Accessibility and Disability in PreK-12 CS: Results from a Landscape Survey of Teachers

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ABSTRACT

Despite the interest in equity, little research has considered students with disabilities in PreK-12 computer science education. The 2022 Computer Science Teachers Association and Kapor Center facilitated Landscape Survey of PreK-12 CS Teachers, which had over 2200 responses, gives us new insight. There were few significant differences between the experiences and perceptions of teachers with disabilities and those without. Accessibility was the least taught computing concept. Furthermore, teachers reported on a variety of barriers that students with disabilities encounter related to structural barriers, students choosing note to take CS, and teachers' perceptions of student ability. The findings point to the need for interventions related to resources, outreach, and policy.

CCS CONCEPTS

• Social and professional topics ~ User characteristics ~ People with disabilities • Human-centered computing ~ Accessibility • Applied computing ~ Education

KEYWORDS

PreK-12 CS education, accessibility, disability

ACM Reference format:

Brianna Blaser, Richard E. Ladner, Bryan Twarek, Andreas Stefik, and Hannah Stabler. 2024. Accessibility and disability in preK-12 CS: Results from a landscape survey of teachers. In *In Proceedings of the 2024 RESPECT Annual Conference (RESPECT 2024), May 16–17, 2024, Atlanta, GA, USA.* ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/3653666.3656071

RESPECT 2024, May 16–17, 2024, Atlanta, GA, USA.

ACM ISBN 979-8-4007-0626-4/24/05. https://doi.org/10.1145/3653666.3656071

1 INTRODUCTION

People with disabilities make up an important and sizable portion of the population. Despite being 15% of the world population according to the World Health Organization [1], researchers have spent little time examining the population in the context of computer science education, either as students or as educators. Researchers rarely ask about disability, for a variety of reasons [2]. Indeed, when we talk about computer science (CS) for all, disability is often ignored [3]. Some work has shown that there are accessibility barriers with programming languages [4], curriculum [5, 6, 7], and pedagogy [8, 9, 10], but gaps remain. In recent years, there has been increased attention to disability in preK-12 CS education [11]. Notably, in 2020 the annual State of CS Education report published by Code.org, Expanding Computing Education Pathways, and the Computer Science Teachers Association (CSTA) began including information about the enrollment of students with disabilities, specifically those students who are covered by Individuals with Disabilities Education Act (IDEA) or Section 504 of the Civil Rights Act [12].

In 2022, CSTA and the Kapor Center conducted a landscape survey of preK-12 computer science teachers in the U.S. [13]. CSTA, a professional organization for CS teachers, supports preK-12 CS educators. The Kapor Center works on equity in computing with a focus on the intersection of racial justice and technology. The survey, which sought an understanding of teachers' perceptions of equity and CS, resulted in a published report titled *Moving Towards a Vision of Equitable Computer Science: Results of a Landscape Survey of PreK-12 CS Teachers in the United States* [13]. The survey had several questions related to disability and accessibility. Two related findings are highlighted in the initial report—9% of CS teachers identify as having a disability, and 20% of CS teachers teach about accessibility. This paper further analyzes and reports on the results of other survey questions related to disability and accessibility, thereby extending our knowledge about teachers with disabilities and about the barriers that all teachers have in teaching students with disabilities. We found no difference in the experiences of teachers with disabilities and those without, but teachers with disabilities are more likely to teach accessibility. Finally, teachers see three types of barriers to the participation of students with disabilities in CS: structural barriers, students choosing not to take CS, and abilities of students with disabilities. These findings are unique in the literature on students with disabilities in preK-12 CS because they come from a large-scale survey.

2 THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

According to the National Center for Education Statistics, in 2021, there are about 7.3 million young people between the ages of 3 and 21 who are served under IDEA [14]. Another approximately 1.7 million students are served under section 504 [15]. This totals to about 12% of the preK-12 student population. Most of these students are in general education settings. This means that it is common for computer science teachers to have had students with disabilities in their classes. Furthermore, according to the US Census, in 2021, there were about 21.5 million people with a disability between the ages of 18 and 64 (working age) who have a disability, of which only about 8.7 million are employed [16]. At that time there were about 165 million people in the workforce, which means that, in 2021, about 5.4% of the workforce has a disability. This demographic profile of disability in the workforce and in preK-12 schools provide the foundation for analyzing the demographics of the 2022 Landscape Survey data.

