Equity and Inclusion through UDL in K-6 Computer Science Education: Perspectives of Teachers and Instructional Coaches

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Through a mixed-methods approach that utilized teacher surveys and a focus group with computer science (CS) instructional coaches, this study examined elementary teachers' confidence in meeting the needs of students with disabilities, the extent to which the teachers could use the Universal Design for Learning (UDL) framework in CS education, and the strategies that their CS instructional coaches used with them to help meet the needs of all learners, including those with disabilities. Findings from a Wilcoxon signed-rank test and a general linear regression of the teacher surveys revealed that teachers' confidence in teaching CS and in meeting the needs of students with disabilities increased over the 5 month coaching study, but their understanding of UDL remained low throughout the study. A qualitative thematic analysis of open-response survey questions revealed that the teachers could identify instructional strategies that support the inclusion of students with disabilities in CS instruction. These strategies aligned with high leverage practices (HLPs) and included modeling, the use of explicit instruction, and opportunities for repeated instruction. When asked to identify UDL approaches, however, they had more difficulty. The focus group with coaches revealed that the coaches' primary aim related broadly to equity and specifically to access to and the quality of CS instruction. However, although they introduced UDL-based strategies, they struggled to systematically incorporate UDL into coaching activities and did not explicitly label these strategies as part of the UDL framework on a consistent basis. This finding explains, to a large extent, the teachers' limited understanding of UDL in the context of CS education.

CCS Concepts: • **Social and professional topics → K-12 education;**

Additional Key Words and Phrases: Students with disabilities, universal design for learning, CS instructional coaching

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1 INTRODUCTION

Increasingly, there is an expectation that every K-12 student should have access to **computer science (CS)** education. Although there are multiple factors driving the push for CS for All, including the need to prepare learners for technology-centered jobs, the essence of CS for All is deeply rooted in a call for educational equity [42]. This focus on equity has primarily been driven by a push to improve the historical and continuous under-representation of women and people of color in computing instruction and careers (e.g., [27, 37, 48]). More recently, as part of the CS equity movement, there has been growing attention to the inclusion of people with disabilities in CS education (e.g., [8]). The researchers and practitioners calling for disability to enter the CS for All equity discourse have pointed to the lack of focus on accessibility, inclusion, and participation of students with disabilities in K-12 CS education. The lack of attention to students with disabilities has resulted in a lack of accessible computational tools, limited understanding of specialized instructional approaches that address the needs of students with disabilities, and reduced commitment to the inclusion of students with disabilities in K-12 CS education [23]. This lack of inclusion not only denies students with disabilities their right to access the general curriculum, but also excludes them from a subject area meant to prepare all students to become computationally literate citizens in a digital world.

Access and inclusion affects millions of children in the United States. According to the National Center for Education Statistics (2021), approximately 7.3 million children receive special education services under the **Individuals with Disabilities Education Act (IDEA)** [35], which is a federal law that requires that students with disabilities receive a free and appropriate education in the least restrictive environment. Another large group of learners receive accommodations and supports under Section 504 of the Rehabilitation Act of 1973, which is a civil rights law prohibiting discrimination of people with disabilities. It is important to note that most of these learners are educated in general education settings alongside their peers [35]. Thus, any teacher who is providing CS instruction likely has students with disabilities in their classrooms. Not considering their instructional needs during CS education thus results in a lack of access to the general curriculum and perpetuates the stigmatization and *otherizing* of these learners.

Students with disabilities must have access to the general curriculum, including CS learning opportunities. However, students with disabilities are less likely to be included in CS education [7] and, even if they are included in such initiatives, they are more likely to be segregated from their peers by being given other activities because their teachers lack expertise in inclusive CS pedagogies [17]. Traditional models of education in which students with disabilities are separated from their peers and/or otherized through deficit-based models, have led to stark differences in outcomes for these students, including higher dropout rates, limited employment opportunities, lower college graduation rates, and higher rates of incarceration [46]. Simply placing a child in a general education (or CS) classroom, however, will not guarantee better outcomes or an effective education. Studies about teachers' attitudes toward inclusion show that teachers often view inclusion as a privilege that depends on certain biological traits rather than on their instructional practice [24]. This focus on students' physiological traits as a *ticket to inclusion* absolves teachers from feeling responsible for instructional failures. Simply put, many teachers view inclusion as a privilege reserved for those learners with disabilities who already have the necessary skills, abilities, and dispositions to succeed in the classroom [21].

In order for real change to occur, we must not only challenge the commonly held assumptions about who belongs in CS education, but also actively promote effective pedagogical practices and tools focused on inclusion and accessibility. Although there has recently been greater emphasis on the inclusion of students with disabilities in K-12 CS education, much of this discussion has focused on advocacy and the overall importance of access and inclusion while less attention has been paid to specific instructional approaches that promote full participation and learning [40]. Thus, in order to avoid the commonly circulating discourse of disability from a deficit perspective, our focus must shift to include efficacious, research-based instructional approaches in these conversations. Without a focus on both advocacy and effective practices, the change in classrooms will be insufficient to meet the goal of equity and accessibility for all.

2 INCLUSIVE INSTRUCTIONAL APPROACHES IN K-12 CS EDUCATION

As the majority of students with disabilities are educated alongside students without disabilities, teachers are held accountable for their progress according to the grade level curriculum standards, including in CS. While access to the same curriculum and educational standards is an improvement to historical practices of exclusion and sub-standard instruction, teachers often do not receive the preparation and support necessary to ensure student success. Although practices teachers commonly use, such as differentiation or providing accommodations and modifications, are essential to meeting the individualized needs of learners with disabilities, they may not always adequately adjust to the complex factors of inequity that present barriers for these learners. Using these strategies to expand learning opportunities is helpful, but we need to also consider strategies that promote inclusion and participation more broadly.

Despite the limited attention to the inclusion of students with disabilities in K-12 CS education, there is a growing body of literature that points toward promising instructional approaches. Rather than focusing on fixing problems inherent within the learners (i.e., deficit models of disability), these approaches are based on the assumption that certain instructional practices can increase access and engagement for all learners (i.e., social construction of disability). Thus, these pedagogical practices flip the narrative from blaming the learner toward an emphasis on reducing barriers to learning. These instructional approaches include **Universal Design for Learning** (**UDL**) [14] and **High Leverage Practices** (**HLPs**) [30].

2.1 Pathway to Universal Design for Learning in K-12 CS Education

The roots of **Universal Design** (**UD**) were first established in the 1950s by civil rights legislation that addressed concerns of social justice. In the following decades the disability rights movement and activists gained prominence leading to the emergence of the UD paradigm [12]. The increased activism led to the expansion of UD through disability rights legislation (e.g., American with Disabilities Act, Section 504) as well as design of products by private entities to address the growing population of older individuals and individuals with disabilities [38]. The UD movement aims to establish a universal standard of designing environments, buildings, and products that are accessible and usable by the widest possible spectrum of diverse learners [25]. Classic examples of UD are ramps to building entrances, curb cuts, and automatic doors. Each of these ensures access to individuals with disabilities and also benefits parents pushing strollers, children riding bikes, and delivery workers. While UD aims to ensure usable and accessible products, environments, and programs to a diverse population, UDL extends the construct to address the critical issue of proactively designing learning experiences that will be usable and accessible to a diverse population of students, including students with disabilities [34].

