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School-Embedded and District-Wide Coaching in K-8 Computer Science: Implications for Including Students with Disabilities

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As schools implement initiatives that bring computer science (CS) to academically diverse K-12 schools, they face heightened demands for supporting teachers in meeting the needs of a broad range of learners. However, limited knowledge exists about pedagogical approaches to teaching CS, especially to students with disabilities. This paper focuses on coaching to support K-8 CS teachers in meeting the needs of these learners. The study involved qualitative case studies of two commonly implemented coaching models: Use of a school-

embedded coach and use of a district-wide itinerant coach. These coaching models were applied to CS instruction to support teachers in meeting the needs of students with disabilities. Findings revealed that within both CS coaching models, co-planning and co-teaching played were essential for teachers to effectively address the needs of their students with disabilities. Instructional pedagogies that coaches promoted included scaffolded project planning (e.g., planning computational artifacts), student collaboration (e.g., pair programming), and immediate student feedback (e.g., debugging suggestions). Within both coaching models, trust building and increasing teachers' CS instructional skills were emphasized. Differences between coaching models included a stronger level of familiarity between the coach and teachers in the school-embedded coaching and different approaches to accountability and co-planning logistics.

With national and local calls to increase access to K-12 computer science (CS) instruction for all students (e.g., The White House, 2016), school districts must find and prepare teachers to teach within these programs. At the elementary and middle school levels, these efforts may be challenging as teachers often teach multiple subjects, and adding a new area of instruction may seem daunting. Thus, a major focus of bringing CS to schools is providing professional supports to teachers who may not have had prior CS experience (Yadav, Berges, Dands, & Good, 2016). Districts often utilize professional development (PD) to address both content and pedagogy knowledge (Guskey & Yoon, 2009). Unfortunately, with the rush to bring CS to schools, PD often translates into single training opportunities that either focus on a particular CS topic or programming language (Ryoo, Goode, & Margolis, 2016). Despite this challenge, PD needs to be included if CS education programs will be successful, especially when instructing a wide range of learners, including those with disabilities.

Students with disabilities in K-8 CS instruction

According to the National Center for Education Statistics, approximately 13% of students in U.S. public schools receive special education services. Most of these learners are taught either part or full time in the regular classroom (NCES, 2017a; NCES; 2017b). Given these statistics, it can be assumed that most CS classrooms will include students with disabilities.

A growing body of literature points to the fact that these learners can succeed in CS education if given the necessary supports and accommodations (e.g., Ladner & Israel, 2015; Ray, Israel, Lee, & Do, 2018). For example, Snodgrass, Israel, and Reese (2016) found that once teachers applied individualized supports that students with disabilities received in other content areas, their engagement increased. Taylor, Vasquez, and Donehower (2017) focused on explicit instruction to teach robotics to students with Down Syndrome and found that the students learned the programming commands to complete the robotics tasks. Thus, when students with disabilities received supports, they demonstrated positive outcomes. However, because few CS teachers have access to instructional strategies designed to support students with disabilities, they may struggle to meet the needs of these learners (Israel, Pearson, Tapia, Wherfel, & Reese, 2015). Thus, it is critical to provide teachers with strategies for including these learners in CS activities.

Teacher Professional Development, Coaching, and K-8 CS education

Conservation of resources theory and CS education. Adding a new area of instruction, such as CS, may prove difficult to novice and veteran teachers. Conservation of Resources (COR) theory suggests that overwhelming workloads may reduce the energy teachers have to engage in new responsibilities, such as teaching a new subject. COR theory also posits that individuals have limited resources (e.g., time, energy) which they deploy strategically to meet the goals most important to them (Alacon, 2011; Battini et al., 2017). As teachers face challenges such as new instructional demands, their identification with their work may falter. However, when they possess sufficient resources, teachers are in a better position to invest those resources toward achieving their goals (Halbesleben, Neveu, Paustian-Underdahl, & Westman, 2014). It is important to examine supports available to teachers as they integrate CS into their classrooms. Continuous, high quality interaction with experienced colleagues such as coaches can play a formative role in helping teachers succeed (Cornett & Knight, 2009; Johnson, 2004).

CS teacher professional development and coaching. Given COR theory, there is a need to focus on teacher development and PD (Desimone, 2009; Guskey & Yoon, 2009). Coaching is one method of PD that has been shown to be effective in preparing teachers for the highly complex demands of teaching a new content area in academically diverse settings (Desimone & Pak, 2017; Ray et al., 2018). Several studies outside of CS educa-

tion have demonstrated the efficacy of coaching. Kretlow and Bartholomew (2010) found that across a review of thirteen studies, coaching increased teachers' application and accuracy of evidence-based practices. Other studies have examined the effects of coaching within inclusive classrooms that contain students with and without disabilities. For example, several studies have connected teacher beliefs about students' academic abilities, teachers' responsibility toward all students, and self-efficacy about their ability to impact student learning (e.g., Jordan, Schwartz, & McGhie-Richmond, 2009; Weiner, 2003). Further, Cantrell and Hughes (2008) found that coaching positively impacted these beliefs and self-efficacy reports, specifically teachers' belief that they can influence learning.

Coaching model guiding this study. The current study relied on principles and practices of instructional coaching. Instructional coaching (Knight, 2009) offers teachers opportunities for job-embedded PD wherein teachers can apply new pedagogical approaches within their own classrooms (Darling-Hammond, 2006). This coaching model focuses on coaching for evidence-based instructional practices (Knight, 2009). Additionally, instructional coaching rests on five features of effective PD, including: (a) a focus on instructional content; (b) opportunities for teachers to engage in active learning such as observing the coach, receiving feedback, and analyzing student work; (c) an aim for coherence between the instructional content the teacher is responsible for teaching with the teacher's knowledge and beliefs, student needs, and school/district policies; (d) ongoing and sustained duration of coaching support; and (e) a focus on collective participation and community building among the teachers (Desimone & Pak, 2017). For example, several studies of instructional coaching within both reading and mathematics point to how coaches and teachers engage in robust subject-matter discussions related to effective pedagogical approaches, student learning, and assessments (Desimone & Pak, 2017). This coaching model often utilize a gradual release approach, in which the coach initially has more teaching responsibilities and, as the teacher gains skills and confidence, that responsibility is transferred to the teacher. The instructional coach models pedagogical approaches, co-teaches with the teacher, and provides feedback and support to help the teacher gain proficiency. By doing so, instructional coaching has been shown to be effective in increasing teacher responsibility and teacher instructional knowledge in a specific subject-area (Collet, 2012) and could be effective in supporting CS teachers.

When considering coaching in areas such as elementary mathematics or reading, pedagogical practices are typically well defined with evidence-based practices that have been researched prior to implementation of coach-

ing (e.g., Denton & Hasbrouck, 2009). However, when considering K-8 CS instruction that includes students with disabilities, few evidence-based instructional practices exist that coaches can anchor to their support (Snodgrass, Israel, & Reese, 2016). Thus, coaching may rely on translating evidence-based practices from other disciplines.

Meanwhile, research-based pedagogies in K-12 CS are beginning to emerge (e.g., Ray et al., 2018). CS coaches must take these pedagogical practices and find ways of conveying them to teachers. For example, pair programming is unique to CS as it was derived from an industry best practice. Pair programming has been shown to improve academic subject-area performance, confidence, and retention (Braught, Eby, & Wahls, 2008; McChesney, 2016; McDowell, Werner, Bullock, & Fernald, 2006). However, some studies also suggest that pair programming can lead to inequity among partners (e.g., Lewis & Shah, 2015). Translating practices such as pair programming into K-8 CS education effectively can be difficult because of the limited and possible contradictory findings in the literature. Thus, CS coaches rely on a limited but growing pedagogical evidence base and must create teacher PD experiences that translate these emerging pedagogies into practice with little guidance from research, curricular resources, or materials.

