participation is often considered "not practical" by those tasked with implementing support plans for disabled students [53]. Physically or logistically inaccessible facilities or resources [45], financial struggles [69], and a lack role models or education about available opportunities [58] all interfere with ensuring that disabled students are offered the same opportunities as non-disabled students.

3.1 Physical and Logistical Support Structuring and Prioritization

While data on co-curricular and STEM participation for disabled students is limited and additional work is needed (see Section 5), we can identify some areas for improvement based on the data that is available. One of these areas is prioritization of co-curricular experiences within the support structures provided for disabled students. Individualized Education Plans (IEPs) are the primary tool used in U.S. K-12 public schools to ensure that disabled students achieve educational goals in compliance with the federal Individuals with Disabilities Education Act (IDEA). However, when IEPs are written, they typically focus on inclusion for curricular and classroom activities—as of 2010, only 0.1-12.3% (depending on the student's disability category) of IEPs included mention of extra- or co-curricular activities [7]. Educators often do not consider extra-curricular involvement as a crucial component of a student's education [14], and evaluation criteria for support often only take into account classroom activities, despite the documented benefits to academic achievement from participation in co-curriculars and the legal mandate under the IDEA to include disabled students in *all* school activities (classroom, co-curricular, and extracurricular).

These challenges exist in higher education as well; research has indicated that disabled graduate students often struggle to receive accommodations for student teaching [44], and that students engaged in research activities find it challenging to ask for or receive accommodations [8]. Undergraduate and graduate co-curriculars are also legally required to be accessible under the IDEA, but university student support services are typically not designed to support co-curricular activities. This is a particular problem for PhD students, for whom the majority of training is research and teaching.

3.2 Co-Curricular Costs

Even students with access to accommodations that include their participation in co-curriculars can face bars to participation. On average, extra- and co-curricular activities are expensive; costs depend on the type of activity, but average about $700 per year. Activities which require travel or special equipment carry costs closer to $2500 [69]. Many disabled people encounter a variety of healthcare-related out-of-pocket expenses, from service animals to assistive technologies to hospital visits. As of 2019, 25.9% of households including an adult with a disability live below the poverty line, compared with 11.4% of those without a disability [1, 27]. As a result, these activities place a higher burden on students with disabilities.

3.3 Mentorship

Positive role models have a strong effect on impressions of stereotypes and future aspirations. For example, girls who grow up with exposure to women in traditionally male fields (e.g. politicians, faculty) are more likely to work in male-dominated and STEM industries themselves [17]. The representation of disabled students in co-curricular activities can affect their likelihood of recruitment similarly: a lack of access to these role models can have a de-motivating effect [68], leading to poorer academic performance and discouraging students from enrolling in STEM courses [71]. Furthermore, when a group is poorly represented, their absence tends to perpetuate stereotypes [55] about them, making it more difficult for students to join the group and feel like they are understood and belong [33]. Representation matters to students outside the represented group, as well: in a series of studies conducted between 2003 and 2005 with over 15,000 participants who either were or supervised undergraduate research programs, student confidence in their ability to succeed in academia was higher among those students who had both mentors of the same race and gender and of different races and genders from themselves [61]. While more research is needed into how disabled student participation, leadership, and mentorship can improve representation, if disabled students are unable to see other disabled people in the academic and industry roles they aspire to, they may be less likely to continue in STEM.

3.4 Belonging

One of the principles under the IDEA is that of the "least restrictive environment"—that a disabled student should be placed in an environment as close to that of their non-disabled peers as possible while still ensuring that they receive the support they need to access the curriculum. Integrated educational activities are strongly preferred whenever possible over segregated activities. However, for opt-in co-curricular activities, groups of students tend to self-segregate among different co-curricular activities. While there is minimal research on this phenomenon specifically for disabled students, we can draw parallels to research grouping students by other characteristics. For instance, racial minorities tend to have lower levels of participation in sports, and girls tend to participate more in arts and academic clubs than boys [47]. As discussed in Section 2, different types of activities carry different status for college admissions and other professional opportunities, so this can limit the benefits of co-curricular activity participation for students.