UDL is an instructional approach focused on reducing barriers to learning and empowering students to become expert learners [14]. A primary tenet of UDL is that there is a great deal of variability in the way all students, with or without disabilities, engage and learn, so we should no longer design instructional experiences in a "one size fits all" manner. Thus, instruction must be flexible enough to meet the needs of a broad range of learners. UDL provides a framework for considering such flexibility by introducing three broad principles: (1) multiple means of engaging and motivating learners; (2) multiple means of representing information so students can perceive and comprehend that information; and (3) multiple means for providing students opportunities to express what they know and navigate the environment in which they learn. Although UDL is not exclusively geared toward students with disabilities, it has been shown in multiple studies to increase learning, engagement, and inclusion of students with disabilities across subject areas (e.g., see review of literature by [36]).

Within K-12 CS education in particular, UDL has started to emerge as an effective method of meeting the needs of all learners. The literature attesting to this has provided a framing for how to apply UDL within the context of elementary and middle school instructional settings (e.g., [17, 19]) and has suggested professional development approaches to support teachers in implementing UDL-based CS education [41]. These studies point toward methods of making CS instruction more flexible in order to facilitate greater participation among all students, including those with disabilities. In examining the implementation of UDL-based CS instruction, Israel and colleagues (2020) found that teachers primarily applied UDL to CS education by representing content in multiple ways, offering students choices in the types of computational artifacts they created and optimizing engagement by making CS activities personally relevant [16]. Ray and colleagues (2018), however, found that teachers required a great deal of professional development and coaching in order to apply UDL in an efficacious manner. Without such support, teachers' implementation of UDL tended to be more superficial [41]. Both studies reinforced the idea that application of UDL is contextual, showing that it is implemented differently based on the instructional goals and needs of the students. Beyond these, few studies have examined the implementation of UDL in K-12 CS education, the views of teachers about UDL implementation, or the relationship between factors such as teachers' expertise in CS instruction, their attitudes about UDL, and their beliefs about their own abilities to meet the needs of students with disabilities in elementary CS education.

2.2 High Leverage Practices in K-12 CS Education

Design and implementation of equitable and accessible instruction for students with disabilities must be grounded in effective instructional practices. Researchers [26] have identified a common set of evidence-based practices that support student growth and achievement. These practices, however, have not been consistently implemented. Unfortunately, the limited utilization of evidence-based practices has resulted in a failure to ensure accessibility of instruction to all students or to adequately address the unique needs of students with disabilities [31]. In response to this research-to-practice gap, scholars in collaboration with the **Council for Exceptional Children** (**CEC**) created a comprehensive set of HLPs critical to ensuring high-quality instruction that meets the individualized needs of students with disabilities. The CEC published a collection of 22 HLPs that, when implemented, support students with disabilities through effective collaboration, assessment, social-emotional-behavior support, and instruction [32]. Instructional HLPs such as adaptations to instructional tasks, explicit instruction, scaffolded support, and strategies to promote engagement are widely accepted approaches that can support learning for a broad range of students who struggle academically. The use of HLPs within subject area instruction, including in CS, will lead to improved outcomes for diverse student populations.

Despite the effectiveness of HLPs, the CS education literature does not explicitly call out these practices as HLPs. For example, several studies utilized explicit instruction by providing think-alouds with step-by-step demonstrations, bringing attention to features in programming interfaces, but these studies do not connect explicit instruction to HLPs. Table 1 provides specific examples of practices that align with HLPs in CS education.

Table 1. Aligning HLPs to CS Education Studies

HLP	Example in CS Instruction
#13 Adaptations to curriculum and tasks	Hansen and colleagues used differentiation and UDL to support 4th–6th grade students with a range of instructional needs during programming instruction [13].
#15 Provide scaffolded supports	Touretzky and colleagues designed a three-stage CS instructional progression that included a highly scaffolded approach to programming in a summer camp for students ages 10–17 [45].
#16 Use explicit instruction	Ray and colleagues (2018) described case studies where teachers used explicit instruction within the context of more open-ended CS inquiry activities to make those activities more engaging and accessible to elementary students with disabilities [41].
#18 Promote active engagement	Israel and colleagues (2020) studied academic engagement of students with autism during elementary computer science instruction [17] and considered engagement along three dimensions: (a) engagement with the computational activity, (b) engagement with peers, and (c) engagement with teachers.

2.3 High-Quality CS Professional Development through Coaching

To counter the narrative of conditional inclusion in which students with disabilities are not viewed as full participants, teachers need further education in inclusive pedagogical design and instructional practices that support the learning of all students. **Professional development** (**PD**) is a powerful approach for promoting changes in teachers' knowledge and practice [5]. There is evidence that following participation in high-quality PD, teachers can increase their content and pedagogical knowledge, leading to improved student outcomes [11].

One commonly used PD model to support teachers is coaching. Instructional coaching is considered a high-impact PD model because it can be designed to incorporate critical features of effective PD including content focus, active learning, job-embedded collaboration, models and modeling, expert support, and opportunities for feedback and reflection [4, 6]. Studies have shown that coaching is a particularly effective method of transferring teacher learning from PD contexts to classrooms and may improve the rate that instructional practices are adopted by as much as 80% [4, 20, 39, 47]. A coaching model of PD allows for the development of partnerships between teachers and coaches through which they can proactively analyze their unique teaching contexts, identify goals, and work collaboratively to improve instructional practices in order to reach them [22]. Since PD in CS education not only introduces teachers to an entirely new content area, but also instills high-quality and inclusive instructional practices, coaching is particularly suited to it. Table 2 illustrates practices embedded in a coaching model for each feature of effective PD.

2.4 Purpose of this Study and Research Questions

The purpose of this study was to unpack how these variables affect teachers' confidence in meeting the needs of students with disabilities. Given the limited research regarding the implementation of accessible and inclusive K-12 CS education, this study has two primary foci: investigating K-6 teachers' comfort in teaching CS to students with disabilities and investigating how CS instructional coaches provide support to teachers in instructing learners with disabilities. Research questions include the following:

(1) How confident are elementary teachers in supporting students with disabilities in CS education?

Table 2. Application of High Quality PD in CS Education Coaching

Feature of Effective PD	Application to CS Coaching
Content-focused	CS coaching is focused around CS/CT content, and often supports teachers as they develop fluency with CS content [29].
Active learning	During coaching, teachers develop, teach, and reflect on CS lessons with the support of an expert.
Job-embedded collaboration	Teachers collaborate with coaches to co-plan CS instruction, and they may also co-teach CS lessons that contain new content [18].
Models & modeling	Coaches not only provide teachers with models of common CS learning activities and projects, but may also engage in model teaching while coaching.
Coaching & expert support	Coaches are able to provide expert feedback on content and pedagogy, while providing the personal connection and safe space needed for teachers to challenge beliefs and examine their values [28].
Feedback & reflection	Feedback and reflection is core to the coaching cycle.
Sustained duration	Coaching is designed to be developed as a sustained, supportive relationship between the coach and the teacher that builds teacher resilience [1].

