Maya Israel (University of Florida / Creative Technology Research Lab)

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Equity principles for including learners with disabilities in K-12 CS education

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Abstract

To truly consider equity and inclusion in K-12 computer science (CS) education, we must take active steps to include all learners, including those with disabilities. Although teachers are committed to supporting all learners in CS education, they often report that they lack the pedagogical strategies to adequately meet the needs of all these learners. This chapter has two aims. First, it highlights what we currently know about the inclusion of students with disabilities in K-12 CS education from an equity perspective. Second, this chapter also frames Universal Design for Learning (UDL) as an approach that can be used to more meaningfully include all learners in CS education by highlighting instructional strategies that result in increased participation, learning, and belonging of students with disabilities in K-12 CS education.

Introduction

Although there has been growing attention to equity and inclusion of all learners in K-12 computer science (CS) education, this attention has often not included the participation of learners with disabilities. This lack of attention has resulted in both a limited understanding of the extent to which students with disabilities are included in CS education as well as lack of pedagogical approaches that teachers can use to include students with disabilities in their CS instruction. The purpose of this chapter, therefore, is to outline four equity principles that can guide the discourse about the participation of students with disabilities in K-12 CS education.

CS equity principles

Equity principle 1: Learner variability is the norm and is an asset in the CS education classroom

When looking into most K-12 classrooms, it quickly becomes clear that learner variability is the rule, not the exception (Pape, 2018, Rose, 2016). Students have a range of expertise, background knowledge, languages, strengths, and challenges. Additionally, this variability is not static; strengths in one area do not predict strengths in other areas. For example, some learners will have strong visual spatial abilities but struggle with planning projects that require multiple steps. Other students will have experience with coding open-ended computational artifacts but when asked to apply those skills within the context of a CS plus math lesson, they may struggle with generalizing these skills because of limited understanding of the mathematical concepts integrated within the CS lesson. Thus, we all have a jagged learning profile; strengths in one area do not necessitate strengths in others (Rose, 2016). Thus, CS teachers work in classrooms that are diverse, so designing learning experiences for the average learner makes little sense.

When considering the participation of students with disabilities within this context, we normalize disability as part of the human condition. It is simply part of the variability that exists in society. In the United States, for example, according to the National Center for Education Statistics (2021), there are currently approximately 7.3 million children receiving special education services due to a disability (Irwin et al., 2021). Additionally, disability should be considered part of the human condition rather than something different or outside of the "normal" experience. In fact, the World Health Organization (2002) situated disability as part of typical human functioning. Similarly, the Individuals with Disability Education Act (IDEA, 2004), which is the legislation in the United States that guides services for students with disabilities, begins with the statement, "Disability is a natural part of the human experience and in no way diminishes the right of individuals to participate in or contribute to society." It is important to note that, like all people, this group of learners is not homogeneous, and they bring unique lived experiences, knowledge, and perspectives into their learning environment. Additionally, the majority of these learners are taught alongside their peers in general education settings, so teachers should assume that their CS classroom will include learners with disabilities. When we acknowledge learner variability from this perspective as well as this data, it no longer becomes acceptable to design instructional experiences that are "one size fits all". Instead, instruction should be designed and flexible enough to include all learners.

Equity principle 2: All learners, including those with disabilities, deserve to be included in K-12 CS education

For meaningful participation of all learners to occur, we must challenge our assumptions about who belongs in CS. Making the stand that all learners, including those with disabilities, deserve the opportunity to be included in CS education is a critical step towards access and equity in CS education (Ladner & Israel, 2016). When this shift takes place, teachers realize that students with disabilities are an integral part of their classrooms. This shift also showcases the strengths of learners with disabilities as their participation finally is acknowledged as meaningful and impactful on the classroom community, thus countering the deficit perspective often associated with learners with disabilities.

Who has access to CS becomes complicated when examining access by disability categorization. In fact, it is difficult to know the extent to which students with disabilities are included in K-12 CS education due to issues such as confidentiality, how disability is classified, and permission to ask for sensitive information such as disability status in educational research (Blaser & Ladner, 2020). A recent study in New York City Public Schools showcased the complexity of studying the participation of students with disabilities in CS education, as students with some disabilities were included to a greater or lesser extent than students with other disabilities. In this study, Fancseli and Israel (2021) concluded that, when examining the data in aggregate, students with disabilities were included in CS education at a rate similar to students without disabilities. However, when examining that data by students' disability categorization and grade level, students with certain disabilities were included at lower and higher rates than their peers and students with other disabilities. For example, although 9.5 % of high school learners in New York City Public Schools take CS coursework, only 6% of students with learning disabilities do so, but 12.6% of students with Autism take high school CS. This phenomenon can be explained by other research suggesting that teachers' views towards inclusion of students with disabilities often relate to teachers' views of who has the necessary

Table 1. Barriers to inclusion of learners with disabilities in K-12 CS education.

