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Balancing teachers' needs in times of crisis: investigating how computer science instructional coaches and teachers navigated remote professional development during COVID-19

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ABSTRACT

This study investigated how Chicago Public Schools (CPS) computer science (CS) teachers and instructional coaches navigated remote professional development (PD) during the pandemic. Analyzing multiple sources of qualitative data, we explored how coaches adapted PD to address teachers' unique needs and how teachers experienced remote PD. We found that the coaching team designed PD to help teachers translate key instructional strategies into the remote learning environment and increasingly centered their PD design efforts on improving teacher engagement and wellbeing. Teachers primarily valued the relational aspects of PD, including opportunities for collaboration and personalized support from instructional coaches. Leveraging an ecological framework, we found that the pandemic and remote learning contexts amplified preexisting PD challenges experienced by teachers and coaches. Findings suggest that PD researchers and designers should focus on teacher wellbeing and that districts should invest in flexible and adaptable PD structures to meet CS teachers' varied needs.

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Exploring computer science; professional development; instructional coaching; COVID-19; teacher wellbeing; qualitative methods

In 2016, Chicago Public Schools (CPS) became the first district in the U.S. to establish Computer Science (CS) as a high school graduation requirement (Barrow et al., 2020). This policy pressed CPS to rapidly expand the Exploring Computer Science (ECS) curriculum and teacher professional development (PD) program, recruit new CS teachers, train other-content teachers to teach CS, and provide PD to CS teachers with varied professional backgrounds and experiences (McGee et al., 2022). Since students' opportunities to take CS courses depend on the availability of qualified teachers, and students' learning experiences and outcomes depend largely on teachers' opportunities to continually develop their practice, maintaining a robust system of teacher PD is imperative to the district's goal to ensuring equitable access to CS education. Yet, the disruption of COVID-19 threatened to halt the district's progress in providing PD to CS teachers and increasing students' access to high-quality, equitable CS instruction.

As schools nationwide shifted to remote instruction in March 2020, a long-standing research practice partnership (RPP) comprised of university CS faculty, educational

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researchers, curriculum designers, and CPS teachers and administrators developed a remote PD series ("ECS-Remote") to support ECS teachers with teaching virtually. Drawing on qualitative data, this study investigates how CS instructional coaches and teachers in CPS navigated remote PD during the pandemic. We found that, consistent with their original goals, the coaching team emphasized several key instructional strategies and supported teachers in translating those strategies to the remote learning environment; additionally, the coaching team increasingly centered their PD design efforts on improving teacher engagement and wellbeing. Teachers primarily valued the relational aspects of PD, including collaboration with other teachers and personalized support from coaches. Finally, our analyses showed that the pandemic and remote learning contexts amplified, rather than created, the PD challenges experienced by CS teachers and coaches while also providing opportunities to innovate with different PD structures.

This study makes several contributions to research, policy, and practice. First, this study contributes to research on CS teachers' experiences with remote PD during COVID-19 and illustrates how the pandemic created a window of opportunity to innovate with PD structures. Second, leveraging recent research on effective PD (Darling-Hammond et al., 2017; Desimone & Garet, 2015; Short & Hirsh, 2020) and an ecological perspective on teacher learning (Ehrenfeld, 2022), this paper demonstrates the analytic utility of situating PD within multiple, interacting contexts and suggests that future education research concerning the pandemic should account for preexisting institutional conditions and crises. The context of the pandemic and protests against racial injustice, as well as broader policy efforts to expand historically marginalized students' access to CS, illuminated the need for future ECS PD to redouble its efforts to help teachers develop and implement culturally responsive lessons. Finally, findings indicate that PD could be designed to focus both on content and teacher wellbeing and provide opportunities for teachers to build community during and beyond contexts of crisis. In what follows, we first present our literature review and conceptual framework. Next, we describe our data sources, analyses, and findings. We conclude with implications for research, policy, and practice.

Literature review

In this section, we overview research on CS teacher PD related to the following themes: efforts to expand CS education and recruit and train new CS teachers; culturally relevant education (CRE) in the CS context and implications for teacher PD; and, the challenges and opportunities of teacher PD during and beyond the pandemic.