(2) To what extent does instructional coaching influence teacher confidence in teaching CS to students with disabilities?
(3) How familiar are elementary teachers with using the UDL framework to support all students in CS education?
(4) Which factors do teachers consider efficacious for successfully including students with disabilities in CS education?
(5) How are CS instructional coaches addressing inclusion and UDL in their coaching practices?

3 METHODS

This study made use of a sequential mixed-methods approach [3] that included two data sources: online pre- and post-surveys administered to teachers in the fall and spring of the 2019–2020 academic year and a follow-up focus group with the instructional coaches who worked with them on implementing CS in their classrooms.

3.1 Participants

This study took place in two schools in a large, urban school district in the Northeast that implemented a district-wide CS for All initiative. Tables 3 and 4 provide demographic information of these schools. Both schools had students who received special education services under IDEA. In school 1, 21% of the student population had an **individualized education plan** (**IEP**) for an identified disability, and in school 2, 11% of the student population had an IEP. Students in both schools also received accommodations under Section 504 of the Rehabilitation Act of 1973. Due to the ways schools collect data about disability, the number of students with 504 plans or with diagnosed disabilities who do not have an IEP is unknown. At both schools, the majority of students with IEPs had high incidence disabilities, which fell under the IDEA categories: Specific Learning Disability, Speech or Language Impairment, Autism Spectrum Disorder, Other Health Impairment, and Emotional Disturbance. While a handful of students were taught in separate special education classrooms, the majority of students with IEPs were taught in inclusive settings that could range

Table 3. School Race Demographics 1

	Race				
	Asian	Black	Hispanic	White	Other
School 1	3%	8%	86%	2%	1%
School 2	32%	11%	15%	35%	7%

Table 4. School Demographics 2

	Free/Reduced Lunch	Students with Disabilities	English Language Learners
School 1	90%	21%	29%
School 2	27%	11%	15%

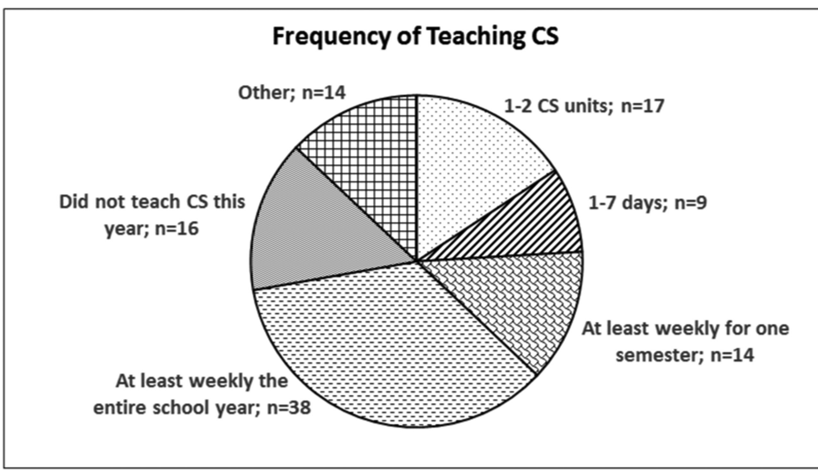

Fig. 1. Teachers' reports of Frequency of Teaching CS.

from one to two students with IEPs to up to 40% of the class being made up with students with IEPs.

3.1.1 Teachers. CS instructional coaching and PD that emphasized inclusion of students with disabilities was implemented across both schools. Overall, 108 teachers and four instructional coaches who worked with them provided consent and participated in this study. At the end of the study, the 108 participants that responded to the post-survey were asked how frequently they taught CS during the academic year (see Figure 1).

The 14 participants (13%) that responded "Other" gave more descriptive answers including details about specific concepts they taught, such as computational thinking, or that they were co-teaching or not in a position to teach CS in a classroom. The participants also described how they taught CS during the year and could identify more than one answer. 60 participants taught CS as a stand-alone class, 62 integrated CS into another subject area, 9 taught CS as an after school or lunch club, and 16 stated that they did not teach CS this year.

Of the 108 teachers, 66 responded to both the pre-survey and post-survey. These 66 teachers' surveys were used for the pre/post analysis. Of these 66 teachers, 37 were general education teachers, 16 were special education teachers (across resource, co-teaching, and self-contained settings), six were school-based coaches (such as technology, math), three taught gifted and talented, and four taught English as a New Language. These teachers had a range of teaching experience from teachers in their first 3 years of teaching to teachers who have taught for more than 30 years. Almost half of the teachers had not taught CS previously (n = 29) while 26 had taught CS for 1 year, 12 taught CS for 2 years, four teachers taught CS previously for 3 years, and three teachers taught CS for 4 years.

3.1.2 CS Instructional Coaches. Four coaches participated in the study. Coach A had 4 years of coaching experience with a background in informal education programs. Coach A's focus was on collaborating with teachers to design CS experiences that fit into their school culture and courses. Thus, Coach A spent a majority of coaching time introducing teachers to new content and co-developing learning activities for students. These activities ranged from unplugged computational thinking at one school to a physical computing program at another school. Coach B had 2 years of CS coaching experience with a background as a technology teacher and instructional technology coach. Coach B focused on working with teachers and administrators to refine CS curricula and create consistency in the school's CS initiative. This coach provided a deeper dive for teachers who had CS experience through working with them to modify and refine their existing lessons with a focus on accessibility and equity for all of the students in their classes. Coach C had 5 years of coaching experience with a background in CS education as a classroom teacher and program developer. Coach C focused on the role of a coach as a trusted resource within a school community. This coach worked with a team of teachers in leadership roles to expand their CS program, offered PD, co-planned with grade teams, and provided co-teaching. The focus was on universal computational thinking, while phasing in CS gradually, one grade team at a time. Coach D was considered the "lead coach" as Coach D facilitated the community of practice for the other coaches, provided the coaches with PD on effective coaching practices, and supported the other coaches in CS coaching in their instructional settings. Coach D had 5 years of CS coaching experience. This coach also had a background in special education and UDL. Because of Coach D's unique role, this coach did not provide direct services to schools and teachers, but rather focused on facilitating the CS coach community of practice for the other coaches and worked on coach development. This coach was also part of the research team and supported school-based data collection efforts.

3.2 Equity-Based CS Coaching Intervention

The CS coaching intervention included both PD aimed at the CS instructional coaches and the subsequent coaching and support that the coaches provided to the teachers.