Within high school CS education, research on coaching has begun to emerge as a way to support teachers (e.g., Margolis, Ryoo, & Goode, 2017; Ryoo, Goode, & Margolis, 2016). Margolis and colleagues (2017) found that coaching positively impacted teacher pedagogy and supported CS content knowledge. These authors described nine activities that coaches engage in including reflecting with teachers on their practice, planning lessons and units, sharing resources, modeling instruction, co-teaching, analyzing student work, arranging for teachers to visit other CS classrooms, and engaging in goal- framing conversations. Although research is emerging in coaching for high school CS teachers, little exist about how coaching can support elementary and middle school CS teachers or its effect on teachers who work with students with disabilities.

Purpose of this study

The purpose of this study was to examine the affordances and challenges of the two commonly used CS instructional coaching approaches used in schools to meeting the needs of teachers who work with students with disabilities. One approach involved school-embedded instructional coach-

ing and the other involved a district-based instructional coach who traveled among schools. Three research questions guided this study:

1. What CS coaching support did teachers receive to meet the needs of students with disabilities?
2. What strategies did CS coaches focus on for meeting the needs of students with disabilities in K-8 CS activities?
3. In what ways were CS coaching supports similar and different between school-based coaching as compared to district-based coaching?

METHODS

This study made use of a qualitative case study approach to examine the experiences of two CS coaches and the teachers with whom they worked in K-8 CS classes that included students with disabilities (Stake, 2006). Each coach was initially studied as an independent case and then the cases were examined collectively in a cross-case analysis for comparisons of similarities and differences. Multiple data sources were used and triangulated in this study including teacher interviews, coaching logs, classroom observations, and lesson plans.

Setting and Participants

Participants were recruited from two school districts with different approaches to CS coaching. The first (District pseudonym: District X) was a large school district in the Northeast that employed a district-wide coach that traveled from school to school. The second site was a mid-sized school in the Midwest (School Pseudonym: Woodside Elementary School) that committed to integrating CS across the grade levels and with all students. This school had a school-embedded coach who worked with all the teachers. Both districts had CS for All initiatives and had a wide range of socioeconomic and cultural diversity as well as students with disabilities who received CS instruction at least weekly. Table 1 provides additional information about the teacher participants across both school settings.

School-embedded coach at Woodside Elementary School. Ms. Davidson was the CS coach at Woodside Elementary School. At the time of the study, Ms. Davidson was in her ninth year at Woodside. She spent the majority of her career at Woodside as a third grade teacher. At the beginning of the CS for All initiative in 2012, Ms. Davidson was new to CS and be-

gan implementing CS in her own classroom. In 2016, Ms. Davidson transitioned to becoming the CS coach. Thirteen teachers at Woodside agreed to participate in this study. Of the 13 teachers, ten were classroom teachers, two taught specials (i.e., art and music), and one was a special education teacher who oversaw paraeducators who supported students with disabilities in CS classes. All classrooms were inclusive general education settings that included students both with and without disabilities. No self-contained special education classroom teachers participated in this study as the students with disabilities were included in the CS education activities. Ms. Davidson worked with teachers who had a wide range of CS experiences as the CS for All initiative at Woodside began in 2012. Six of the 13 teachers had been at the school since the beginning of the CS for All initiative and had at least four years of CS teaching experience. The rest of the teachers came to the school after the initial implementation of CS for All.

District-wide coach at District X. Ms. Simmons was the CS coach at District X, a large school district in the Northeast with a CS for All initiative. Prior to her work as a CS coach in 2016, Ms. Simmons was a curriculum developer with a CS education curriculum. Additionally, she worked as both a CS teacher and a special education teacher in District X for four years, although not in the schools in which she coached. Unlike Woodside Elementary, in which most teachers taught CS, District X had only a few teachers in each school that taught CS. Therefore, Ms. Simmons traveled from school to school to support teachers across the district. Ten teachers with whom Ms. Simmons worked agreed to participate in this study. The ten teachers in District X had a lot more variability than the teachers with whom Ms. Davidson worked because Ms. Simmons worked with teachers across multiple positions (e.g., general elementary and middle school classes, inclusive co-taught general education classes, self-contained special education classes in general education schools, and special education teachers in schools for students with disabilities). Lastly, Ms. Simmons primarily worked with teachers with limited CS experience because (a) this was the first year of implementing the CS coaching model, and (b) she worked with teachers that had the greatest support needs. Of the ten teachers with whom Ms. Simmons worked, nine had either no previous CS experience or less than one year at the time of the study.

Table 1
Teacher Characteristics Across School Sites

	District X Teachers	Woodside Teachers
General Education teachers	6	10
Special education teachers	4	0
Specials teachers (e.g., music/art)	0	2
Special education teacher (i.e., supervising paraeducators)	0	1
Elementary school setting	3	13 (all participants)
Middle school setting	6	0

Data Collection and Analysis

This study made use of a comparative case study approach (Stake, 2006) with a constant comparative analysis (Glaser & Strauss, 1967). Each instructional coaching approach was initially treated as a separate case with respect to each data collection source. Therefore, District X and Woodside School were each treated as an individual case study. Four researchers in total analyzed the data across the two case studies. Two of the four researchers analyzed data for District X and the other two researchers analyzed the data for Woodside Elementary School. Within each case, associated data were analyzed and constantly compared to other data sources in order to gain a cohesive understanding of the coaching approaches used. Initial data analysis included an open-coding phase wherein data were first organized into discrete units. A structured coding scheme was developed across data sources within a Google Doc. The researchers met throughout this phase to discuss their coding process, refine codes, and add explicit definitions and examples to the coding scheme. As the researchers operationalized codes, the shared Google Doc was revised. Table 2 provides a list of sample codes, definitions, and examples. Data sources within each case study were triangulated with each other (i.e., lesson plans, coaching logs, teacher interviews, and observations of instruction and coaching sessions).