We are also interested in the extent to which CS teachers are teaching about accessibility. Designers and engineers need to learn about accessibility in order to ensure that our technology is universally designed for all people, including those with disabilities. There is unmet demand from technology companies for employees who are knowledgeable about accessibility so that they can build accessible products [17]. Beyond that, teaching about accessibility has the potential to attract students with disabilities to CS classes [18].

When the 2022 Landscape Survey was developed, CSTA and the Kapor Center were collaborating as part of the Alliance for Identity Inclusive Computing Education (AiiCE) [19]. AiiCE has a commitment to include disability and accessibility across alliance activities, and as such, questions about disability and accessibility were included in the 2022 survey. In doing so, we hoped to learn more about the disability status of CS teachers, their experiences teaching students with disabilities, and the integration of accessibility into preK-12 CS education.
We had three research questions that guided the work:

1. How do the experiences of CS teachers with disabilities compare to those without?
2. Are CS teachers teaching about accessibility in their classes?
3. What are teachers' perceptions of and experiences with teaching students with disabilities?

3 POSITIONALITY

Together, we have varied backgrounds in computer science, education, and equity, and some of us have disabilities. In particular, we have a shared interest in accessibility and disability inclusion in computer science education and careers. We have deep connections within the disability community and are interested in ensuring that CS education is welcoming and accessible to students with disabilities and that accessibility is taught within computing curricula so that future designers and engineers can make accessible products.

4 METHODOLOGY

Data was collected in summer 2022. It consisted of 84 items across seven sections: Teacher Demographics, School Demographics, Satisfaction with Computer Science Teaching; Instructional Practice, Cultural Competence, Satisfaction with Curriculum, Perceptions of Incorporating Culturally Relevant Pedagogy, and Professional Development. The survey was distributed in multiple settings including via emails from organizations, blog posts, social media, and newsletters. A $10 incentive was given to participants. A total of 2238 CS teachers participated in the survey from all 50 states, Washington, DC, and Puerto Rico. In this analysis, we are only reporting on questions directly related to accessibility and disability.

The survey asked teachers about their own disability status as well as about students with IEPs (individualized education programs) and 504 plans. Students served under IDEA typically have an IEP, and students served under 504 will have a 504 plan. Multiple survey items related to disability:

- How does participation of students with IEPs or 504 plans in your CS class(es) compare to their overall school population?
- What do you think are the main barriers that prevent students with IEPs or 504 plans from fully participating and succeeding?
- Please select which category best describes your confidence in teaching students with IEPs or 504 plans: very confident, confident, somewhat confident, and not confident.
- Which concepts or skills do you teach in your CS courses? Select all that apply. (Accessibility is included as one of the options).
- Do you identify as having a disability or other chronic condition?
- How would you describe your disability or chronic condition? Select all that apply.

Qualitative analyses were conducted by coding open-ended responses by theme and identifying groupings of themes. Note that throughout the paper, we use both person-first language (e.g., a person with a disability) and identity-first language (e.g., disabled person). Within the disability community, there is not a consensus about a preferred term [20]. We also note that the survey asked about students with IEPs and 504 plans. Not all students with disabilities will have either an IEP or 504 plan, particularly students who do not have a formal diagnosis.

5 RESULTS

5.1 Teachers with disabilities

A total of 209 (9.3%) teachers in the survey identified as having a disability or chronic condition. The most common disability-type was health-related, followed by mental health and attention (See table 1.)

We were interested in the extent to which teachers with disabilities had different experiences, especially with regard to belonging, community, and equity. In a careful analysis of the quantitative data, we found that there was minimal, or no, difference between those with disabilities and those without across the measures. Statistical testing using a two-way ANOVA followed by multiple comparison tests supports our hunch, showing a minimal and tiny effect size at best $F(1, 26072) = 0.07$, $p = .793$, $\eta^2_G < .001$. For this reason, we think the data related to our other research questions is more informative for the CS education community and policy makers and will focus the paper on that.