3.2.1 Support and PD for the Instructional Coaches. In order to support the CS instructional coaches in providing coaching in UDL-based CS education, the coaches participated in their own professional learning throughout the study. At the beginning of the school year, the CS instructional coaches participated in a 2-hour workshop focused on applying the UDL framework to CS education. This workshop included an overview of UDL in general, the UDL guidelines with CS-specific examples, and a practice session for co-planning with teachers using a UDL perspective. This overview was presented as a short talk that touched on the myth of the average learner, the neuroscientific basis of UDL, and a description of the current landscape of CS education for students with disabilities.

The next phase was a group activity that modeled co-planning using the UDL framework. Coaches identified learning goals as well as potential barriers to instruction. They then thought about how to apply the UDL framework by offering multiple means of representation, engagement, and action and expression. Coaches were provided with examples and also co-planned a sample lesson as a group. They then examined examples of UDL implementation from real classroom environments. Finally, the coaches discussed what it would look like for them to integrate

UDL into their coaching and how they could do that consistently across the team. This initial workshop was followed by ongoing weekly meetings where they discussed their coaching activities. Additionally, the coaches worked together to design and iterate on supports to be used during coaching sessions in order to keep UDL central to the coaching process. With the support of Coach D and a university-based UDL expert, the coaches discussed their approach to incorporating UDL into coaching, developed UDL-specific coaching tools, and discussed problems related to implementation. Coaches also were provided with a template for UDL professional development and were asked to incorporate UDL concepts into the PD they offered to the teachers with whom they worked.

3.2.2 CS Instructional Coaching Model. The goal of the CS instructional coaching model was to establish and support CS for All initiatives that persisted beyond the duration of coaching support. Each participating school made a commitment to developing a CS education program for either a whole grade level or across the whole school. Schools were assigned a coach who became part of the school community. In addition to CS instructional coaching, each coach consulted with administrators and teacher leaders to either develop or expand the school's CS program. They also provided on-site, CS content-focused PD for teachers throughout the school year. UDL was central to the implementation of the coaching model. This focus on UDL began with the PD offered to the coaches, and then extended to the collaborative interactions between the coaches and teachers. Coach D had extensive expertise in UDL while the other coaches had a range of knowledge in UDL implementation. Thus, the three direct service coaches completed a 2-hour initial UDL PD with Coach D and others from the research team. The primary focus of the coaches' work was to provide equity-focused coaching to teachers through an iterative coaching cycle that involved co-plan/co-teach/debrief. During the co-planning stage, the coach worked with a teacher or team of teachers to plan units and lessons that included CS instruction. The coach also helped to address content knowledge gaps during this stage, provided a planning structure, asked the teacher open-ended questions to prompt pedagogical conversations, and prepared the teacher for implementation. During the co-teaching stage, the coach taught the class alongside the teacher. The coaches used different models based on teacher growth needs including model teaching by the coach and *one teach, one assist* in which the coach observed while providing subtle instructional prompts to the teacher. During the debriefing stage, the teacher and coach reflected on the lesson, the coach offered feedback, and the teacher set goals for the next session, incorporating the reflection and feedback into their plan. The coaching cycle process was time-consuming, so it was scheduled differently in each school to accommodate existing schedules. Some coaches did the debrief and co-planning stages during one meeting. Some met with the same teachers for an entire semester or school year, while others met with teachers in 5-week cycles. When a teacher was being coached, the goal was to complete this cycle once per week. However, due to the many competing demands in schools, these cycles were not always completed with the same level of consistency.

3.3 Data Collection

3.3.1 Teacher Surveys. Data included surveys administered to teachers in Fall 2019 and Spring 2020, with 5 months between pre-survey and post-survey completion. These surveys were administered to gain a broad understanding of teachers' attitudes about teaching CS to students with disabilities and to gauge their understanding of different approaches to meeting those students' needs in this subject area. Surveys included (a) demographic information (e.g., grade level, setting, previous CS teaching experience); (b) Likert scale items related to attitudes about and comfort with teaching CS, understanding of UDL in the context of CS, and confidence in teaching CS to students with disabilities; and (c) open-ended response items about UDL and strategies for supporting students with disabilities. These survey items were developed by research scientists, CS instructional coaches, and university faculty and had been piloted the previous year. Items were revised based on both teacher and researcher input gathered during the 2018-2019 academic year (see Appendix).

3.3.2 Focus Groups. A focus group was conducted with the coaches in April 2020. The focus group used a semi-structured question protocol developed by researchers in collaboration with an expert in CS instructional coaching who has provided professional development to CS coaches for the past 4 years (see Appendix). Focus group questions included items such as the following: (1) What kinds of academic supports are you providing to teachers to meet the needs of students with diverse instructional needs, including those with disabilities? (2) How do you define UDL? (3) How comfortable are you in coaching teachers to implement UDL in CS education? (4) What does UDL look like in your coaching practice? Because the lead coach is a member of the research team, this coach did not conduct the focus group interview. Rather, this coach participated as a member of the focus group while others on the research team conducted the focus group. This focus group was audio recorded and later transcribed for analysis.

3.4 Data Analysis

A sequential mixed-methods approach was used for data analysis (QUAN→QUAL) in this study. This approach allowed the research team to evaluate the data through a process wherein the quantitative analysis of the survey informed the development of the focus group question protocol.

3.4.1 Quantitative Data Analysis. Quantitative data analyses began with calculating descriptive statistics (means and standard deviation) in SPSS for the demographic questions and the four Likert scale items (i.e., I look forward to teaching CS; I am confident in teaching CS; I am confident in teaching CS to students with disabilities; and I am confident in implementing UDL in the context of CS). Because there is a decades-long debate in the literature about the use of paired-samples t-tests and the Wilcoxon signed-rank test for Likert scale items (see [33]); both approaches were used and revealed similar findings. These analyses were computed to ascertain whether there were significant changes from pre-survey to post-survey responses on these Likert items. Lastly, because our data meets the assumptions for parametric testing, a general linear regression model was calculated to see if years teaching CS, confidence in teaching CS in general, and understanding of UDL in the context of CS education predicted confidence in teaching CS to students with disabilities.

3.4.2 Qualitative Data Analysis. Qualitative analysis involved using a constant comparative process [10] that resulted in operationalization of codes, classifications into a coding scheme, clarifications of any ambiguities, and finally consensus across researchers. Two types of qualitative procedures were used in this study: one process for the open-ended survey items and another for the focus group discussion. The open-response survey items were coded using a deductive content analysis methodology [43], given that we had theoretically driven categories based on the UDL framework and other research-based practices related to the inclusion of students with disabilities. These codes corresponded to UDL-based practices such as "multiple means of engagement" or "multiple means of representation" as well as pedagogical practices such as "modeling" and "explicit instruction." On the other hand, the focus group data was coded using an inductive approach as codes were derived directly from the raw data. Through this analytic process, the categories emerged directly from the data. For both the open-ended survey items and the focus group, qualitative analysis involved repeated readings to gain a sense of the data followed by the grouping of phrases into like and unlike categories. As categories emerged, previously coded data was checked

Table 5. Paired-Sample *t*-Test Results

Item	Pretest	Posttest	t-value
Confidence in teaching CS	M = 3.5, SD = 0.85	M = 3.86, SD = 0.788	t = 2.97, p = 0.004
Confidence in teaching CS to students with disabilities	M = 3.25, SD = 1.22	M = 3.5, SD = 0.93	t = 2.16, p = 0.035
Understanding of how to apply UDL in K-12 CS education	M = 1.41, SD = 0.95	M = 1.56, SD = 1.03	t = 1.19, p = 0.236

against the new categories as part of the constant comparative analysis. Lastly, these categories were organized hierarchically into themes.