Table 2
Example Codes and Examples

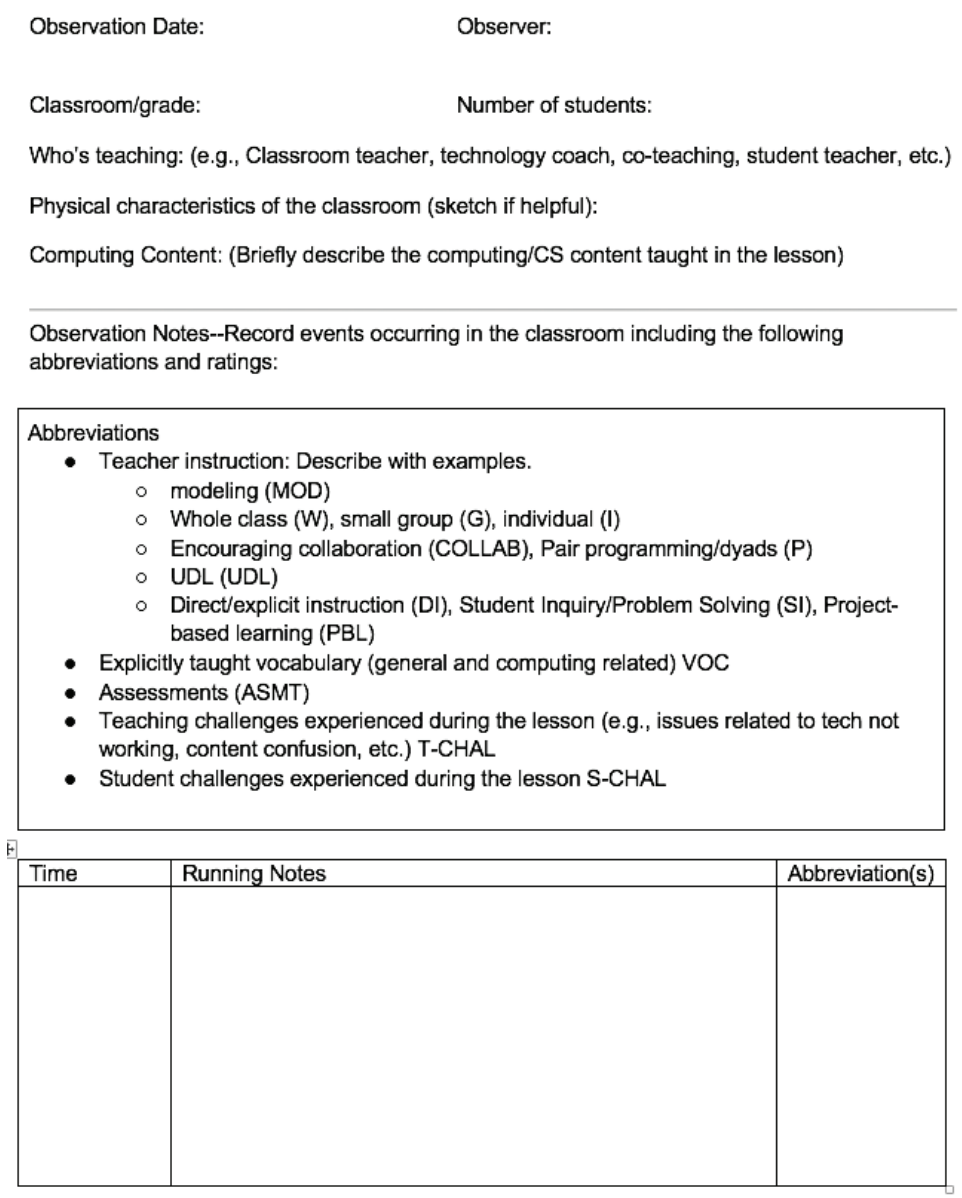
Code Category	Code Sub-category	Example	Sample code
Coaching supports	Specific coaching activities	Discussion of goals, skills may need to be addressed	Teacher interview transcript: "The coach and I evaluate as we are teaching lessons and what skills may need to addressed"
Strategies used to support students with disabilities in CS/CT	Explicit supports to increase understanding	Use of teacher modeling of "big ideas" of the lesson	Observation notes: Teacher and coach model debugging by building a physical tower that falls down. Coach says to teacher, "Man! That's frustrating. I wonder how we can build it differently so it doesn't fall down?"
	Use of Universal Design for Learning (UDL)	Teacher provides multiple ways of presenting information and offering student choice in projects	Observation notes: Teacher reminded students about what an algorithm was and pointed to the graphical representation of the steps used to wash hands while discussing the definition at the same time.

Lesson plans and coaching logs. The coaches in this study collected lesson plans that they collaboratively planned and implemented with teachers. When teachers used an established curriculum that did not require modification, no lesson plans were collected (e.g., Code.org, Code Studio activities). Coaching logs were a combination of naturalistic observations of the classroom during scheduled coaching periods and email correspondences that described the instruction. Notes vary in length depending on the type of coaching activity (i.e., model teaching, co-teaching) administered during a given class period. These coaching logs, along with collected lesson plans were coded and included in the structured coding scheme. Codes related to CS content and activities as well as pedagogical approaches embedded in the lessons and notes. Example codes included (a) Type of session (e.g., class observation, co-planning, co-teaching, debrief); (b) grade level; (c) inclusive strategies (e.g., whether UDL was noted, explicit instruction, student collaboration, and (d) classroom materials needed or used for instruction.

Teacher interviews. A semi-structured interview protocol of ten questions was developed to address questions about coaching supports and pedagogical approaches for meeting the needs of students with disabilities. Interviews took approximately 25-30 minutes. Questions were refined based

on a previous study (Ray et al., 2018) wherein questions were piloted and field tested. Example questions included: (a) We are interested in how students with disabilities are included in CS/CT instruction. Can you talk about the experiences of your students with disabilities this year? Probe for examples; (b) what strategies do you think helped students be successful during CS/CT? (c) What types of coaching activities did you participate in this year? Probe: Was there any specific CS content that was new to you? (d) what types of supports did you receive to make CS accessible to students with disabilities? (e) Is there anything else you would like to tell us either about coaching this year or about the needs/supports for students with disabilities? The 23 teachers in this study were all interviewed. All interviews were audio recorded and transcribed. This process involved one member of the research team transcribing the interviews followed by another member checking for accuracy and correcting errors in transcription. The research team then coded the first interview together to discuss codes and emerging themes. Through this process, codes were further operationalized and refined. They then analyzed a second interview independently and compared data analysis. This process resulted in further clarification of codes.

Observations of coaching sessions and instruction. Observations of CS classes were conducted using a structured observation protocol that was field tested for a previous study (Ray et al., 2018). This observation protocol included codes for who was teaching (e.g., classroom teacher, coach, paraeducators), and teacher and coach behaviors (e.g., modeling, encouraging collaboration, providing direct instruction, explicitly teaching vocabulary). Field notes were recorded in a three-column format with headings for time, running notes, and code abbreviations. Figure 1 provides a screenshot of the observation protocol.



Observation Date: Observer:

Classroom/grade: Number of students:

Who's teaching: (e.g., Classroom teacher, technology coach, co-teaching, student teacher, etc.)

Physical characteristics of the classroom (sketch if helpful):

Computing Content: (Briefly describe the computing/CS content taught in the lesson)

Observation Notes--Record events occurring in the classroom including the following abbreviations and ratings:

Abbreviations

- Teacher instruction: Describe with examples.
  - modeling (MOD)
  - Whole class (W), small group (G), individual (I)
  - Encouraging collaboration (COLLAB), Pair programming/dyads (P)
  - UDL (UDL)
  - Direct/explicit instruction (DI), Student Inquiry/Problem Solving (SI), Project-based learning (PBL)
- Explicitly taught vocabulary (general and computing related) VOC
- Assessments (ASMT)
- Teaching challenges experienced during the lesson (e.g., issues related to tech not working, content confusion, etc.) T-CHAL
- Student challenges experienced during the lesson S-CHAL

Time	Running Notes	Abbreviation(s)

Figure 1. Screen shot of classroom observation protocol.

Interrater Reliability. Cohen's Kappa coefficient (Cohen, 1968) was computed to ascertain the level of interrater reliability among the researchers who analyzed data for each of the two case studies. Kappa scores range from -1 to +1 with scores of 0.61 to 0.8 indicating substantial agreement and scores above 0.81 indicating near perfect agreement. As mentioned above, four researchers analyzed the data. Two of the researchers analyzed data from District X and the other two analyzed data from Woodside

School. However, all four researchers discussed overall code descriptions and examples in order to ensure consistency between the two case studies. After refining the codes in the interview transcripts, lesson plans, and coaching notes, Cohen's Kappa reliability was computed between the two researchers for District X at Kappa = 0.86 ($p < 0.001$) and for Woodside School at Kappa = 1.00 ($p < 0.001$). To maintain a high interrater reliability, 20% of data sources were coded by each of the two-member research teams.