Table 1. Disability-type among teachers who identified as having a disability

Disability-type	N	Percentage among teachers with disabilities
Health	84	40.0%
Mental health	48	22.9%
Attention	48	22.9%
Hearing	29	13.9%
Mobility	29	13.9%
Learning	28	13.4%
Vision	22	10.5%
Autism	8	3.8%
Speech	3	1.4%
Other	29	13.9%

5.2 Teaching about Accessibility

When asked "Which concepts or skills do you teach in your CS courses?" and presented with 17 concepts and skills, accessibility was the least likely to be taught. A total of 457 (20.4%) teachers taught about accessibility. As a comparison, 65% taught about programming and 61% about computational thinking, the concepts that were identified as taught most often. Those who taught web development, app development, or ethics were more likely to teach accessibility topics at 36%, 35%, and 36%, respectively. Inversely, of the 457 who taught accessibility, 382 (83.6%) taught at least one of these three topics. Among teachers with disabilities, 31% (n = 65) taught about accessibility. Among teachers with a vision related disability, 45% (n = 10 out of 22) teach about accessibility.

We then conducted a chi-squared test across three groups of teachers 1) those without disabilities, 2) those with disabilities other than blindness or visual impairments, and 3) those with specifically blindness or visual impairments to evaluate whether there was a proportional difference between the number of teachers that report teaching about accessibility. The data was placed into Tidy format so each row would reflect a single teacher. We use the disability status as an independent factor of 'groups' and whether or not they teach accessibility as the outcome factor. Results show that there was a difference between the groups $\chi2(2, N = 2018) = 17.52$, $p < .001$. Post hoc analysis was conducted using pairwise chi-squared comparisons with a Bonferroni correction for family-wise error. These tests showed that those without disabilities may differ from those with specifically blindness ($p = .008$), as well as those with other disabilities ($p = .006$). We did not have sufficient evidence to conclude whether or not there was a difference between those with blindness disabilities and those with other disabilities. The number of people in our sample with disabilities, let alone one specific kind, was much smaller than those without. Thus, we also ran a chi-squared test to compare teachers between just those without disabilities to those with disabilities of any kind $\chi2(1, N = 2018) = 14.47$, $p < .001$. The point being that even if we exclude the one group, the interpretation is the same.

The data suggests that teachers with disabilities, who may have personal experience with inaccessible technology, are more likely to teach about accessibility. Teachers who are blind or have low vision, and likely have experience with inaccessible technology, are even more likely to teach about accessibility than teachers with other disabilities. We warn the reader, however, that sample sizes vary considerably in such data, because inevitably there are more teachers without disabilities than with. As such, while the data only suggests the statements above, more data in the disabilities space is helpful.

Table 2. Average teacher agreement on statements related to belonging and inclusion (1 = strongly disagree and 4 = strongly agree)

Statement	Teachers with a disability or chronic condition	Teachers without a disability or chronic condition	Multiple Comparison Tukey adjusted p-value

I truly enjoy teaching computer science.	3.5	3.4	1.00
I see myself as a computer science teacher.	3.3	3.3	1.00
I feel part of a community of computer science teachers.	2.9	3.0	1.00
I frequently talk to peers about computer science teaching.	3.1	3.1	1.00
I hope to continue working in computer science throughout my career in education.	3.5	3.5	1.00
I feel that learning computer science is important to all students regardless of their identity (e.g., gender, race/ethnicity, and disability).	3.7	3.6	0.995
Issues related to racism, sexism, ableism, and other inequities should be openly discussed in computer science classrooms.	2.9	2.9	1.000
Effective computer science teaching incorporates diverse cultures and experiences into classroom lessons and discussions.	3.3	3.3	1.000
I have control over how I teach computer science.	3.3	3.4	1.000
I have the materials, supplies, equipment, and space necessary to do my job.	2.9	3.1	0.607
I have the professional support necessary to be a successful computer science teacher.	3.0	3.1	0.998
I work hard to be the best computer science teacher that I can be.	3.6	3.5	0.947
I have the opportunity to collaborate with other computer science teachers	2.9	3.0	0.973