3.4.3 Credibility and Trustworthiness. The credibility of qualitative data analysis rests upon rigorous approaches in analysis and trustworthiness procedures. The research team used a dialogical intersubjectivity analysis method [2] to ensure consensus between researchers coding data and researchers and participants. A dialogical intersubjective analysis method was used as opposed to intercoder reliability in order to develop and ensure consensus. Thus, instead of conducting a traditional interrater reliability analysis wherein some data was coded independently, all data was examined collaboratively through a constant comparative methodology. Through this process, we operationalized, defined, and clarified categories as the coding scheme was being developed and then worked collaboratively to code and check the data. First, for the coach focus group, member check procedures were conducted with all four of the coaches to clarify themes that emerged from the data. Second, the research team performed data analysis collaboratively. Third, a constant comparative approach was taken to ensure that all data were analyzed against all other data. For example, analysis of post-survey open-ended questions began with a categorical analysis of the participant's answers through a discussion by the entire research team. The questions were then divided for initial analysis between two team members for initial coding. The two then met to compare codes and discuss overlapping categories. They revised the codes based on this discussion, then recoded the data based on the revised coding scheme. The team members met once more to assess the changes made, discuss questions, and come to a consensus before meeting with the whole research team. The team then collaboratively discussed all of the codes, categories, and emerging themes. Changes were made to a few of the codes and to which categories answers were assigned. The research team went through everything once more to finalize the analysis.

4 RESULTS

4.1 Teacher Surveys: Quantitative Analysis Results

Teachers who participated in this study experienced significant improvements in their general confidence in teaching CS as well as in their confidence in teaching CS to students with disabilities. Both the paired samples *t*-tests and the Wilcoxon signed-rank test revealed significant differences in two of the dependent measures. Table 5 provides the paired samples *t*-test results.

The Wilcoxon signed-rank test similarly showed statistically significant increases in teachers' reported confidence in teaching CS from pre-survey ($n = 66$; $Mdn = 3$) to post-survey ($n = 65$; $Mdn = 4$), $Z = 3.32$; $p < 0.001$. Similar significant increases were found in the teachers' reported confidence in teaching CS to students with disabilities from pre-survey ($n = 66$; $Mds = 3$) to post-survey ($n = 64$; $Mdn = 4$), $Z = 2.12$; $p = 0.034$. As a first step in understanding the relationship between teachers' confidence in teaching CS to students with disabilities and whether they believed they could apply UDL in the context of CS education, we asked teachers about their perceptions about their ability to apply UDL in CS education. The scale for this item included the following: having no understanding of UDL, having heard about UDL without knowing how to apply it, having an understanding of how to apply UDL in contexts outside of CS education, and having an understanding of how to apply UDL to CS education. From pre-survey ($n = 66$; $Mdn = 1$) to post-survey ($n = 61$; $Mdn = 2$), there was no significant change in teachers' beliefs about application of UDL ($Z = 1.35$, $p = 0.18$), which remained extremely low across pre-survey and post-survey. A multiple linear regression was calculated to predict teachers' end of year confidence in teaching CS to students with disabilities based on the number of years they had taught CS, their end of year confidence in teaching CS in general, and their understanding of UDL in the context of CS. A significant regression equation was found $F(3, 57) = 11.54$, $p < 0.001$ with an $R2 = 0.35$. Therefore, 35% of all the variance in teachers' reporting of their confidence in teaching CS to students with disabilities can be attributed to these three independent variables. All three of these independent variables were found to be significant (years teaching CS: $p = 0.04$; general understanding of UDL in the context of CS: $p < 0.001$; and general confidence in teaching CS: $p < 0.001$).

4.2 Teacher Perspectives About Inclusion and Factors Leading to Success of Students with Disabilities During CS Instruction

While only 66 teachers completed the pre-survey and post-survey, 108 teachers completed free-response questions on the post-survey in which they listed factors that contributed to the success of students with disabilities in CS education and described the UDL framework in their own words. These items were intended to provide additional context to the Likert scale items.

4.2.1 Supporting Students with Disabilities During CS Instruction. Overall, teachers responded positively to the inclusion of students with disabilities in CS instruction and expressed confidence in their abilities to help students with disabilities succeed in inclusive CS learning environments. Teachers considered CS to be an area in which they could include students with disabilities through structured support. They perceived CS instruction as conducive to active participation, allowing students to make connections between the content and their own lives. Additionally, they described CS as offering students with disabilities opportunities for success that they may not experience in their core content classrooms. For instance, one teacher wrote, "CS provides a great opportunity for students with disabilities to demonstrate their abilities. It provides different channels for them to demonstrate understanding and to communicate the ideas they might not be able to express verbally or in other traditional ways." On this post-survey, the majority of teachers ($n = 74$) described at least one factor that contributed to the success of students with disabilities during CS instruction, while 31% of the teachers ($n = 34$) did not provide an answer or responded "not sure." Of the 74 teachers who provided an answer to the question about strategies to support students with disabilities, 150 distinct responses were coded. Some teachers, therefore, provided several strategies that were each coded independently. Analysis of these codes revealed four thematic categories (see Table 6): (a) instructional design: broad approaches; (b) instructional design: strategies; (c) instructional implementation: pedagogical practices; and (d) instructional values.

Analysis of these 74 teachers' responses revealed that 57% ($n = 42$) described broad ideas of instructional design that impact the success of students with disabilities during CS instruction. One such strategy was the use of problem-based, interactive lessons rather than teacher-led didactic instruction. Teachers expressed that hands-on, exploratory approaches can create a learning experience that students feel is personally relevant to their lives. For example, one teacher wrote, "These are extremely engaging and hands-on activities. Students are not being lectured, but [are] fully participating in the lesson." Additionally, the teachers expressed that instruction that allows students to "explore" and "tinker" independently creates an atmosphere that normalizes and em-