Cross Case Analysis. Once individual case study data analysis was completed, cross-case analysis was conducted and focused on similarities and differences in the instructional coaching approaches. Cross-case analysis was an inductive analytic approach where a general explanation across the two cases was built (Merriam, 1998; Yin, 1994). Emerging themes and subthemes across data from both case studies were extracted. These themes related to coaching approaches that were used across settings (e.g., co-planning and co-teaching), pedagogical approaches that the coaches modeled and encouraged (e.g., modeling, project planning), and teacher capacity building (e.g., increasing teachers' understanding of CS/CT concepts). When differences in coaching approaches were exposed in the data, these differences were also extracted (e.g., differences in familiarity between coaches and teachers as well as accountability structures). In this way, the two case studies were constantly compared to the other in order to gain a robust understanding of the two coaching models. Themes that emerged from the individual case studies and cross-case analysis were then provided to the participants for a member-check procedure (Patton, 1999). This process allowed the participants to corroborate themes, offer additional explanation, or question the researchers about the analysis. As a final step, the research team shared the themes that emerged from the cross-case analysis with the participants and requested feedback.

RESULTS

RQ1: What coaching supports did teachers receive to address the needs of students with disabilities?

Across both coaching settings, teachers and CS coaches engaged in two interrelated coaching supports: Co-planning and co-teaching. Co-planning involved lesson development, discussions of material, and reflection. Co-teaching involved lesson implementation that ranged from coach-led to teacher-led instruction. All teachers participated in each of these coaching

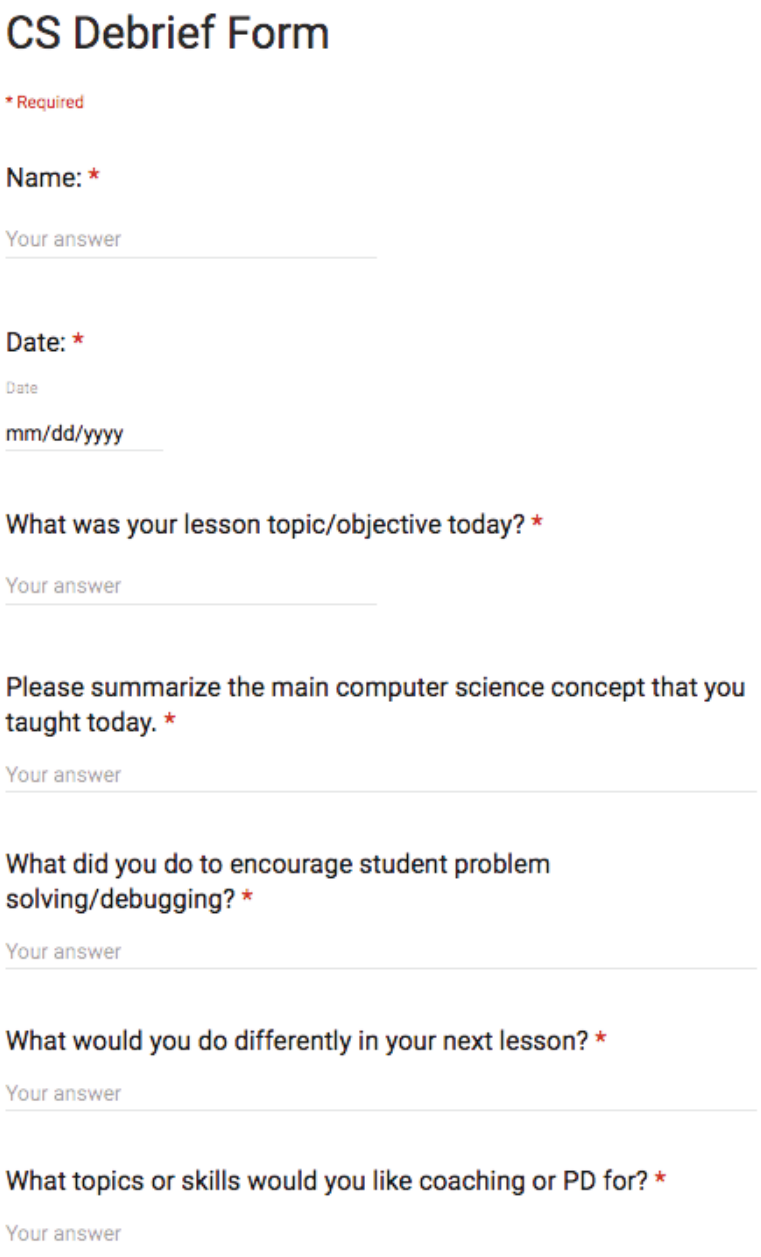
activities, but the amount spent in each coaching support varied among the teachers.

Co-planning. Both the school-embedded coach, Ms. Davidson, and the district-based coach, Ms. Simmons, worked with the teachers in co-planning CS activities. Co-planning addressed four areas: (a) materials and lesson logistics, (b) CS content knowledge, (c) CS instructional pedagogies aimed at diverse learners, and (d) lesson debriefing and reflection. All participants in this study indicated that co-planning sessions were critical to implementing CS instruction. Mr. Norris, a second grade teacher who worked closely with Ms. Davidson stated, "During these meetings, we share what direction we want to take our instruction. Our discussions focus on planning out lessons, gathering materials, discussing key teaching points, assessments, and ensuring that the lessons align with our code standards." Ms. Simmons attempted to schedule and implement weekly co-planning activities with the teachers across the schools with whom she worked. These sessions involved reflections on previous instructional experiences as well as the creation of lesson plans. Observations of co-planning meetings revealed that Ms. Simmons typically began by asking teachers about their general impressions, concerns, and successes. These conversations led to discussions about next steps and goals for upcoming instruction. Planning for upcoming instruction often became about the question, "What comes next?" Because CS was a new subject area to most teachers that Ms. Simmons met with, they were in the process of gaining experience to know which skills build on other skills and to map out the full pathway to a bigger learning goal. For example, several teachers would finish teaching loops, but not know how to connect loops to the next concept in the curriculum or how they might extend the concept of loops to better prepare students to apply the skill.

Ms. Simmons used a structured question protocol that led teachers through this reflective process. During these conversations, she took notes in a Google Doc that she later shared with the teachers (see Figure 2). Ms. Davidson took a different approach wherein she met quarterly with teachers in grade-level teams for half-day sessions. During these sessions, the CS coach and teachers reflected on previous CS instruction, discussed goals for the upcoming quarter, and made plans for instruction for that quarter. Figure 3 provides an example from Ms. Davidson's planning notes with a fourth grade teacher. According to Ms. Davidson, debriefing conversations typically focused on both challenges that students had and suggestions for making instruction more engaging and accessible for those learners. Planning conversations focused on four types of CS activities: (a) unplugged activities that introduced CS concepts, (b) instruction in online programs that teach

CS such as Google CS First or Code.org Code Studio, (c) general projects in the Scratch programming environment such as students animating their names, and (d) integrated CS activities into content areas such as mathematics, science, and language arts. Ms. Davidson also met with teachers quarterly for one 40-minute planning period. During these times, the principal also joined the meetings to learn how CS was implemented across the grades. Ms. Davidson indicated that it was important for administrators to understand how CS was implemented in order to continue to receive buy-in from the administration. In addition, Ms. Davidson met with the teachers whenever they requested at lunch, after school, or during the teachers' other planning times, although she indicated that she hesitated to take more time than allotted since the teachers did not have a great deal of planning time across subject areas.

Materials and logistics conversations. A major task that both coaches engaged in involved providing resources, tools, and instructional materials to teachers with whom they worked. Consequently, co-planning discussions often focused on what materials were needed for upcoming lessons (e.g., creation of algorithm cards with visuals and words for Code and Go Robot Mouse, copies of students' coding journals). Alongside materials-related conversations, the coaches and teachers discussed logistics associated with those materials such as time to retrieve materials and laptops and procedures for helping students with logins.