Expansion of computer science education and teacher professional development

Over the past decade, school districts, states, the federal government, and external organizations have made a concerted effort to increase students' access to CS education (Barrow et al., 2020). Such efforts, including the Obama administration's CS For All initiative (2016) and new state and district policies positioning CS to fulfill high school graduation requirements, necessitated the recruitment and training of new CS teachers (McGee et al., 2022; Yadav et al., 2016). One of the most common barriers to expanding students' access to CS education reported by school and district leaders is the lack of

qualified CS teachers or funds to train other content area teachers to teach CS (Barrow et al., 2020; Bruno et al., 2022). Given the relatively small number of teacher candidates graduating with a CS teaching license, non-CS teachers are often asked to teach CS courses. Thus, efforts to expand students' access to CS education rely on the recruitment of and ongoing PD for CS teachers, particularly those without CS backgrounds.

Recent studies have documented the substantial increase in CS teacher PD programs over the past decade and common challenges and affordances of expanding PD opportunities to CS teachers. Ni et al. (2021) recent literature review of 41 different PD programs and professional learning communities (PLCs) for CS teachers found that effective CS PD programs share characteristics with other-content area PDs, including content focus, active learning, and coaching (Darling-Hammond et al., 2017; Desimone & Garet, 2015) with additional features specific for CS education. For example, studies have emphasized the importance of focusing on CS content knowledge and pedagogical content knowledge (PCK) and providing teachers with contextualized follow-up classroom support in implementing new strategies (Mouza, Codding, et al., 2022). Other specific design features of CS PD programs are highly collaborative in nature and include the teacher-learner-observer model, pair programming, lesson design contests, and lead teacher model (Ni et al., 2021). Additionally, PLCs for CS teachers have been found to increase teachers' self-efficacy and collaboration, empower educators as decision-makers and co-creators of CS curriculum, strengthen teachers' PCK, and provide support and a sense of community for CS teachers (Dogan et al., 2016; Ni et al., 2021).

CS PD programs employ in-person, hybrid, and remote formats (Ni et al., 2021). One program that began experimenting with virtual and hybrid PD before the pandemic is ECS, a widely used, introductory CS program consisting of a yearlong course curriculum and extensive teacher PD programming. ECS is inquiry-driven and emphasizes problem solving, computational practices, and modes of inquiry associated with CS over specific syntax or tools and was designed to provide all students, especially those from historically underrepresented backgrounds in STEM fields (e.g. women, Black, and Latinx students), with an introduction to the field of CS (Goode & Margolis, 2011; Goode et al., 2014). The ECS teacher PD program involves a summer institute, quarterly workshops, and a follow-up summer workshop (Goode et al., 2014). One specific design feature of ECS PD is the teacher-learner-observer model, which involves small groups co-planning and co-teaching an assigned lesson, other participants acting as students, PD facilitators serving as silent observers, and everyone having time to debrief, reflect, and replan based on feedback and discussion (Goode & Margolis, 2011). A study of an online ECS PD program noted a surprising result of "the excitement teachers expressed for being part of a national learning community of teachers, even when more local teachers might be available for collaboration" (Goode et al., 2020, p. 57). The authors posit that this remote PD option is especially needed to reach CS teachers across large geographic areas, such as rural communities.

Culturally relevant education in computer science and implications for professional development

Students from historically marginalized backgrounds benefit academically, socially, and emotionally when their learning environments reflect and affirm their cultural

and linguistic assets, community values, interests, and lived experiences (Gay, 2002; Ladson-Billings, 1995; Villegas & Lucas, 2002). Culturally responsive (CR) teaching leverages "the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" (Gay, 2002, p. 106). CR teachers create classroom environments that encourage student sense-making, involve students in inquiry projects that have personal meaning to them, and promote conversations about topics that are relevant to students but often excluded from class discussions (Villegas & Lucas, 2002). While some scholars distinguish between culturally relevant pedagogy (Ladson-Billings, 1995) and culturally responsive teaching, we use the terms "culturally responsive" (CR) and "culturally responsive education" (CRE) throughout this piece to encompass these and other related frameworks.