Table 6. Strategies for Supporting Students with Disabilities

Instructional Design: Broad Approaches	Instructional Design: Strategies	Instructional Implementation: Pedagogical Practices	Instructional Values
Hands-on leaning (n = 27)	Visual learning (n = 17)	Modeling (n = 7)	Accessible (n = 1)
Problem solving and higher order thinking (n = 7)	Step-by-step instruction (n = 11)	Repetition (n = 6)	Flexible (n = 2)
Real world, relevant learning (n = 7)	Differentiation (n = 8)	Teacher support (n = 6)	Communicate ideas (n = 1)
Student friendly activities (n = 1)	Multiple strategies and approaches (n = 4)	Feedback (n = 1)	Varied materials/ technology (n = 9)
	Accommodations (n = 4)	Explicit instruction (n = 11)	Engagement (n = 7)
	Collaborations (n = 3)	Relationship building (n = 2)	
	Models (n = 3)		

braces failure as part of the learning process. While teachers described instructional designs that promote more open-ended and active activities, they also recognized the importance of incorporating a variety of instructional strategies that provide structure and allow them to attend to individual student needs. Of the teachers who provided a response to this item, 74% (n = 55) identified specific instructional strategies, with the one most frequently viewed as supportive being the use of visual supports. This observation makes sense as a known barrier to students with disabilities in inclusive environments is encountering text that is higher than their independent reading level. Teachers' identification of the benefits of step-by-step instructions and scaffolding indicates an understanding of student differences in executive functioning and attention skills. Collaboration and peer support were also noted as ways to engage students with disabilities. One teacher stated that, "CS also allows for collaboration and debugging which shows students that it is o.k. to make mistakes." Teachers also identified differentiation and accommodations, strategies that focus on providing specific students what they need to successfully participate in the CS lessons.

The third theme that arose was factors related to instructional implementation with 45% (n = 33) of teachers describing specific pedagogical practices they incorporated into their CS lessons. Interestingly, the teachers did not generally describe UDL when asked about these pedagogical practices. Instead, many of the practices they identified corresponded to HLPs that are essential to improving outcomes for students with disabilities. These practices include explicit instruction, modeling, repetition, teacher support, and feedback. While these practices are often implemented within a UDL approach, they do not constitute use of UDL by themselves.

Lastly, in addition to specific instructional strategies and pedagogical practices, 27% (n = 20) of teachers identified overarching instructional values that support the inclusion of all students in CS instruction. This category relates more closely to the UDL framework than the previous categories and included the ideas of engagement, accessibility, flexibility, and communication.

4.2.2 Universal Design for Learning: Teacher Definitions. When answering the open-ended question, "Please describe Universal Design for Learning (UDL) in your own words," almost half of the 108 teachers either did not respond (19%, n = 21) or answered "I don't know" (29%, n = 31). This finding corresponds to the answers the teachers provided to the Likert scale survey question regarding teacher confidence in teaching through the UDL framework: 65 either did not answer, (8%, n = 9) answered "I have never heard of UDL" (17%, n = 18), or answered "I have heard about UDL, but I don't know how to implement it" (35%, n = 38).

From the 56 teachers that did provide a description of UDL, 129 responses were coded. Some teachers provided responses that contained more than one description of UDL; these responses were coded independently resulting in more coded responses than the number of teachers. 71%

Table 7. Teachers's General Definitions of UDL

General Definitions of UDL provided by Teachers
Meeting the needs of all learners (n = 24)
Flexible teaching methods and planning (n = 16)
Understanding how people learn (n = 14)
Access/accessibility (n = 13)
Flexible classroom environment (n = 8)
UDL as an instructional framework (n = 7)
Equal opportunity to learning (n = 5)
Multiple approaches (n = 4)

(n = 91) of the teacher responses were general descriptions of UDL that could cover the entire framework; these were sorted into an "All" category (see Table 7). The responses that described specific aspects of UDL were sorted based on the three broad principles of UDL (Engagement, Representation, and Action and Expression; see Table 8). There were also a few results that could not be sorted into any of the categories.

The most common responses sorted into the "All" category stated, in some form, that UDL was used to meet the needs of all learners (n = 24). Responses such as "Meeting the needs for all the students in your classroom," "Meeting the needs for ALL learners," and "Design learning experiences to meet the needs of all students" were assigned this code. The second most common type of response in the "All" category focused on teaching methods, planning, or design (n = 16). Example responses included "UDL helps you as a teacher to plan lessons for the different types of learners in your class," "Using a variety of teaching methods to give access to all types of learners," and "The ability to develop lessons and learning that all students are able to access". Responses that were sorted by the three principles of UDL made up 22% (n = 29) of the responses and the remaining 7% (n = 9) were sorted into an "Other" category.

Of the 129 responses, teacher descriptions of the UDL *Engagement principle* based on the UDL guidelines included collaboration, personally relevant problem solving, and student choice (12%, n = 16) (see Table 8). One example of a teacher's description of UDL sorted into this category was, "Students approach real life problems by debugging, collaborating, tinkering, and using other strategies that apply to the task at hand." Responses categorized under *Representation* included 'flexible access to instructional content, materials, and scaffolding' (7%, n = 9). "Scaffolding student learning to reach their level and creating activities that meet that level for learning to be that much more accessible" is one example of a teacher description of UDL sorted under Representation. The third category, *Action and Expression*, was represented by teacher responses such as "Transferring and applying the skills we learn in CS to other subjects... like debugging and trying different ways or taking more efficient paths to solve problems." These responses also contained descriptions of UDL such as demonstrating understanding, immediate feedback, and skill transfer (3%, n = 4). The "Other" category included teacher descriptions of UDL such as accommodating learning differences (n = 6), being familiar with UDL but not comfortable teaching using this framework (n = 1), UDL as focused on students with disabilities (n = 1), and **Understanding by Design** (**UBD**), which is a different framework altogether (n = 1).

4.3 Instructional Coaches Focus Group Results

The research team conducted a focus group with the four CS instructional coaches in order to collect information about their time coaching, their approaches to UDL, and their interpretations of the experiences of their assigned teachers. During the focus group, three themes arose among

Table 8. Teachers's Definitions of UDL

Engagement	Representation	Action and Expression
Collaboration ($n = 1$)	Flexible access to content ($n = 4$)	Flexible assessing of understanding ($n = 1$)
Engagement ($n = 1$)	Flexible materials ($n = 4$)	Immediate feedback ($n = 1$)
Individualized learning ($n = 6$)	Scaffolding instructional materials ($n = 1$)	Skill transfer ($n = 2$)
Personally relevant ($n = 3$)		
Student choice ($n = 3$)		

the coaches. The first theme across the coaches' responses was a commitment to equity as a shared value among the coaches. They spoke about equity in terms of ensuring all students had access to high-quality CS instruction. They identified several areas that caused barriers to equity in the schools that they worked with including which teachers received coaching, inclusive instructional practices in the classroom, what technology was available to students and how it was shared, and the time that the school dedicated to CS learning. Coach A explained, "The first thing comes down to logistics is what devices we have, what tools are we using, what materials are being utilized and whether those tools are accessible to all students who gravitate towards them. How are they being presented to the student? That's the first step when it comes to, you know, thinking about equity in the classroom." Coach C further explained, "They [referring to a school] have three pillars. They call it content, equity, and access. So that's the theme of their entire curriculum. So you always have those pillars in your head all the time; and that, I guess, was the most impactful in what I do." A second theme that emerged throughout focus group conversation was teacher agency. The coaches worked to empower teachers to make the CS lessons their own and adapt CS lessons to their specific groups of students. Coach C explained, "Anytime a teacher makes an edit to your lesson plan, that's amazing...Because they are now owning it, so they can make sure that it reaches their kids." Other strategies for building teacher agency that came up most often include fostering trusting and supportive relationships with teachers and building their confidence with CS content and tools over time. The coaches described how teachers also became more motivated to teach CS when they saw the inclusive strategies working for all the students in their classrooms, even the ones who they struggle to engage in other subject areas.