Another factor that can lead to segregated activities or the exclusion of some students is the psychological phenomenon of ingroup favoritism [22]. Prior work has shown that disabled engineering students are generally less likely to experience social inclusion and professional respect in their programs than their non-disabled peers, and are more likely to consider leaving or to actually leave their programs, regardless of their level of success in the program [15]. Moreover, while ingroup bias can help members form community and work together effectively, it also magnifies stereotypes of those outside the group and can lead to their exclusion, devaluation, or oppression [59]. This is to the detriment of all students—it limits the networking opportunities and mentoring connections available to students identified in Section 2, and does not meet the requirements under the IDEA for inclusion.

4 Supporting Co-Curricular Participation for All Students

Given the overwhelming evidence for the benefits of co-curricular activities for STEM students at the high school and college level, it seems clear that disabled STEM students would benefit from more participation in co-curricular activities. In this section we propose five approaches to support co-curricular participation for all students.

4.1 Empower Co-Curricular Leaders to Make Changes

Several recent works provide actionable guidance for making co-curricular activities based in makerspaces inclusive for all students. The Do-It Center at the University of Washington's "ADEPT Accessibility Briefs" provide guidelines for makerspace operators [16] to make their spaces more accessible, focused particularly on guidelines for physical accessibility. Allen et al. [5] provide additional suggestions for increasing makerspace participation, including fostering belonging with inclusive communities and staff hiring, and providing resources to "makerspace the makerspace" to empower disabled students and their non-disabled peers to change the space and its rules to address access issues [5]. This kind of adaptive programming often requires financial resources, so educational institutions can support students by allocating budget for accessibility initiatives. Other types of co-curricular activities may be able to apply these guidelines, but further research is required to identify actionable guidance that will be easy to apply for co-curricular student leaders, staff facilitators, and faculty advisors.

4.2 Reduce Stigma and Increase Support for Co-Curricular Accommodations

Institutions and co-curricular facilitators (including research PIs) can also help improve co-curricular accessibility by reducing the stigma associated with asking for accommodations. This is especially important in competitive programs, where students may feel that asking for accommodations puts them at a disadvantage compared to other applicants. Recent work by Dori-Hacohen and Murai [20] suggests reducing the stigma and logistical difficulties of asking for accommodations with "dynamic micro-accommodations" (DyMMAs). These DyMMAs can be used by both faculty and students as "an informal mechanism reducing stigma and smoothing over many of the day-to-day challenges in research environments, especially regarding dynamic disabilities, neurodivergence, and other hidden or variable access needs." [20] This dynamic micro-accommodation paradigm grants support as-required to any member of the research team, regardless of their disability status, seniority, or the temporary or permanent nature of their access needs, addressing access needs proactively and immediately. Further work in this area is warranted to identify methods for applying micro-accommodations in co-curricular activities other than research.

At all levels, educational institutions should budget and plan for making activities accessible both in and out of the classroom, and outreach to disabled students specifically should be included in recruitment for co-curricular activities. Creating proactive accommodations and incorporating universal design principles reduces