CRE frameworks specific to the CS context advocate for developing CR curriculum and equipping teachers with the pedagogical skills to make learning relevant, responsive, and affirming to students given their identities (Davis et al., 2021; Leonard & Sentance, 2021; Madkins et al., 2020; Morales-Chicas et al., 2019; Scott et al., 2015). While efforts to broaden participation of historically marginalized students (e.g. CSforAll, ECS, Black Girls Code) are important for diversifying CS and STEM fields, CRE frameworks in CS argue for moving "beyond participation narratives to address pervasive inequities, racism, and racist practices within CS education and the computing, tech, and related fields … to empower students to integrate their computer science knowledge with efforts to solve issues relevant to minoritized communities" (Madkins et al., 2020, p. 6). For example, the Culturally Responsive-Sustaining CS Framework (Davis et al., 2021) argues for acknowledging racism in CS, enacting anti-racist practices, creating inclusive and equitable classroom cultures, using rigorous curriculum and pedagogical moves to encourage socio-political critiques, centering of student voice and agency, incorporating family and community assets, and exposing students to diverse professionals and role models in CS and technology-related careers. From its inception, ECS embraced CR pedagogical practices. During ECS PD, teachers discuss the role of bias in CS education through by discussing *Stuck in the Shallow End* (Margolis et al., 2010) and reflect on the equitable practices exemplified in the teacher-learning-observer experiences.

Nonetheless, research indicates that many teachers struggle to connect theories of CRE to practice (Ladson-Billings, 2008). The infusion of CRE in STEM courses lags behind that of other subject areas (Brown et al., 2019), and PD on STEM content/pedagogy is often separate from PD on CRE (Hudley & Mallinson, 2017). Unsurprisingly, then, a survey of 3,700 CS teachers found that less than 60% of teachers felt equipped to use CR pedagogies, believed their existing curricular resources were CR, or felt confident about incorporating critical discussions of computing's role in society and as a driver of inequality (Davis et al., 2021). Research on a CRE-focused PD program for ECS teachers found that, although teachers embraced learning about students' identities, they felt overwhelmed by the amount of student data they received from student surveys and were unsure about how to adapt lessons in CR ways based on this information (Blazquez, McGee, & McGee-Tekula, 2023). These findings illustrate how, even with PD, many teachers struggle to infuse CRE practices into their instruction.

Challenges to providing effective professional development for computer science teachers

Many PD structures developed for the CS context (e.g. pair programming, lead teacher model, and lesson design contests) are considered "innovative" forms of PD, in that they engage teachers in collaborative, active, and contextualized learning (Darling-Hammond et al., 2017; Ni et al., 2021). However, the recent expansion of CS education also created unique challenges for training the rapidly growing cadre of CS teachers. For example, many CS teachers are "instructionally isolated" (Patrick et al., 2023), or the only CS teacher within their schools (Goode et al., 2020; Yadav et al., 2016). Instructionally isolated teachers lack access to meaningful collaboration and community, which highlights the importance of PD – especially PLCs – to teach CS content and instructional strategies and build community among CS teachers (Ni et al., 2021).

Another PD challenge unique to the CS context stems from the small number of licensed CS teachers, resulting in teachers from various other content area being assigned to teach CS (Bruno et al., 2022; Goode et al., 2020; McGee et al., 2022; Yadav et al., 2016). For example, after enacting the graduation requirement, CPS tripled the number of new CS teachers it added each year with a greater number of teachers becoming CS teachers through PD, compared to those who earned CS endorsements (McGee et al., 2022). The volume of teachers coming from content areas outside of CS increases the likelihood of PD sessions involving participants with a wide range of needs (Bruno et al., 2022).