Barriers to inclusion	**Examples**
Systemic barriers	- Inaccessible CS curricula, tools, and materials developed and adopted widely - Biases of decision makers about who belongs in CS
School-level barriers	- Scheduling priorities wherein students must leave CS instruction to receive specialized instruction (e.g., reading support, speech therapy) - Lack of CS professional development aimed at special education teachers and instructional aides - Lack of professional development in inclusive practices aimed at CS teachers - Lack of available assistive technologies for students to use alongside CS tools - Lack of accessible curricula, tools, and materials
Classroom-level barriers	- Biases about the abilities and motivations of some learners - Teachers' limited knowledge of inclusive pedagogical practices - Over- or under-supporting students based on assumptions of competence (or lack of competence) rather than on data

abilities and dispositions to succeed in the CS classroom (Israel et al., under review). These studies point towards the need to (a) examine participation in CS in a more in-depth way, and (b) not lump all students with disabilities into a single category. Thus, the belief that all students should have access to CS manifests both initiatives that examine participation data in order to address any participation gaps as well as beliefs and actions of individual teachers that promote participation and inclusion.

Equity principle 3: Understanding barriers and pathways to inclusion and access in CS education is critical

Inclusive CS education that meaningfully includes learners with disabilities cannot occur without a thorough examination of both the barriers and pathways to participation. This examination must focus not only on whether students with disabilities are enrolled in CS education, because simply placing children in a CS classroom does not guarantee that they will have meaningful educational experiences (Israel et al., 2020 under review). Thus, we must use an ecological systems approach that examines barriers and pathways in the classrooms, schools, and broader systems that influence decisions about participation. Table 1 provides some barriers at different levels along with examples of such barriers.

The barriers in Table 1 are not simple; consequently, solutions might require a great deal of coordination and effort. When we begin

Table 2. Pathways to inclusion of students with disabilities in K-12 CS education.

Pathways to inclusion	**Examples**
Systemic barriers	- Wide-scale expectation for the development of accessible CS curricula, tools, and materials - Advocacy by decision makers about CS for all learners across school environments - Inclusion of disability as part of the inclusive CS education discourse
School-level pathways	- Availability of CS education to all students, across instructional settings - Scheduling that allows students to attend both CS instruction as well as specialized instruction - Time allocated for co-planning between CS educators and specialized instructors such as special education teachers and English as a Second Language (ESL) educators - Institutionalization of co-teaching in CS classrooms to ensure necessary individualization as needed - Access to assistive technologies in CS classrooms
Classroom-level pathways	- Teachers' commitment to meaningful participation of students with disabilities in CS education - Teachers' use of inclusive pedagogical approaches such as Universal Design for Learning - Classroom-level advocacy for the participation of all learners in CS education (advocating for students to not be removed from CS instruction)

to unpack and understand these barriers, we can start considering ways of addressing them and creating pathways to inclusion. For example, if a school recognizes that many students do not attend CS instruction because specialized instruction is scheduled for the same time, school administrators, teachers, and other service providers can work together to address this scheduling challenge. Specialized instruction (e.g., intensive reading intervention) can take place at a different time. Alternatively, specialists can work within the CS instructional context. For example, the speech therapist might reinforce communication skills during CS instructional time. Table 2 provides some common pathways and examples.

Equity principle 4: Proactively designing instruction to account for the range of learners is key to successful inclusion

In addition to challenging common assumptions about who belongs in CS education and understanding barriers and pathways, it is critical to use pedagogical practices focused on inclusion and accessibility. One such approach is the Universal Design for Learning (UDL) framework, which is a proactive approach to

Table 3. UDL principles and applications in K-12 CS education.
Note. Adapted from Israel, M., Lash, T., Ray, M. (2017).

UDL principle	**Explanation**	**Examples in CS education**
Multiple means of engagement	Learners come into classrooms with different motivations and different ways that they engage in content. Thus, providing different ways of engaging learners is critical.	- Provide choice in student projects - Provide supports and extensions in projects - Model perseverance and problem solving - Break up coding activities with opportunities for reflection such as “turn and talks” with peers
Multiple means of representation	Learners differ in how they prefer to acquire and process information. Thus, having a range of representations is critical.	- Provide access to video tutorials of computing tasks - Select coding apps and websites that allow students to adjust visual settings (e.g., font size, contrast) - Provide graphic organizers and anchor charts with reference to blocks or relevant syntax
Multiple means of action and expression	Learners differ in how they best demonstrate and express their understanding. Thus, providing options for how students demonstrate their learning is critical.	- Include unplugged activities that demonstrate the physical relationship of computing concepts - Provide multiple entry points into computational projects - Guide students to set goals for long-term computational projects