CS Debrief Form

* Required

Name: *

Your answer

Date: *

Date

mm/dd/yyyy

What was your lesson topic/objective today? *

Your answer

Please summarize the main computer science concept that you taught today. *

Your answer

What did you do to encourage student problem solving/debugging? *

Your answer

What would you do differently in your next lesson? *

Your answer

What topics or skills would you like coaching or PD for? *

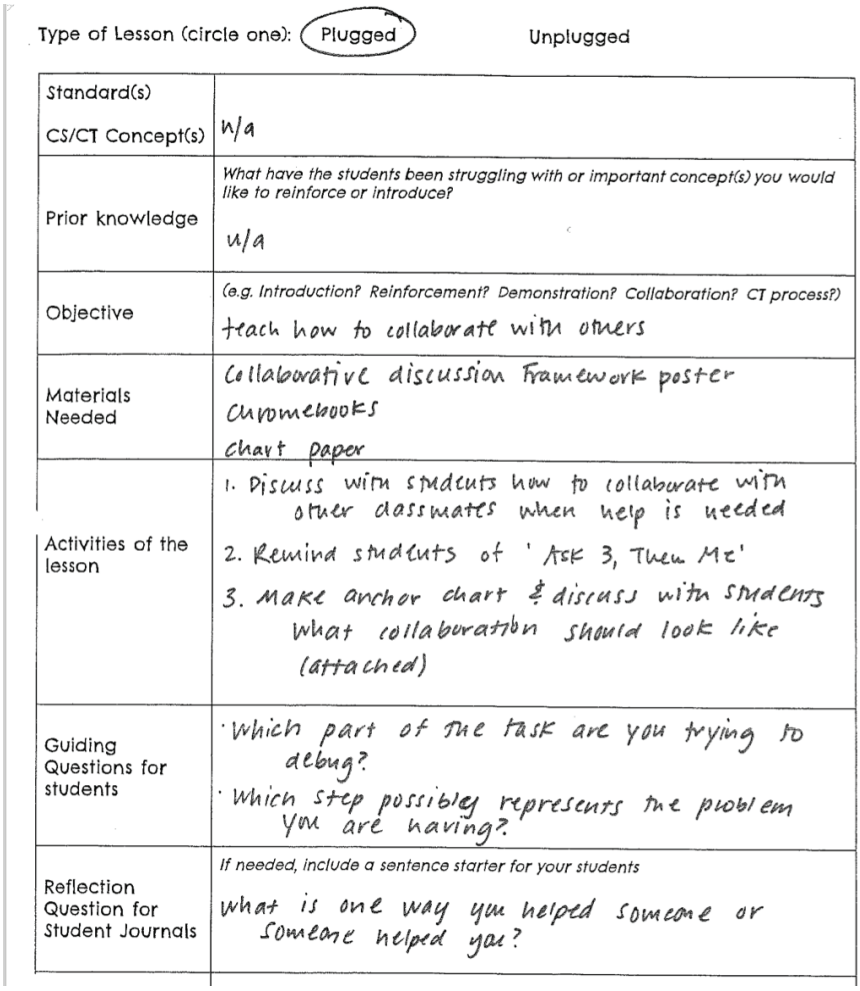
Your answer

Figure 2. Google Form Question Protocol used by Ms. Simmons.

In both coaching models, the coaches found resources at the schools and from outside resources (e.g., securing the Dash and Dot robots for a robotics lesson). These resources also addressed general CS instruction (e.g., finding lesson plans to teach debugging strategies) and curricular resourc-

es specific to meeting the needs of students with disabilities (e.g., creating scaffolded learning materials). In most of these cases, the coaches developed materials rather than expecting teachers to create the materials on their own, especially with novice CS teachers. Because Ms. Simmons worked with novice CS educators, she developed instructional materials. Ms. Davidson also did a great deal of materials development, but she stated that more experienced teachers did not request as many materials developed. For example, Ms. Lee, a kindergarten teacher with four years of CS teaching experience, did most lesson planning and materials development independently and only relied on Ms. Davidson for occasional support.

CS Content. CS content conversations typically involved clarifications about big ideas critical for lesson implementation. These conversations typically involved discussions about how the lessons taught tied to computational thinking (CT) ideas such as understanding how programs can be revised to increase the efficiency of those programs or how conditional logic can be used to add sophistication to programs. Ms. Davidson stated that teachers often had gaps in knowledge about these computational concepts as well as how they could convey these concepts to students. For example, she discussed a conversation in which a teacher asked about the difference between a program and algorithm, so they unpacked the similarities and differences. Ms. Simmons also reported having CS "big idea" conversations with teachers. She stated that she had several conversations with teachers around the topic of conditionals and conditional logic. Ms. Simmons explained that some of the CS curricula and tools that teachers used to teach did not clearly differentiate between the broad concept of "conditionals", the "if" statements used to program conditionals, and the Boolean data type. Teachers often asked for clarification about the relationship between these concepts. These conversations often led to additional discussions about how to bring vocabulary and big ideas into instruction.



Type of Lesson (circle one): Plugged Unplugged

Standard(s) CS/CT Concept(s)	n/a
Prior knowledge	*What have the students been struggling with or important concept(s) you would like to reinforce or introduce?* n/a
Objective	*(e.g. Introduction? Reinforcement? Demonstration? Collaboration? CT process?)* teach how to collaborate with others
Materials Needed	Collaborative discussion framework poster Chromebooks chart paper
Activities of the lesson	1. Discuss with students how to collaborate with other classmates when help is needed 2. Remind students of 'Ask 3, Then Me' 3. Make anchor chart & discuss with students what collaboration should look like (attached)
Guiding Questions for students	· Which part of the task are you trying to debug? · Which step possibley represents the problem you are having?
Reflection Question for Student Journals	*If needed, include a sentence starter for your students* what is one way you helped someone or someone helped you?

Figure 3. Coaching planning notes from Woodside Elementary School.

Co-planning discussions focused on CS content did not occur in isolation. These conversations cycled between clarification and expansion of CS content and instructional pedagogy, as the teachers were more interested in making sure that they were teaching the CS content in an authentic and accurate manner. Consequently, when discussing CS content, it was always in the context of language to use with students and clarification of how to reinforce those concepts within activities. For example, when discussing the concept of an algorithm in CS with Ms. Stone, K-2 special education teacher, Ms. Simmons explained that the term *algorithm* was used for a procedure that can be implemented in a step-by-step manner. This conversation led to how algorithms can be taught to students using ideas with which the students were familiar. At the end of this co-planning discussion, Ms. Stone and Ms. Simmons created a visual of students washing their hands along with the definition, "A list of steps you can follow to finish a task".

CS instructional pedagogy. A third co-planning activity involved conversations about CS pedagogy. These conversations were the predominant interactions observed across settings. Pedagogy conversations included strategies for differentiating instruction for individual learners and whole-class strategies. Ms. Parker, a first grade teacher from Woodside, explained, "We talked about ways to differentiate for students and we gather materials that we'll need for the lessons we're doing...We think about what we'll do and reflect on what works [which] helps us make decisions." Ms. Rice, another teacher from Woodside, discussed whole-class strategies that Ms. Davidson suggested including pre-teaching big ideas to help struggling learners.