5.3 Teaching Students with Disabilities

When asked how the participation of students with IEPs or 504 plans in their classes compared to their overall school population, 60% of teachers (n= 1312) indicated that the participation of students with IEPs or 504 plans was on par with the population in their overall school. 7.9% indicated that students with IEPs or 504 plans were overrepresented and 32% indicated students with IEPs or 504 plans were underrepresented. Among the teachers surveyed, 73% (n = 1582) indicated that they were confident or very confident teaching students with IEPs or 504 plans. Only 3% (n = 70) said they were not at all confident teaching students with IEPs or 504 plans. These percentages seem to reflect that teachers are comfortable teaching students with disabilities.

In an open-ended question, teachers were asked about the main barriers that prevent students with IEPs or 504 plans from fully participating and succeeding in CS education. Over 1100 teachers responded to the open-ended question. Of these, about 100 responses indicated they couldn't provide insight and over 100 indicated that either they didn't see barriers for students with disabilities or that students were represented in their classes. As one teacher said, "The majority of my CS students have IEPs, 504, [and] lack social skills. I welcome the out of place kids." Another noted, "All students in my elementary school have CS as a 'special.'"

Among the remaining comments, three major themes arose:

- structural barriers within their school setting,
- students with disabilities are not choosing to take computer science, and
- teachers perceive that the abilities of students with disabilities present a barrier.

These themes are discussed in detail below. A small number of teachers commented that students with disabilities may not get sufficient support from home or their parents, but this was much less prevalent than the themes discussed below.

5.3.1 Structural Barriers. Teacher comments pointed to several structural barriers within the educational system that present barriers to students with disabilities related to curriculum, technology, educators' expertise, a need for more resources for students with IEPs and 504 plans, and scheduling issues. Some comments pointed to a need for appropriate curriculum that included sufficient scaffolding or options for differentiation and modification. One teacher noted that, "CS curriculum has a less extensive toolkit of accommodations and modifications than most academic subjects." Another said, "Most CS programs from…curriculum providers don't provide insight to these students' needs." A few teachers expressed concern that students with disabilities wouldn't be able to use the technology they would need to take CS.

Another theme arose related to educators' expertise or encouragement of students with disabilities. These comments addressed classroom teachers, special education teachers, counselors, and administrators. Related comments included the following:

- "Intervention specialists have told me they feel intimidated by the content and don't know how to support IEPs."
- "A lack of information with most educators that show these students can do complicated things in CS despite their diagnosis."
- "Guidance counselors do not suggest or recommend CS to the students."
- "Not sure our administration understands how easily adaptable CS is for IEP students."

Other teachers' comments noted that there wasn't sufficient support for students with disabilities once they were in CS classes. Many comments indicated that students with disabilities don't get support from aides or paraeducators in their electives, but only in core courses. When CS isn't considered a core course, students with disabilities may not get this sort of support. Simply put, "Since this is a non-core class, SPED teachers are not required to assist in these classes." Others noted that there weren't enough aides to provide individual support in CS classes or that classroom teachers need more planning time in order to modify activities.

Finally, scheduling constraints also presented barriers for students with disabilities. Many noted that an AP designation meant that students with disabilities were not placed in CS courses. Others indicated that prerequisites or corequisites, particularly related to math, were barriers to students with disabilities. One teacher noted that these "students are not strong in algebra, which is a requirement for the CS Essentials and AP CSP course." Other teachers noted that students are encouraged to focus on core subjects or graduation requirements. Others noted that students with disabilities are pulled out of CS, because it is not a core class, in order to receive services or interventions. Many students with disabilities need to use their electives for support classes, which meant they didn't have room in their schedule to take CS. One teacher noted that, "The school often places these students in more intensive classes for math or language arts during elective time, therefore giving them fewer electives to choose from."

5.3.2 Student Choice. Many teachers indicated that students with disabilities were not choosing to take computer science because of a lack of interest in or awareness of CS; misconceptions about computing, including that it will be too difficult or inaccessible; or because of a lack of exposure to computers, role models with disabilities, or encouragement to take computing.