planning instruction that reduces barriers to learning and empowers all learners to become expert learners (Hitchcock et al., 2002). This framework assumes that there is no single instructional approach that is optimal for all learners in all contexts. Thus, we must build flexibility into our instruction, tools, and materials so that we can reach all learners. UDL has three major principles that provide guidance in how to consider instructional flexibility. Within each of the three principles, there are guidelines and checkpoints that provide the details of how to enact those principles. The UDL principles can be applied within all aspects of instruction, including the curriculum that is chosen as well as how it is enacted (Burgstahler, 2009; Burgstahler, 2011). Table 3 provides a summary of these principles and guidelines alongside examples for CS education. An example of a UDL-based instructional activity involves developing a “multiple entry point” activity wherein students have options between like-activities that have differences in the level of scaffolding provided. Teachers can, thus, provide options wherein students choose between computational tasks that include:

- Playing and remixing a Scratch project that has already been constructed.
- Debugging a program that has errors using the same “play and remix” project.
- Constructing from a “exploded” code project wherein students reconstruct code that has been deconstructed using the same “play and remix” project.
- Extending beyond the original project with additional tasks and steps. Students are not told which option to pick but can toggle between projects, and all participants meet learning objectives, and are meaningfully included in the classroom activity.

Illustrative example from the field: BrowardCODES-for-All project

The BrowardCODES-for-All project was a collaboration between BrowardCODES, the computer science education initiative in Broward County Public Schools[7] and the Creative Technology Research Lab at the University of Florida[8]. It focused on professional development (PD) aimed at special education teachers in Broward County Public Schools to encourage them to integrate CS into their instruction in a way that meaningfully meets the needs of their learners. This PD included topics such as how to integrate UDL into CS education, individualizing CS instruction for students who had more significant needs, Florida CS standards, cross-curricular connections (e.g., literacy and math instruction), exploration of accessibility features within CS software and hardware, and a lot of time for play and exploration. Additionally, time was reserved to discuss ways of overcoming challenges that the teachers experienced. Challenges ranged across three main areas:

1. Access to tools and resources: Through grant funding, teachers were given tools such as Wonder Workshop Dash and Sphero robots, extensions such as the Wonder Workshop Puzzlets pack for Dash robot. However, they did not receive whole-class sets. This limited set of tools resulted in challenges when the teachers wanted to implement whole-class instruction using these devices. Discussions related to overcoming these barriers primarily focused on ways of organizing center-based learning stations, bringing in more unplugged activities, and utilizing pair programming so that two learners can share a device.

2. Accessibility challenges: Teachers described the need to support students with low vision or mobility issues. A considerable amount of time was spent exploring features within the tools themselves (e.g. the capability of the Sphero robots to be navigated using voice and swiping commands). We also had discussions about adding Braille to the Puzzlets tool so that students with low vision could utilize that tool to program the Dash robot to move rather than using touch-screen devices, which were not accessible to students who are blind or have low vision.

3. Instructional approach challenges: Other challenges that the teachers described focused on which instructional strategies would engage learners best. The teachers reported that their students were often frustrated when their code did not work as intended or, during pair programming, the navigator was not as engaged as the driver. These sets of challenges were discussed as opportunities to introduce UDL-based instructional approaches such as teaching effective collaboration strategies with consistent feedback, clear goal setting, and acknowledging and celebrating persistence and learning through failure.

Through this PD, the special education teachers created lesson plans that they implemented in their classrooms. They used a combination of

[7] https://www.browardschools.com/Page/35959
[8] https://ctrl.education.ufl.edu/

UDL-based approaches alongside individualized support so that all their learners could engage meaningfully in CS education.

Conclusion

The inclusion of students with disabilities in CS education is just emerging in the CS education discourse. The limited research that does exist points to the promise of approaches such as UDL (Israel et al., 2020), but also points to the need to provide teachers with professional development and other support so that they can best meet the needs of all their learners (Israel et al., 2018). Many additional research questions remain about how to best serve this population of learners. Fancseli and Israel (2021) outlined some of these major questions that included: To what extent is participation of students with disabilities influenced by attitudes and perceptions about who belongs in CS? And given the intersectional nature of disability with other factors, what is the relationship between CS participation, disability status and other demographic factors such as race/ethnicity, socioeconomic status, and gender? Other questions remain about the relationship between inclusive educational practices and the learning outcomes of all learners, including those with disabilities.

Additional resources

- The UDL Principles can be found at CAST: https://udlguidelines.cast.org/
- Application of UDL in K-12 CS education can be found at the Creative Technology Research Lab at the University of Florida website: https://ctrl.education.ufl.edu/wp-content/uploads/sites/5/2020/05/Copy-of-UDL-and-CS_CT-remix.pdf
- Further resources about access and inclusion in CS education can be found at the AccessCSforAll Center at the University of Washington: https://www.washington.edu/accesscomputing/accesscsforall

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