A whole-class pedagogical approach that Ms. Simmons discussed with all her teachers was Universal Design for Learning (UDL). Coaching logs and lesson plans indicated that these conversations involved conversations about providing additional instructional delivery options such as including additional ways of representing information (e.g., not only through print materials) or allowing students to demonstrate their understanding (e.g., not only through paper and pencil assessments such as journaling). For example, Ms. Simmons explained that CS is commonly taught with a heavy reliance on text since all professional programming languages are text-based. Consequently, she worked with teachers to identify options for teachers to convey new information to their students such as incorporating hands-on coding instruction with manipulatives and physical activities as well as the use of multi-media coding instruction with videos, visual guides, and interactive tutorials.

Problem solving and debugging are both core processes in CS learning. These processes naturally bring up feelings of frustration. Both Ms. Davidson and Ms. Simmons assisted teachers in anticipating students' frustration when encountering "buggy" programs and planning options to help them stay engaged when they experience frustration. In a lesson plan that Ms. Simmons created with Ms. Stone who is a special education teacher working with students in grades K-2, for example, the following explanation was written, "Engagement: Students will receive side coaching for managing difficult emotions. Students will receive scaffolding (bug basket) and reinforcement (stickers and verbal praise) for practicing persistence while building."

Co-teaching. Both coaches spoke about the need to co-teach to support teachers who had limited experience in CS instruction or lacked confidence in their CS teaching skills. However, they differed in how they saw their roles as co-teachers. Whereas both acknowledged the need to strategically

balance their role in supporting teachers in implementing instruction by modeling effective CS instruction and encouraging the classroom teachers to teach themselves, the way in which they navigated this balance between teaching the students and supporting the teachers differed. Ms. Simmons indicated that although the teachers with whom she worked often wanted her to teach the first few CS classes, she found that the teachers were less likely to take on more teaching responsibilities in future classes if she took the initial teaching responsibility. In these situations, Ms. Simmons created opportunities for fairly simple CS activities that the teachers would feel comfortable leading rather than lead instruction. On the other hand, Ms. Davidson was observed taking on a more active instructional role with teachers new to CS education and then deliberately passing on teaching responsibilities to the classroom teachers as they gained confidence and experience. For example, Ms. Hunter, the art teacher who was coached by Ms. Davidson, explained that it was helpful to "watch other people do it [teach CS], doing it yourself, and then having the support to go for ideas and questions."

An additional variable introduced in District X was the use of co-teaching between general education and special education teachers during CS instruction to meet the needs of students with disabilities. Whereas Woodside included co-teaching in core academic classes, District X also included co-teaching during CS instruction. There were more adults in the class to support students with disabilities including special education teachers and paraeducators. In these cases, Ms. Simmons capitalized on the naturally occurring co-teaching arrangements between the CS teachers and special education teachers. For example, in one 5th grade classroom, Ms. Simmons set aside time to meet with Ms. Carlson, the 5th grade math teacher. Because Ms. Carlson received more intensive coaching, she could lead the class while Ms. Simmons coached the special education co-teacher on supporting student problem solving during the class period.

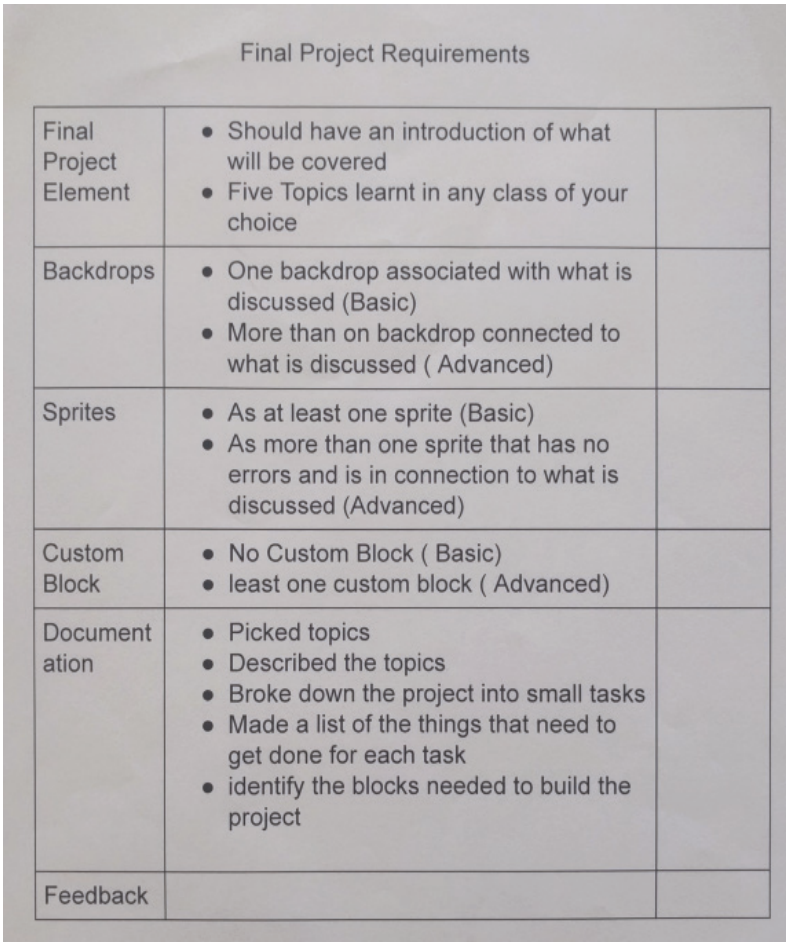
RQ2: What strategies did coaches provide for teachers to include students with disabilities in K-8 CS activities?

Teachers were asked to meaningfully include students with disabilities in CS instruction, even if they were general education teachers with no special education experience. Rather than overwhelming teachers, the coaches gradually built up teachers' practical knowledge. This "just in time" model allowed for teachers to immediately apply new strategies in the classroom as they learned them. Additionally, strategies that the coaches suggested for

including students with disabilities directly addressed successes or challenges that the teachers and coaches observed.

Instructional strategies to support students with disabilities. All teachers identified one or more specific instructional strategies that they had learned from the coaches to meet the needs of learners with disabilities. Examples of instructional strategies included: protocols for planning complex CS projects, strategies for managing student collaboration, and providing students with immediate feedback. Each teacher expressed that these strategies worked well in their classrooms and transformed their experience of teaching CS.

Project planning protocols. All the teachers described strategies to help students work through complex multi-step CS projects, including elements of software design and development such as identifying the needs of the user, planning, and iterating based on testing and user feedback. Ms. Baxter, the music teacher at Woodside, described a conversation with her CS coach wherein they discussed strategies such as scaffolding projects by beginning with a planning page and then transitioning to a CS activity. She explained that this process helped students think about what they want to do. She also stated that Ms. Davidson suggested that her students journal about their experiences with computing to reflect on successes and challenges. Both coaches worked with teachers to develop checklists to help students plan projects and monitor their own progress. Sometimes checklists were required to be filled out and sometimes teachers provided all students with checklists but allowed them to choose whether they wanted to use them or not. Figure 4 provides an example checklist that Ms. Simmons created with Ms. Gonzalez, a sixth grade teacher, to clarify the necessary components of the projects.



Final Project Requirements

Final Project Element	• Should have an introduction of what will be covered • Five Topics learnt in any class of your choice	
Backdrops	• One backdrop associated with what is discussed (Basic) • More than on backdrop connected to what is discussed (Advanced)	
Sprites	• As at least one sprite (Basic) • As more than one sprite that has no errors and is in connection to what is discussed (Advanced)	
Custom Block	• No Custom Block (Basic) • least one custom block (Advanced)	
Document ation	• Picked topics • Described the topics • Broke down the project into small tasks • Made a list of the things that need to get done for each task • identify the blocks needed to build the project	
Feedback		

Figure 4. Project Checklist Created by Ms. Simmons and Ms. Gonzalez.