Overall, prior to the pandemic, the rapid expansion of CS education in the U.S. created a demand for new CS teachers and an increase in CS PD programs. Despite the many successes and innovations of CS PD and PLC models, the rapidly expanding field of CS education confronts the challenge of supporting instructionally isolated teachers and teachers with a wide range of CS backgrounds and PD needs.

Professional development for computer science teachers during COVID-19

COVID-19 emerged while many states and districts were in the process of expanding CS education and adopting policies requiring students to take CS. To meet the demand for new CS teachers, districts continued providing PD throughout the pandemic in virtual formats. Virtual CS PD programs existed before the pandemic and have been effective in increasing teachers' CS content knowledge, PCK, efficacy, and sense of community (Goode et al., 2020; Ni et al., 2021). Studies of remote CS teacher PD during the pandemic found that virtual PD increased teachers' knowledge and confidence and that teachers valued many aspects of virtual PD, including opportunities for collaboration, networking, and learning CS content (Crick et al., 2021a; Mouza, Mead, et al., 2022; Skuratowicz et al., 2021). Despite the stress and uncertainty of the pandemic, a study of remote PD designed for elementary teachers around infusing computational thinking found that proactively addressing teachers' technological issues, creating "shared physical experiences" (e.g. mailing materials, props, personalized water bottles, and snacks ahead of time), infusing combination of individual and group activities, and giving teachers agency to move to different "rooms" created an engaging and positive PD experience (Skuratowicz et al., 2021). Further, a multi-national study found that compared to other teachers, CS teachers had significantly more positive attitudes toward

online teaching; however, CS teachers expressed concerns about their abilities to effectively teach about technology in an online setting and their increased workload (Crick et al., 2021b).

Emerging studies of CS teacher PD during the pandemic have shown the effectiveness of remote CS PD programs to overcome some of the disruptions caused by the pandemic and improve teachers' efficacy and content knowledge. At the same time, research on the teacher workforce in the context of COVID-19 has documented increases in teacher burnout, stress, working hours, intentions to leave the profession, and actual turnover (Bacher-Hicks et al., 2023; Diliberti & Schwartz, 2023; Diliberti et al., 2021; Gicheva, 2021; Goldhaber & Theobald, 2023). Because many CS teachers are drawn from other subject areas, broader teacher workforce trends are inextricably linked to the future of expanding CS education. While studies of CS teacher PD during the pandemic focused primarily on the design features of PD and teachers' immediate perceptions of PD, we know less about how CS teachers and PD providers experienced remote PD within multiple contexts: the pandemic, their schools and districts, and broader policy efforts to expand students' access to CS education.

Conceptual framework

To investigate the intersection of CS teacher PD and the COVID-19 context, our conceptual framework combines insights from research on effective teacher PD and a novel framework emphasizing the multiple, intersecting contexts of teacher learning. Effective PD refers to "structured professional learning that results in changes in teacher practices and improvements in student learning outcomes" (Darling-Hammond et al., 2017). According to a commonly used framework, shown in Figure 1, PD should lead to improved student learning outcomes by fostering shifts in teachers' knowledge, skills, beliefs, and attitudes and subsequent changes in teachers' practice (Desimone, 2009; Desimone & Garet, 2015).

Combining insights from recent literature (Darling-Hammond et al., 2017; Desimone, 2009; Desimone & Garet, 2015; Short & Hirsh, 2020), we identified and defined nine core components of effective teacher PD. These include content focus, active learning, coherence, sustained duration, collective participation, modeling of effective practices, focus on

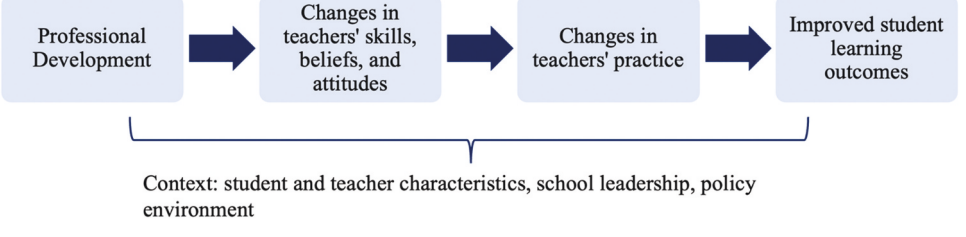

Figure 1. Typical framework for analyzing professional development impacts. This figure depicts a typical framework for analyzing professional development, originated by Desimone (2009), p. 195.