- "These students may struggle with anxiety or what they've been told about themselves. They may not think they are 'enough' to learn something technical, which has a connotation of being difficult."
- "Coding and advanced STEM courses are intimidating."
- "[They] don't think it applies to them. Perception, intimidation, and stereotypes. Some students believe you have to be super smart or others cannot relate or don't [have] a clear understanding of what computer science is all about."

5.3.3 Teacher Perceptions of Students' Abilities. The final theme that emerged was the teachers' perceptions that students' abilities presented a barrier. Some teachers merely answered the question with "ability" without further explanation. Other teachers pointed to concerns about executive functioning in students with disabilities, namely things like time management, concentration, and memorization. Perhaps related, others noted concerns about the behavior of students with disabilities. Other teachers noted the difficulty or pace of their course, language abilities related to reading or vocabulary, and math and logic skills. Related comments are below:

- "In order to learn the large amount of information for CS, students have to memorize a lot of abstract concepts, all of which must be retained to do the next thing. So the pace and volume of information are really tough for them."
- "Some of my students are easily distracted if an assignment has more than 4 steps that must be accomplished in a certain order."
- "Students with math learning issues struggle with the concepts if they take computer science too early in their high school career."
- "Reading disabilities, like dyslexia, make reading long lines of code a huge challenge."
- "Behavior tends to spike during specials."

Note that these comments reflect the perceptions of the teachers and may not reflect the actual abilities of students with disabilities.

6 DISCUSSION AND CONCLUSION

It is of note that 9.3% of the CS teachers surveyed indicated that they had a disability or chronic condition. This is higher than the 5.4% of the general workforce that has a disability and higher than the 6% of preK-12 teachers with a disability according to according to Census data [21]. It is important to note that the Census item about disability is different from that used in the landscape survey, making it difficult to make sense of this comparison [2, 22]. In particular, the Census data takes a functional limitations approach to the definition of disability, while the survey asked whether the teacher identified as having a disability or chronic condition. We found few differences between the experiences of teachers with disabilities and those without, but this could be an artifact of the specific survey; we caution that surveys done from different perspectives may be necessary. Future work on CS teachers with disabilities that asks explicit questions about whether their disability-related accessibility needs are met within their workplaces or within professional development (PD) may provide additional insight on the experiences of teachers with disabilities and suggest ways that school districts and PD providers can support CS teachers with disabilities.

In the survey, 20.4% of CS teachers reported teaching about accessibility. This is comparable to the rate at which CS is taught in postsecondary computing courses [23]. We found that teachers with disabilities were more likely to teach about accessibility. This may reflect that teachers with disabilities have more experience using assistive technology or encountering inaccessible technology. Indeed, similar work at the postsecondary level found that faculty who knew someone with a disability were more likely to teach about accessibility and that a lack of materials about accessibility presented a barrier [23]. Adding content and resources related to accessibility in PreK-12 CS curricula may increase the extent to which these teachers are including accessibility in their courses.

This survey reinforces the known inequity of access to CS education for students with disabilities. A total of 32% of survey respondents indicated that students with disabilities were underrepresented in CS at their school and 7.9% indicated they were overrepresented. The 2023 State of CS Education Report found that 10% of students in foundational CS classes had IEPs, despite being 15% of students and that 3% of students in foundational CS classes had 504 plans, which was the same as their proportion of the student population [24]. It may be that the over- or under-representation of students with disabilities differs between students covered under IDEA or Section 504, which may reflect a difference between students with different types of disabilities.

Our analysis of qualitative data regarding barriers faced by students with disabilities highlighted three themes. Namely, there are structural barriers within the school setting, students with disabilities are not choosing to take computer science, and teachers perceive that the abilities of students with disabilities present a barrier. Regarding teachers' perceptions, we feel the need to point out that these perceptions may not be accurate. Indeed, this may reflect a lack of expertise among educators about ways to engage students with disabilities in CS education. A key challenge that emerged from the overall survey was lack of administrator and counselor understanding and support for CS [13]. This lack of understanding and support may impact students with disabilities differently than non-disabled students in that they can experience both gatekeeping (i.e., they are excluded based on beliefs they are not able to participate or succeed) and dumping (i.e., overloading elective CS courses without consistent instructional supports, based on a lack of understanding of the academic nature of CS courses).