Promoting student collaboration. In both coaching models, the coaches worked with teachers to create strategies to help students collaborate more effectively. For example, coaching notes from Ms. Davidson and Mr. Norris, a second grade teacher, included an anchor chart for help giving/help seeking. The "collaborator" roles included two tasks: (a) You must be kind, and (b) You must help the seeker find the answer but not give the answer to them. The roles of the person seeking help also included two tasks: (a) First try two debugging strategies, and (b) Next, find someone close to you who will help you learn. This task also included the prompt, "You must be able to tell them what you were trying to do and what two strategies you've already tried." Thus, Ms. Davidson and Mr. Norris discussed an explicit help-seeking and help-giving strategy to help students work together. Ms. Simmons also co-developed scaffolds for peer collaboration. In one classroom, the students were given handouts with questions for helpers and sentence starters for help seekers. The first question and sentence starter

were, "What do you want your sprite to do?" and "I want my sprite to…." In another example, the teacher developed a graphic organizer based on four types of feedback (clarifying, valuing, stating concerns, and suggesting) each type of feedback had sentence starters and questions to consider. In *clarifying,* one question was, "Are there aspects of this work that you don't understand?" Both coaches encouraged teachers to utilize collaboration, such as pair programming, and encouraged teachers to introduce student collaboration strategies through modeling and explicit instruction. Thus, both coaches helped the teachers create opportunities to teach students how to collaborate.

Providing immediate feedback. A main strategy seen across both school sites was the emphasis that the coaches put on providing immediate, corrective feedback to the students. This immediate and corrective feedback was not, however, focused on providing students with explicit steps to solving problems. Both coaches emphasized the importance of "think aloud" techniques in which teachers would guide the students to think about their own thinking. These "think alouds" included questioning and making statements to help the students clarify their problem, steps that they attempted, and strategies for solving their problem. Both coaches encouraged teachers to shift their mindset from helping students create code that runs correctly every time to moving students towards independent problem solving and creative expression. In one example, Mr. Langley, a third grade teacher that worked with Ms. Simmons described a strategy that was implemented related to assisting students. He explained:

> Another thing that was really big that she [the coach] supported was actually teaching students to debug a problem as a group. I wanted to just straight up help them…. instead of saying, "Oh, what direction do you need to go to get to the point?" "How many blocks did you use?" Instead of saying "Use this block. Use that block," give them explicit instruction [about how to problem solve].

The coaches and teachers differentiated this strategy by using various forms of formative assessments and self-assessments. In a fifth grade classroom that Ms. Simmons was co-teaching, for example, the teacher gave students three colored cups. The students put the red cup on top of their desks if they needed help, the blue cup if they were doing ok, and the purple cup if they felt they had mastered the concept and could help others. This teacher also had an observation sheet that she used to check off both CS concepts that each student used that day in their program, as well as problem solving behaviors and attitudes that each student displayed while working.

RQ 3: In what ways were coaching supports similar and different between school-based coaching as compared to district-based coaching?

Similarities between coaching models. In both school-based and district-based coaching models, the primary objectives of the coaches were similar. Both coaches focused heavily on two primary areas: building trust with the teachers and building CS teaching instructional capacity.

Trust building. Both coaches discussed trust-building within coach-teacher relationships. Observation notes revealed that coaches spent time asking reflective questions and acknowledging teachers' concerns. When asked about trust building, Ms. Davidson explained:

> The first thing I make sure I do is have a good and trusting relationship with whomever I am coaching. I think teachers need to know that I am not there to correct them or tell them what they are doing is wrong, but I am there to support them and make them better.

Similarly, Ms. Simmons expressed that building trusting relationships with teachers is the foundation of coaching. She explained that teachers must feel safe to take the risk in teaching CS and in having reflective discussions that involve receiving feedback on their teaching. She stated:

> The best compliment I ever received was when a teacher said, 'I wish you could just be my co-teacher! Even though I am in the position of coaching this teacher, she not only trusts our relationship, she trusts me with her classroom. That is a really big deal!

Thus, the coaches indicated that to help improve teaching practices, they had to establish trust.

Teacher capacity building. A common theme between coaches was a focus on teacher capacity building. As indicated above, both coaches engaged in a range of supports, including co-planning, co-teaching, resource sharing, and reflecting. Within these supports, there was an effort to scaffold the teachers towards increased independence by building their CS knowledge and teaching skills. Especially when working with teachers with limited CS experience, the coaches shared lesson plans and modeled instruction. During co-planning, the coaches often demonstrated how to use CS tools as well as ways of using the tools for instruction. For example, in observing Ms. Davidson in a coaching session with a kindergarten teacher, the special education teacher, and the paraeducator who supported students

with disabilities, coaching took the form of both introduction to tools and brainstorming how to use them for students with disabilities. Ms. Davidson introduced the teachers and paraeducator to the Code & Go Robot Mouse, the KIBO robot kit, and the codeSpark Foos. The teachers and paraeducator had time to explore. As they did, Ms. Davidson spoke with them about how they might use these tools for instruction, with a particular focus on how to support the students with disabilities. Thus, this exploration time involved a focus on tool familiarity as well as pedagogy. Ms. Simmons used a similar approach. She set up self-directed stations that allowed teachers to explore tools such as Dash & Dot and Scratch Jr. After teachers had a chance to use the tools themselves, then they transitioned into individual or grade team discussions about using them for instruction.

As teachers gained expertise, the coaches shifted responsibilities to the teachers. For teachers with greater comfort with technology, both coaches began shifting co-planning and co-teaching responsibilities sooner. In fact, both coaches indicated that when working with teachers with limited CS teaching experience who had interest in technology, they could shift more CS teaching responsibilities sooner than those with more CS experience but with lack of comfort with technology in general. Ms. Davidson explained that one of the third grade teachers with whom she works was fearful of technology, so her coaching strategies resemble those used with newer CS teachers. On the other hand, a new fourth grade teacher to the school, Ms. Franklin, has taken on a great deal of CS planning and teaching ownership this year. Ms. Davidson explained that Ms. Franklin, "asks a lot of questions about the capabilities of what her kids can do. She's doing a unit on the human body and wants to see if there is a Scratch project to integrate." Thus, although Ms. Franklin still needed a great deal of support, she began to explore instructional ideas and used the CS coach as a resource to implement her own CS teaching goals.

Differences in Coaching Models. The primary differences between school-based and district-based coaching models were (a) the level of familiarity between the coaches and the teachers, (b) accountability mechanisms, and (c) planning time logistics.

Level of familiarity between coaches and teachers. A major difference between the school-embedded coach and the district-wide coach was the level of familiarity between coaches and teachers. Whereas Ms. Davidson had a fairly informal relationship with the teachers, Ms. Simmons had a more formalized relationship with teachers. Although both coaches structured their coaching sessions (e.g., discussion of successes and challenges, and future lesson planning), Ms. Davidson conducted coaching sessions in-

formally whereas Ms. Simmons used a structured coaching guide with a set question protocol.

The different coaching approaches resulted in differing levels of familiarity between coaches and teachers. Ms. Davidson was a classroom teacher at Woodside Elementary School for seven years prior to becoming the CS coach. Thus, she knew the teachers in her school prior to her role as a CS coach. Ms. Davidson explained that she established credibility with teachers as they knew her as a trusted colleague prior to forming a coaching relationship. On the other hand, Ms. Simmons was new to the teachers and only had interactions with them during the co-planning and co-teaching times. Thus, there were limited opportunities for relationship building outside of CS coaching. Ms. Simmons acknowledged both the advantages and disadvantages of the limited familiarity she has with the teachers that she coaches, "I'm a neutral party. I'm not involved in school politics. On the flip side, I'm not part of the school community".