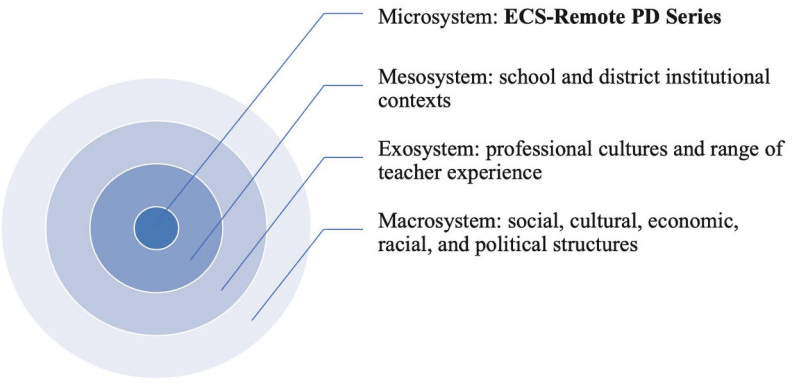

Figure 2. Ecological perspective of ECS-Remote PD series. Adapted from Ehrenfeld (2022).

equitable instruction, change management, and opportunities for feedback, coaching, and reflection (see Appendix A).

Given the unique and unprecedented set of circumstances created by COVID-19, and the challenges associated with the rapid expansion of CS education over the past decade, we leverage an ecological framework to situate our analysis of the ECS-Remote PD series within multiple contexts. Ehrenfeld (2022) argues that the typical PD model (i.e. Figure 1) overlooks how multiple contexts and their interactions shape teacher learning. Applying Ecological Systems Theory (Bronfenbrenner, 1992) to PD research draws attention to multiple contexts of teacher learning, the interconnectedness of these contexts and teacher learning activities, and how teacher learning in PD is shaped by different phases of teacher learning trajectories (Ehrenfeld, 2022). As shown in Figure 2, we situate the ECS-Remote PD series in its immediate context (microsystem), the school and district institutional context and remote instruction policies (mesosystem), the context of teachers' professional backgrounds and experiences with PD (exosystem), and the broader sociopolitical context (macrosystem), including the pandemic, economic uncertainty, and protests in Summer 2020 against racial injustice.

Research context

Chicago Public Schools (CPS) is the nation's fourth-largest school district with over 320,000 students from diverse racial and socioeconomic backgrounds (see Table 1).

Prior to the enactment of the CS graduation policy in 2016, larger schools with fewer low-income students were more likely to offer CS courses, and, overall, less than half of CPS high schools offered any CS courses. Within a year of the policy's enactment, the number of CPS schools offering at least one CS class nearly doubled, with most of that growth coming from the expansion of the ECS curriculum. These efforts led to a significant increase in the number of students taking at least one year of high school CS. Beginning with the class of 2022, around 14,000 students graduate from CPS each year having taken a year of CS courses. Around 80% of CPS students who take CS in are low income, Black, or Latinx/Hispanic students, which matches the demographics of students in the district (McGee et al., 2022). While equitable access to introductory CS coursework

Table 1. CPS student enrollment characteristics.

Demographic Categories	% of Students
Race/Ethnicity	
Hispanic	46.9
Black/African-American	35
White	11.1
Asian	4.5
Multi-Racial or Other Race	2.4
Other Student Characteristics	
Economically Disadvantaged	70.7
English Language Learners	24.7
Diverse Learners (Students with IEPs)	16.1

Demographic information from cps.edu/about/stats-facts (Chicago Public Schools, 2022).

has increased, some disparities remain in students' course-taking patterns. For example, White, Asian, and male students are overrepresented in Advanced Placement CS classes, relative to CPS as a whole (Barrow et al., 2020).