What to Do	How to Do It
Support Change and Maintain Infrastructure	Empower co-curricular leaders to "makerspace the makerspace"—making changes to physical, digital, and hybrid spaces to meet the needs of interested students [5]. Ensure that ADA-mandated accessibility requirements (such as lifts and elevators) are met and maintained in good order.
Reduce Stigma	Reduce the stigma associated with asking for accommodations and normalize a culture of "micro-accommodations" [20].
Increase Support	Design co-curricular activities from the outset to include all students. Incorporate co-curricular participation goals into IEP and 504 special education plans. Provide financial support for students to participate in co-curricular activities.
Teach Accessible Design	Include principles of accessible and universal design in co-curricular projects and in guidance for peer mentors.
Teach Technical and non-cognitive skills together	Incorporate methods for teaching mixed groups of autistic and non-autistic students to address the double-empathy problem[50]. Incorporate co-curricular activities that build technical skills into social skills classes.
Institutional Support	Support faculty and staff with on-demand resources to meet the accessibility needs of specific students. Include universal design training for student leaders of co-curricular and extracurricular groups. Encourage and support official and unofficial mentoring and provide resources for mentors to reach out to students who are unlike themselves. Support co-curricular group leaders and faculty advisors in recruiting students who might not self-select. [49] Make accessible **resources** the default. Make institutional resources such as group web design templates, video-sharing sites, interpretation services, captioning, etc easily available for classroom **and** co-curricular activities, including student-led and unofficial groups.

Table 1: How To Support Co-Curricular Participation

the need for students to request accommodations, which can feel like asking for special treatment and discourage participation [44]. In K-12 schools, participation in co-curricular activities should be included in IEP and 504 goals for students with those supports, and special education resources should be allocated to support co-curricular activities. Explicit inclusion of co-curriculars in IEP goals also provides one potential path to address the issues of belonging and out-group dynamics identified in Section 3.3 for students who are the first with their disability in a particular group.

4.3 Co-Curriculars as a Platform for Informal Teaching and Learning

Classroom educational research for experience-based engineering education can also provide guidance on making co-curriculars more accessible. For example, Street et al. [63]'s research on the application of universal design principles into peer-led team learning classroom instruction can also be incorporated into co-curricular activity design. One of the benefits of co-curricular activities is the peer-leadership model: opportunities for students to be mentored and, in turn, take on mentoring roles for other students. If principles of accessible and universal design are incorporated into the mentoring students receive in their co-curricular activities, not only does this enable the activities to better include disabled students, it provides an opportunity for all students to introduce and practice accessible design principles. This is especially valuable for high school and early-undergraduate students since, due to curriculum pressure in introductory engineering and computer science classes, accessible design is often not taught in classroom settings until late in an undergraduate's college experience, and may not be available at all. In this way, inclusive co-curricular activities serve as a learning environment for applying accessible design principles in addition to foundational mathematical concepts to the sort of real-world, hands-on projects that are most valued by graduate schools and industry.

4.4 Co-Curricular Activities for Non-cognitive Skill Development

The benefits from co-curricular participation to non-cognitive skills [19] match very closely to skills that are often listed as lacking in students with social or executive function disabilities, such as autism. In particular, such skills are particularly impacted by the double-empathy problem and prone to misunderstanding in mixed autistic and non-autistic communications [50]. Existing research on integrated co-curricular activities as a platform for social-emotional learning suggests that this can be effective for many types of disabled students [9], but more investigation is needed into how to facilitate the bi-directional learning that is most effective at addressing mixed communication scenarios while validating the contributions of all the participants. Allocating support from special education staff to co-curricular activities and incorporating co-curricular participation goals into IEPs for disabled students may help facilitate this integration. As with general accessibility training for co-curricular students, this has the advantage of working with both disabled and non-disabled students to chip away at the empathy gap, to their mutual benefit.

In other cases, where a more restricted environment is warranted by the needs of the student, incorporating co-curricular activities into social skills groups just for autistic students and mixing technical skills with developmental goals can help students build both confidence and skills to later join accessible groups of mixed disabled and non-disabled students. Additional research and guidance is also needed for special educators on how to facilitate groups that scaffold co-curricular participation, and for technical staff on how to support these groups.