6.1 Limitations

We must note that there are limitations with the survey. We did not disaggregate the teachers' responses according to the grade level they taught. Disaggregating the data in such a way may provide additional nuance to our findings or highlight differences according to grade level. This is a direction for future work. Similarly, this analysis did not disaggregate by other characteristics of the schools, but doing so could provide further insight.

Furthermore, although the number of teachers who responded to the survey was large, it is not a random sample, which may limit the generality of the results. Some teachers who have a disability or chronic condition may have declined to identify that way in the survey.

Finally, the survey did not define "accessibility" on the item that asked about the skills and concepts that teachers taught. It is possible that teachers did not interpret this item to relate to teaching about accessibility of technology.

6.2 Recommendations

We believe that many of the barriers that teachers reported could be ameliorated through a combination of resources, outreach activities, and policies. With regard to resources, teachers directly identified a need for curricula with options for modification and differentiation options. As curriculum providers develop curricula, they should be attentive to including students with disabilities. It is also apparent that educators—including teachers, aides, and counselors—would benefit from learning about the inclusion of students with disabilities in CS education. Indeed, organizations offering professional development should ensure that their PD addresses the inclusion of students with disabilities. A report from the CSTA PD Committee supported this need, highlighting accessibility was one of the greatest needs for improvement across PD programs seeking accreditation [25]. It is imperative that PD reaches beyond just classroom teachers to ensure that students with disabilities are encouraged to take CS courses and supported in CS once they have chosen it. Indeed, prior work has shown that pre-service special education teachers who are exposed to CS education see the benefit of including students with disabilities in CS education [26]. Finally, it is also apparent that there are not sufficient resources within school districts to provide aides or other support to students with disabilities.

Given the concerns from teachers about students' lack of interest in CS or lack of confidence in taking a CS course, outreach activities that specifically target students with disabilities may be important. This might include ensuring that other outreach activities are accessible. Code.org's Hour of Code is a widespread outreach activity to expose students to coding and yet, it is very difficult to determine if the activities on the Hour of Code page are accessible [27]. Indeed, there are accessibility tags, but Code.org relies upon organizations to attest to whether they are accessible. Many of the activities marked screen reader accessible are not actually accessible. Imagine the frustration a blind student (or the teacher of a blind student) might experience in trying to find an accessible resource.

Finally, policies can support the inclusion of students with disabilities and address the barriers referenced by teachers. It's worth noting that many teachers reported that students would not receive services outside of core classes. One teacher in a school district noted that because all students in their district had to take CS, students with disabilities received the services they needed in CS. Requiring all students to take CS also ensures that students who might otherwise not elect to take CS are exposed, addressing the second theme among the barriers identified by teachers. In addition, policies that directly address the inclusion of students with disabilities can have a real impact. Following the passage of a law that addresses this, the state of Maryland has actively sought out curricula and tools that are accessible to students with disabilities [28].

The large-scale nature of the landscape survey and the explicit questions asked about disability and accessibility give new insight regarding how we can ensure that students with disabilities have access to CS education in preK-12. Together, there are steps we as a community can take to address barriers. Note that there are also a number of resources to support this work. Notably, the CSTA has already done a lot to ensure that students with disabilities are well served in computer science classes which aligns with their stated commitment to equity. They sponsor the CSAccess Working Group that works on providing resources to teachers about accessibility and universal design for learning [29]. In addition, Maya Israel's Creative Technology Research lab has done significant work on using universal design for learning in CS [30], the Quorum programming language provides accessible tools and curricula [31], and the AccessCSforAll project [32] provides individualized support to help educators meet the needs of students with disabilities.

ACKNOWLEDGMENTS

This work is supported by the National Science Foundation under Grant Nos. 2121993, 2122189, 2106392, and 2118453. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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