ECS-Remote professional development series

In March 2020, responding to the immediate challenges of transitioning to remote instruction during COVID-19, the RPP received a grant to support experienced ECS teachers in the remote learning environment.[1] The project was guided by the following questions: 1) How can online PD be designed to support ECS teachers' transition to teaching the course fully or partially online during the 2020–21 school year? 2) How can the instructional coaching model be adapted to support teachers in moving ECS to a remote learning format and to provide remote coaching when school access is restricted?

The RPP designed the "ECS-Remote" PD series to support experienced ECS teachers with their implementation of equitable and inclusive instructional strategies for the remote learning context, to encourage peer coaching and collaboration among ECS teachers, and to generate strategies for supporting teachers remotely. The RPP chose to focus the grant-funded PD series on experienced ECS teachers given that new ECS teachers were already served by existing PD programming and since most CPS students take ECS to fulfill the graduation requirement (Barrow et al., 2020; McGee et al., 2022).

The ECS-Remote PD series consisted of five workshops throughout the 2020–2021 school year, one-on-one and small-group instructional coaching opportunities, and a Coaching PLC to support the instructional coaches' professional growth. The first two-day workshop in August 2020 focused on re-grounding teachers in the ECS philosophy (teaching CS through a culturally relevant, inquiry-based approach; Goode et al., 2014), developing instructional strategies to recreate the ECS experience online, and providing teachers with strategies for fostering social-emotional connections with students. The subsequent four workshops focused on adapting ECS strategies for remote instruction and supporting teachers' use of Google suite tools to implement those strategies. Workshops 2–3 focused on adapting "think-pair-share" – a strategy used to elevate student voice; the fourth reinforced equitable

Table 2. NEXT Summer quarterly workshop attendance.

Date	Participants
August 24–25, 2020	22
October 21, 2020	15
December 9, 2020	8
March 3, 2021	7
April 28, 2021	6

questioning techniques; the final focused on adapting "pair programming" – a strategy that promotes collaboration and student voice. Table 2 shows the dates of each workshop and the number of attending teachers.

After each workshop, teachers completed a survey with close-ended and open-ended responses about their general satisfaction with the workshop and specific instructional takeaways. Although feedback surveys showed that teachers were generally satisfied or highly satisfied with the workshops, workshop attendance declined over the course of the school year from 22 participants over the summer to 6 participants by the end of April.

As part of the ECS-Remote series, teachers had several options for accessing remote instructional coaching: a Coaching Café, a Teachers' Lounge (Google classroom forum), and a teacher peer coaching program based on the Goals, Reality, Options, Will, Tactics, Habits (GROWTH) framework (Whitmore, 2010). The Coaching Café provided opportunities for teachers to engage in informal but structured discussions about different pedagogical topics. The Teachers' Lounge was designed to provide opportunities for small groups of ECS teachers to collaborate with the coaches on effective practices and teaching strategies regarding specific ECS lessons and computer science content.

Finally, to provide coaches with professional support, the RPP created a remote Coaching PLC, composed of the ECS instructional coaches in CPS and the developers of the ECS remote PD series (hereafter, the "coaching team"). The coaching team shared responsibilities for designing and facilitating the ECS-Remote workshops and met twice a month (19 times) throughout the school year. During Coaching PLC meetings, the team reflected on teachers' feedback from the previous workshop, discussed teachers' needs, planned subsequent workshops, and developed a set of coaching strategies for the remote learning environment (see Appendix B).

The design and implementation of the ECS-Remote PD series and data collection were closely integrated. In addition to disseminating feedback surveys given to teachers at the end of each workshop, researchers conducted focus groups and semi-structured interviews (Weiss, 1995) with a total of 13 ECS teachers who participated in various components of the ECS-Remote series. At the end of each Coaching PLC meeting, the coaching team revisited and updated a coaching strategies document. One member of the team summarized the group's discussion into generalized meeting notes to capture the groups' concerns and experiences at a specific time point and shared those notes with administrators in the Office of Computer Science and RPP leaders. The team's concerns and comments were generalized to preserve the confidentiality of individual members.