The final common focus group theme centered on UDL. All of the coaches strongly believed in the use of UDL in CS education, but expressed different levels of confidence in using the vocabulary of UDL themselves. All of the coaches explained that they often struggled to use the language of UDL to hold meaningful conversations with teachers about changes in implementation based on the UDL framework. They said that UDL language did not naturally fit into their discussions with teachers and that the teachers often felt overwhelmed by the unfamiliar vocabulary. Coach D explained, "For me, it's a real challenge to explicitly make this part of coaching...it's not that we are not necessarily incorporating UDL into our coaching but making it explicit has been a big hurdle." The coaches expressed an interest in continuing to explore ways to better support teachers in implementing UDL-based CS instruction.

5 DISCUSSION

This study had three aims, all focused on teachers' and coaches' experiences in seeking to improve the accessibility of CS education for students with disabilities. The research team aimed to investigate the relationship between teachers' confidence in meeting the needs of students with disabilities during CS instruction and whether this confidence is related to factors such as the number of years teaching CS, their confidence teaching CS in general, and their understanding of UDL. Although our regression analysis showed that these factors resulted in 35% of the variance in teachers' reported confidence in teaching CS to students with disabilities, many questions remain. This study also aimed to learn whether teachers' comfort with teaching CS to students with disabilities, as well as their understanding of how to apply UDL to CS instruction, increases after receiving equity-focused, UDL-based CS instructional coaching. Again, our findings were mixed and resulted in more questions than answers. Teachers' general confidence in teaching CS and confidence in meeting the needs of students with disabilities increased, but their understanding of how to apply UDL to CS education remained low. Overall, this study provided a lens into the complexities associated with coaching teachers in inclusive CS education. It shed further light on multiple areas that require additional exploration in order to truly make progress in designing and implementing inclusive CS education that meets the needs of all learners.

5.1 Development of Teachers' Confidence in Teaching CS to Students with Disabilities

At the beginning of the study, the majority of teachers viewed CS as instructional content structured in a way that allows for students with disabilities to experience success and exhibit their unique skills. In contrast to content that requires a more didactic instructional method, teachers expressed that CS presents opportunities for exploration and freethinking. Examining teachers' attitudes and level of confidence resulted in findings regarding research question one, focusing on teaching students with disabilities in CS education. Teachers' positive attitudes extended to most teachers expressing confidence in their ability to support students with disabilities during CS instruction.

In relation to research question two and the growth of teachers' confidence in meeting the needs of students with disabilities during CS instruction, findings revealed that receiving individualized coaching support positively impacted growth. This was true although, despite the coaching focus on applying UDL during CS instruction, we did not find a significant relationship between teachers' increases in confidence and their stated understandings of UDL. Further analyses indicated that teachers' years of experience teaching CS, general confidence in teaching CS, and general understanding of UDL were possible variables in increased confidence levels. Each of these factors provide teachers with a foundation of background knowledge and experience on which they can build as they learn and implement new practices. Teachers with higher levels of experience and confidence teaching CS are able to focus on how they teach and adjust their practices, while less experienced or less confident teachers may still be learning more fundamental aspects of CS content knowledge and building pedagogical practices. Additionally, teachers with better overall understandings of UDL may have already had opportunities to implement UDL practices with diverse classroom populations and thus to observe the improvement in outcomes for all students.

Reflecting on Gusky's (2002) theoretical model of teacher change, teachers' responses indicate that for this set of teachers the model was likely accurate [11]. Through participation in effective PD that included exposure to new knowledge and pedagogical practices, as well as ongoing support from coaches, teachers' confidence in creating inclusive and accessible instruction for all students increased. However, as there was not a significant relationship between increases in confidence and understanding of UDL, this change may be a reflection of the benefits of coaching in general rather than the development of knowledge about UDL. Another potential explanation is that teachers increased their skills in integrating and implementing components of UDL, but did not explicitly make the connection between their practices and UDL. This makes sense as coaches expressed struggling to effectively communicate the relationship between CS instruction and UDL to teachers. Consequently, future research should closely examine the benefits of how a general coaching PD experience improves practice and confidence alongside the potential impact of increased knowledge and application of UDL during inclusive CS instruction. Another potential area for further investigation is how coaching support can be differentiated to align with varying levels of teacher experience.

5.2 Universal Design for Learning Implementation in K-12 CS Education

Asking the teachers about UDL implementation in the context of CS education answered research question three. This research question asked how familiar are elementary teachers with using the UDL framework in supporting all students during CS education. Results showed that most of the teachers struggled to tie UDL to CS education. In fact, most of them either did not answer this question or stated that they did not know how to implement UDL. When teachers did answer this question, they provided broad definitions of UDL instead of specific implementation examples. For the few that provided UDL implementation examples, these primarily fell under the Engagement principle, which was consistent with Israel and colleagues (2020), who found that teachers applied this principle to a greater extent than other UDL principles [17]. Additionally, the Likert scale item asking teachers about their confidence in implementing UDL in CS education remained low throughout the study. These findings were unsurprising when taken together with the coaching focus group, which revealed that the coaches did not explicitly connect instructional strategies to UDL due to their own emerging understandings of UDL and their struggles to incorporate explicit UDL language into their coaching sessions. These findings were unfortunately consistent with other research studies that revealed teachers' challenges in implementing UDL [41].

Although the coaches had a more sophisticated understanding of UDL than the teachers, they struggled to translate that knowledge to co-planning and support. This was especially challenging for those teachers who were new to both CS and UDL, as coaches were concerned about reducing teachers' feelings of overwhelm and increasing motivation. Coaches indicated a desire for more in-depth UDL learning opportunities and resources both for themselves and to help them support teachers. The resources they requested included dedicated UDL PD, additional time for coaching during co-planning sessions, and tangible resources like lesson planning templates or suggested coaching questions. By design, UDL promotes flexible instructional design, but that flexibility can result in ambiguity about how specifically to apply the principles in instructional contexts [15]. Without deep expertise, the flexibility inherent in UDL can result in a lack of direction when applying the framework to specific instructional contexts.