Accountability mechanisms. Both coaches stated that they needed to be accountable to school and district administration, but the ways in which they provided data that would be used for accountability differed. Ms. Simmons created a structured coaching protocol to both maintain professionalism during the coaching sessions and to provide data that could be used both for teacher and coach accountability. She stated that several school administrators requested coaching reports for each teacher. Ms. Simmons acknowledged that investing in CS coaching was an expensive proposition for the school district (e.g., paying substitute teachers to work in classrooms to allow teachers to co-plan with the CS coach). Summaries of coaching notes provided a record that administrators could use to support their decision to invest in CS education, provide data that teachers were implementing CS, and provide data that the coach was spending the necessary time in both planning and co-teaching with the teachers.

Ms. Davidson also discussed the need for accountability and administrator buy-in, but she was only accountable to administrators in one school. Her strategy for informing the administration about CS activities in the school was to invite the principal to the quarterly 40-minute meetings with the teachers. With only one building administration, this strategy was possible. When considering the number of schools with whom Ms. Simmons worked, the school-embedded accountability model used by Ms. Davidson would not be possible.

Co-planning logistics and structure. Although both coaches co-planned with the teachers, plan time was structured differently in each instructional context. The coaches both indicated, however, that decisions related to planning time had less to do with the coaching model; rather, they

were related to administrative decisions about time for planning and teaching.

Three primary differences emerged between co-planning processes between Ms. Simmons and Ms. Davidson. First, whereas Ms. Davidson had fewer, but longer planning times, Ms. Simmons met more regularly with the teachers, but these meetings were shorter in length. Second, Ms. Davidson met with multiple teaches at once in either grade-level teams or collaborating teachers (e.g., the art and music teacher working together) as compared with Ms. Simmons, who met with each teacher individually to plan, create lesson plans, and reflect on instructional practices. Lastly, although both coaches communicated through email with teachers, Ms. Davidson made use of virtual communication to a greater extent than Ms. Simmons. Often, the teachers would send requests, ask questions, and make plans with Ms. Davidson through email. This reliance on virtual communication occurred because the teachers and coach at Woodside did not meet as regularly as those in the Northeastern school district.

Ms. Simmons stated that her primary virtual interactions with teachers were sharing of coaching notes as a record of the conversations. Often, she shared the question protocol that she used to debrief with the teachers (see Figure 2). This question protocol allowed the teachers the opportunity to reflect on their instruction and provide Ms. Simmons with feedback about what supports the teachers requested. Although they did not plan virtually, however, Ms. Simmons did state that the teachers invited her into their Google Classrooms and shared lesson artifacts with her. However, the primary planning occurred face to face.

DISCUSSION

This study investigated school-embedded and district-wide CS coaching for supporting teachers working with students with disabilities. One goal of the current investigation was to unpack the types of supports that CS coaches provided to teachers as they implemented CS instruction for students with disabilities. To this end, this study revealed several findings about the roles of CS coaches. First, findings highlighted how in both school-embedded and district-wide CS coaching, co-planning and co-teaching played an integral role. Second, the study revealed how the coaches tailored their responses to challenges and successes that students with disabilities faced in CS. Most common pedagogies across both coaching settings included scaffolded CS project planning, supports for student collaboration, and immediate feedback.

Implications for Future Research

CS content and pedagogy. Findings highlighted the need to further examine how CS coaches support teachers in including students with disabilities in CS educational experiences. In this study, the goals of the CS coaching were similar across both sites. Teachers in both settings needed support with co-planning, material development, and co-teaching. Especially for new CS teachers, it was important for the coaches to guide them in integrating pedagogical strategies for meeting the needs of students with disabilities. As consistent with Shulman (1986) and Knight (2009), both coaches focused on content knowledge and pedagogy. They provided "just in time" support to teachers within their own instructional practice (Darling-Hammond, 2006). However, because CS education pedagogy at the K-8 level is still emerging, coaches and teachers in this study had to adapt instructional practices from other content areas to CS education.

Both of the coaches in this study implemented instructional strategies to support students with disabilities based on challenges they observed. For example, in both settings, the coaches created CS project planning guides as graphic organizers that provided an anchor for students to situate their understanding, plan for multi-step projects, and receive feedback from their teachers. However, there are no examples of the use of evidence-based practices such as CS project planning graphic organizers in the CS education literature, so the coaches and teachers had to rely on experiences from other disciplines (e.g., inquiry science). Future research should investigate how evidence-based practices for supporting students with disabilities from disciplines such as K-8 mathematics and science can translate into CS education. Rigorous research on CS instructional pedagogies that address the needs of all learners, including those with disabilities, is necessary to guide coaches and teachers in finding, adapting, and using instructional strategies that are most effective for meeting the needs of their diverse learners.

Teachers' comfort with CS and technology. Both coaches stated that the biggest predictor of need for support was comfort with technology as compared to experience with CS education. Although the teachers required considerable support from the coaches, the coaches explained that those teachers willing to experiment with new technologies progressed towards more independence faster than those with more experience with CS who were hesitant about technology adoption. This finding was consistent with research about intrinsic and extrinsic barriers to technology integration (e.g., Ertmer, Ottenbreit-Leftwich, & York, 2006). Extrinsic barriers include lack of time and lack of technical support while intrinsic barriers include teachers' beliefs about the role of technology in teaching and whether their teach-

ing is more teacher-centered as compared to student-centered (e.g., Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2016). When examining this finding in light of COR theory, which posits that teachers operate with a limited set of resources that they deploy strategically, (e.g., Alacon, 2011) as well as barriers to technology integration (e.g., Ertmer et al., 2006), it seems intuitive that K-8 teachers new to CS may be overwhelmed by these new teaching responsibilities, especially those who struggle with integrating instructional technologies into their teaching. However, few studies investigate the relationship between CS teaching efficacy, beliefs about technology integration into teaching, and supports that enable teachers to expand technology experience within CS education. Future research should further investigate intrinsic and extrinsic barriers and enablers of CS-specific technology integration as well as unpack the interrelated nature of coaching supports (e.g., co-planning, co-teaching, materials sharing), teachers' knowledge of CS instruction and pedagogy, their comfort with using technology, and teacher self-efficacy as related to teaching CS. For example, in both coaching sites, teachers identified lack of time for planning as a major barrier. However, because there is a complex relationship between teachers' pedagogical beliefs and their views on instructional barriers, the common issue related to lack of time may be a greater barrier for some teachers as compared to others.

Limitations of the Present Study

Findings from this study should be interpreted in light of several limitations. First, drawing conclusions may be limited due to the small sample size of coaches. Additionally, as this study focused on supports that CS coaches provided to help teachers meet the needs of students with disabilities, findings may or may not generalize to broader CS coaching supports. Thus, this study should be replicated both with a larger sample of coaches and teachers as well as with the inclusion of a broader range of learners including dual language learners, additional students with disabilities, and students at risk for academic failure due to poverty. Lastly, although both coaching sites included paraeducators, the paraeducators were not included in this study beyond observations where they were present alongside teachers. Given the critical role that paraeducators provided to students with disabilities, their voices would have added additional depth to the analysis.

CONCLUSION

This study illustrated how CS coaching took place within both school-embedded and district-wide models. As this study suggests, co-planning and co-teaching were critical supports for K-8 teachers in meeting the needs of students with disabilities in CS activities. To effectively include students with disabilities in CS instruction, school districts must provide teachers with the tools, supports, and resources. Providing coaching for CS can be a way to meet these needs.

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