In Fall 2022, the research team analyzed teacher feedback surveys, interviews, focus groups, and notes from the Coaching PLC meetings and developed a technical report to share with funders and RPP members (Blaushild et al., 2022). These analyses not only provided a unique snapshot into teaching and learning in the COVID-19 context, but also yielded emergent themes related to how the coaching team understood and responded to teachers' specific needs during the pandemic, how those efforts were experienced by teachers, and teachers' desires to deepen their expertise in both CS content and CR teaching. These emergent themes sparked several new research questions, which we explore in this paper.

Research questions

(1) How did teachers and coaches navigate remote PD during the pandemic?
(2) How did the coaching team adapt PD to address teachers' specific needs during the pandemic?
(3) What elements of remote PD were most valued by participating teachers?

Methods and data

To understand how teachers and coaches experienced grant-supported professional learning opportunities, we analyzed data collected throughout the ECS-Remote PD series (2020–2021) and the subsequent two school years. By extending data collection beyond the year of remote/hybrid instruction, our study provides unique insight into how participants experienced PD during the pandemic, reflections on their professional growth over the past few years, and how the challenges and innovations of the 2020–2021 school year persisted, or not, into the post-pandemic context.

Data collection and analysis: phase 1

The first phase of data collection took place throughout the ECS-Remote PD series. After the two-day workshop in Summer 2020, all participating teachers ($N = 22$) completed a survey about their experiences in the workshop, perceptions about equitable instruction in CS, and their concerns about the upcoming school year. In September 2020, the research team conducted two focus groups via Zoom with a sample of teachers who attended the ECS-Remote workshops to gain a deeper understanding of teachers' experiences and to share general feedback from teachers with the coaching team. Toward the end of the ECS-Remote PD series, the research team recruited teachers for individual semi-structured interviews and conducted an additional teacher focus group. Due to a low initial response rate for interviews from teachers in spring 2021, the research team continued recruiting and conducting individual teacher interviews into summer of 2022. These interviews were designed to elicit a retrospective account of participants' experiences with PD during the pandemic, as well as their general perceptions of CS teacher PD opportunities and their professional growth.

To examine teachers' and coaches' experiences with PD throughout SY 2020–2021, we compiled teacher interview and focus group data and the Coaching PLC meeting notes into a single project in Dedoose and applied structured codes (Saldaña, 2013) aligned to the project's research questions (see Appendix A). We then used grounded

coding (Charmaz, 2006) to explore emergent themes and attend to participants' unique experiences and language. Predictably, preliminary analyses showed that the coaching team designed the ECS-Remote series to reinforce several instructional strategies integral to the ECS curriculum framework. However, our grounded coding surfaced emergent themes related to the coaching team's discussions of teacher wellbeing and ongoing development of coaching strategies to respond to a rapidly changing context (e.g. district policies) and COVID related challenges. These emergent themes motivated our new research questions and second phase of data collection and analysis.

Data collection and analysis: phase 2

To delve deeper into teachers' and instructional coaches' PD experiences and adaptations during the pandemic, we reanalyzed previously collected qualitative data and conducted additional interviews with instructional coaches and teachers, shown in Table 3.

Table 4 shows participants' background characteristics and level of involvement in the PD series and research activities. Given the small sample size of instructional coaches, we refer to the coaches using gender neutral pronouns and do not share their demographic information.

Our second phase of analysis involved a mix of deductive and inductive coding strategies (Miles et al., 2014). We first developed a codebook with deductive codes aligned to the study's conceptual framework. These codes included the nine elements of effective

Table 3. Data.

Data Source	Timeline of Data Collection	Number of Sources
Workshop Feedback Surveys	August, 2020 – April, 2021	5
Teacher Focus Groups	September, 2020; April, 2021	3
Teacher Interviews	April 2021 – January 2023	10
PLC Meeting Notes	September, 2020 – June, 2021	19
Instructional Coach Interviews	January-February, 2023	2

Table 4. Description of participants.