4.5 Institutional Support for Inclusive Practices

Finally, to make co-curriculars more accessible to disabled students, we must make supporting and facilitating co-curriculars more accessible. Currently, the existence of co-curriculars is supported primarily by uncompensated faculty labor—and the additional support required for making co-curriculars accessible or welcoming to underrepresented students is primarily taken on by underrepresented faculty members [65]. In addition, many co-curricular activities are primarily run by student leadership, who will also require training in planning accessible activities and have even less access to university resources than faculty advisors. Educational institutions (at every level) need to provide mentoring training to support faculty members and student activity leaders in supporting disabled (and other underrepresented) students [25, 43], and to provide the training in ways that do not further burden faculty advisors (such as “just in time” training or personal mentoring for making resources accessible [28]).

Building accessibility into templates and tools available to the facilitators, faculty advisors, and student leadership can also help co-curricular activities with accessibility, both in person and in their digital resources and recruitment. Incorporating the recommendations from “Universal Design in Higher Education” [12] and similar works on Universal Design into general-purpose university resources like website-creation services, financial tools, and group or classroom-management software would reduce the logistical and financial costs of making these resources accessible (and therefore making them compliant with the IDEA and other equal-access laws). Making those accessible resources available to student group leaders, as well as faculty, would significantly lower the bar to making co-curricular groups’ online presences more accessible. This in turn allows for more recruitment and retaining of students with and without disabilities in these groups.

5 Research Gaps: A Call to Action for the ACM RESPECT Community

A major limitation of our analysis is a lack of direct research on how disabled students participate in STEM education. We identify three major research gaps:

- Factors influencing disabled students’ dropping out of STEM programs
- Factors influencing disabled students’ participation in co-curriculars
- The effectiveness and methods for enacting the recommendations from Section 4.

While we can draw parallels from research into other factors that affect co-curricular participation (such as race, class, gender, and age [47, 57]), research is needed to determine how to best apply these parallels and whether there are unique factors relevant to disabled students.

For example, disabled K-12 students drop out of school at higher rates than their non-disabled peers: as of the school year 2021-2022, the dropout rate of of K-12 students with disabilities who had been served by IDEA was 15% [23]. In comparison, only 5.3% of non-disabled students dropped out in that school year. For university students, however, while the NCES collects information on dropout rates with respect to racial categorizations [24], they do not collect data with respect to disability status. There is also limited research into the specific reasons why disabled students leave STEM university programs (even if they do not drop out of the university), or why they leave STEM fields after graduation.

Additionally, while research on student participation broadly is powerfully supportive of co-curricular activities for skill development and complementing the STEM curriculum, research on disabled student participation is limited. While in section 4 we have provided a sketch of the barriers that exist to disabled students’ participation based on what data is available and research on other under-represented students (such as gender or racial minorities), a focused body of research on the participation of disabled students in co-curriculars is needed to identify areas where there may be barriers that are different from those affecting other under-represented students. Conducting interviews with some of these students could provide insight into their experiences, the unique struggles they face, and the ways in which we can make STEM education more accessible to align with the mandates of the IDEA.

Finally, for each of our recommendations in Section 4, while there is supporting evidence to suggest that these interventions can be effective, research demonstrating their conclusive benefits and providing clear guidance for implementing them is needed. This will enable widespread distribution of accessible co-curricular programs.

6 Conclusion

The benefits of co-curricular activities for recruiting, developing, and sustaining student participation in STEM and in building successful programs for both individual students and STEM communities are well-documented. In order to enable successful STEM skill development of the large number of disabled students at the elementary and secondary level, and to ensure their continued participation at the post-secondary level, in graduate school, academia, and in industry, we need to ensure that co-curricular activities are accessible. Additionally, it needs to be a priority to recruit and support disabled students into co-curricular activities. Through this support, we can ensure that the best and brightest students, including disabled students, receive the training they need to keep advancing the cutting edge of research and design in academia and industry.

7 Positionality Statement

The authors include two doctoral candidates and a faculty member, all in computer science and/or engineering. Two of the authors identify as White and one as multi-racial White and Native American, and all of them identify as female. All three experience forms of disability, including mobility impairments, chronic illness or medical conditions, and neurodivergence.

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