5.3 Factors Teachers Consider Efficacious for Including Students with Disabilities in CS Education

When asked about how to meet the needs of students with disabilities, the teachers identified instructional strategies and pedagogical practices that support improved outcomes and higher levels of engagement for these learners. These findings answer research question four, centering on the factors that teachers considered efficacious for successfully including students with disabilities in CS education. The teachers cited inclusivity, engagement, accessibility, and flexibility as core values, responses that were in concordance with the foundational intent of UDL, even though the teachers did not explicitly connect those values with that particular framework. The teachers indicated that CS provided the flexibility to engage all students in hands-on activities. They also noted explicit pedagogical strategies such as modeling and providing multiple opportunities for practice and feedback as having a positive impact on students' participation and success. It is important to note, however, that while the majority of teachers did identify at least one factor that supported the inclusion of students with disabilities in CS education, almost a third of teachers did not provide an answer or chose "not sure." This finding is consistent with previous research pointing to the need for additional teacher support in inclusive CS practices [18]. Interestingly, the strategies that the teachers cited in their responses aligned more with the construct of HLPs [32] than they did with UDL, even though HLPs were not explicitly introduced as part of the coaching intervention. This finding may be related to the fact that the specific HLPs (e.g., modeling, scaffolding) are more familiar to the teachers, so it was easier for them to apply these familiar strategies than the UDL framework. Thus, the teachers developed an understanding of strategies that support students with disabilities in inclusive settings using familiar instructional approaches, but they fell short in translating these strategies to the broader framework of UDL. Given these findings, future equity-based CS education PD and coaching research should integrate knowledge of the HLPs alongside UDL and support teachers in explicitly identifying the strategies that support students with disabilities. This way, coaches can help teachers develop equity-focused instructional practices that leverage both of these research-based frameworks.

5.4 Coaches' Approaches to Addressing Inclusion and UDL in their Coaching Practice

One of this study's most significant findings stemmed from investigating research question five, 'How are CS instructional coaches addressing inclusion and UDL in their coaching practices'. Results demonstrated that the instructional coaches struggled to help teachers integrate UDL into their instructional practices. Although the coaches all received ongoing professional development in UDL-based CS education and met regularly with the lead instructional coach (Coach D), they still indicated that they struggled with helping the teachers implement UDL-based CS education. The coaches stated that they found it challenging to support teachers in inclusive CS education due to navigating the complexities and individual context of each setting as well as to limited understanding of UDL-based CS education. This finding therefore points to a need for additional resources and mentoring to assist the CS instructional coaches not only to more fully understand the application of UDL to CS education, but also to support them in their instructional coaching roles. However, extremely limited literature exists that examines the professional learning needs of coaches. This limited research lends insight into some of the challenges coaches face (e.g., ill-defined roles, lack of support [9]). For example, Stoetzel and Shedrow (2020) found that coaches encountered challenges associated with the parameters of their roles, their interactions with teachers, and in tailoring their coaching to each teacher's unique instructional context [44]. That study highlighted the need for both initial and ongoing coach PD that is customized to each coach's unique role [44]. Given the lack of research on the needs of instructional coaches, future research should investigate how to better support CS instructional coaches in general and specifically in the implementation of equity-based instructional practices.

5.5 Limitations and Implications for Future Research

Findings from this study should be viewed in light of several limitations. A main limitation to this study is that it ended abruptly and early due to COVID-19. The coaching implementation was scheduled to continue through early summer 2020. However, because schools closed, our intervention was halted. Findings may have been different if the intervention continued through the end of the school year. In light of this limitation, a replication study would provide more information about whether findings from this study would be replicable with additional intervention time. Next, this study took place within one urban school district with the same coaches. These coaches, by design, worked together and collaborated to address the needs of teachers in different schools within this district. Future research should investigate the role of instructional coaching in supporting teachers in different school settings including rural and suburban settings as well as settings that may not have as robust of a CS education initiative. Lastly, given the time required for implementing robust instructional coaching, our study encountered situations where teachers and coaches did not have enough time to conduct coaching cycles to the extent they had hoped. For example, teachers' planning time was sometimes needed for other instructional demands. Therefore, study outcomes may have been influenced by this constraint. Future research should examine barriers, such as time, to effective instructional coaching in the context of CS education so that the field can improve coaching implementation.

6 CONCLUSIONS

This study revealed a deep commitment to the inclusion of students with disabilities in K-6 CS education from both teachers and their instructional coaches, but it also revealed the challenges and complexities of enacting equitable and inclusive CS instruction and coaching. Even with a commitment to equity and inclusion, this study demonstrated the need for additional resources and robust and ongoing professional development in UDL-based CS education to support teachers as well as instructional coaches. The study's implications for practice include the need to develop PD and instructional resources such as example lesson plans, instructional videos, lesson development questions to guide equity-based CS education inclusive of students with disabilities, an integration of HLPs with UDL-based CS instructional strategies, and professional learning communities wherein teachers and CS instructional coaches can both gain expertise and develop professional networks. These resources will hopefully help us move toward a CS education framework that more comprehensively includes students with disabilities.

APPENDIX

A DATA COLLECTION INSTRUMENTS

Pre Survey Questions

(1) What setting(s) do you teach in this year? (list of options including self contained, co-taught, general education, gifted and talented, English as a new language, other)
(2) How many years have you been a full-time classroom teacher?
(3) Have you ever taught computer science (CS)/computing in your classroom? (yes/no)
(4) If you answered yes, how long have you taught CS?
(5) I look forward to teaching computer science (CS) lessons. (5 point Likert scale)
(6) I am confident that I can teach CS lessons effectively. (5 point Likert scale)
(7) I am confident teaching CS to students with disabilities. (5 point Likert scale)
(8) If you are familiar with Universal Design for Learning (UDL), please describe it in your own words. (open-nded question)
(9) How confident are you in teaching through the Universal Design for Learning (UDL) framework? (5 point Likert scale)

Post Survey Questions

(1) Has your instructional setting changed at all since the beginning of this research project? (e.g., change in grade level, content area, number of students)
(2) Please check the answer that best describes how much CS you taught this year. (list of options including none)
(3) I look forward to teaching computer science (CS) lessons (5 point Likert scale).
(4) I am confident that I can teach CS lessons effectively (5 point Likert scale).
(5) How confident are you with teaching CS to students with disabilities? (5 point Likert scale).
(6) What factors do you think contribute to the success of students with disabilities in CS education? (open-ended question)
(7) Please describe Universal Design for Learning (UDL) in your own words. If you are unfamiliar with UDL, it's ok to answer with "I don't know." (open-ended question)

(8) How confident are you in teaching through the Universal Design for Learning (UDL) framework? (5 point Likert scale)

Focus Group Interview Questions

(1) What are your main priorities when you're coaching teachers, specifically as related to access and inclusion in CS education?
(2) What kind of academic supports are you providing to teachers to meet the needs of students with diverse instructional needs, such as students with disabilities, English language learners, and so on?
(3) What is your perspective on what successes you started to see with helping the teachers or what the teachers are doing in making the lessons accessible or reaching the students at their level of need?
(4) What kinds of challenges are you noticing in the classrooms?
(5) How do you define UDL?
(6) In your coaching practice, how are you specifically addressing coaching teachers around UDL?
(7) How comfortable are you with coaching teachers to implement UDL?
(8) Can you describe what types of professional learning you have received in UDL and maybe what you've used working with the teachers?

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