	Demographics		*PD Exposure*		*Research Participation*	
Pseudonym	Gender	Race	Workshops Attended	Coaching	Interview	Focus Group
Teachers						
Blake	M	Black	4	X		X
Shawn	F	White	1	X	X	X
Aaron	M	White	5	X	X	X
Simone	F	Black	3	X		X
Kelsey	F	White	4	X	X	X
Joe	M	White	1	X		X
Sarah	F	Black	1			X
Ruth	F	Black	5	X		X
Stephanie	F	White	4	X	X	
Eve	F	Latinx	5	X	X	X
Elena	M	Latinx	0	X	X	
Jay	M	White	0	X	X	
Kyle	M	White	0	X	X	
Sadie	F	White	3	X	X	

Demographic information for teachers was collected by the district.

PD we identified in recent literature (e.g. content focus) and the four different contexts defined in Ehrenfeld's ecological perspective for PD (e.g. macrosystem). After applying these deductive codes to all data sources, we conducted several rounds of inductive coding to capture emergent themes and participants' unique experiences, and systemically applied these inductive codes to our data (see Appendix A). Finally, we used matrices and memoing (Miles et al., 2014) to explore and examine patterns in the data. We paid particular attention to how the participants adapted to the challenges of remote instruction and which PD contexts and core components were most valued by participating teachers.

Researcher positionality and reflexivity

The authors of this paper were involved in different stages of designing and researching the ECS-Remote PD series. The first author joined the research team after the PD series and initial data collection had taken place and was an "outsider" to the CS context. Using grounded coding (Charmaz, 2006) not informed by any personal or professional experience in CS education, the first author identified several emergent themes for the team to explore and conducted additional interviews with teachers and instructional coaches. The second author joined the research team in 2021 and conducted teacher focus groups and interviews during spring and summer of 2022. Her involvement in the data collection process helped her become familiar with the structure of the ECS-Remote PD series, and her work on a concurrent project with CS teachers in CPS (see: Blazquez, McGee, & McGee-Tekula, 2023; Blazquez, McGee, McGee-Tekula, & Yanek, 2023) brought important perspectives to the discussions about this study's findings and implications. The third and fourth authors were members of the ECS-Remote project team during the planning and implementation of the program and were relative "insiders" to the research context. They were not directly involved in data analysis but provided input on the research design and tools and details about program implementation.

To overcome potential issues of reflexivity stemming from these different perspectives and entry points into the project, we discussed analyses, findings, and implications in regular meetings and compared descriptive and analytic memos to inform our analyses and interpretations of the data. These varied perspectives amplified our analysis by prompting each research team member to consider and develop novel insights.

Limitations

Low teacher response rates in Spring 2021 prompted the researchers to continue recruitment and data collection into 2022 and early 2023. Although this extended recruitment allowed for the research team to include more teacher and instructional coach perspectives, their accounts may be less detailed than data captured closer to the PD series. However, we use workshop feedback surveys, taken by teachers immediately after each workshop, and the Coaching PLC notes, taken immediately after each bi-monthly meeting, to triangulate teachers and coaches' retrospective interview accounts. Further, while interviews are not designed to capture individual's situated behaviors or in-the-moment accounts, they are uniquely positioned to capture individuals' meaning making, imagined scenarios (e.g. ideal professional development programming), and cultural scripts (e.g.

perceptions of equitable CS education; Lamont & Swidler, 2014). Moreover, the individual interviews prompted teachers to reflect on their experiences with remote PD during the pandemic and more broadly about their professional growth and experiences with PD throughout their time teaching CS.

Our study documented the declining participation in the ECS-Remote workshops, the coaching teams' challenges with teacher engagement, and several participating teachers' discussions of why they did not attend a particular PD. However, due to the selection bias issue of teachers who opt into research activities, we do not have a full picture of non-participating teachers' reasons for not engaging or gradually disengaging from CS teacher PD during and beyond the pandemic. Although PD programs provide useful opportunities to recruit teachers for research, future studies should seek to include CS teachers who do not attend PD to understand their needs and potential barriers to accessing PD.

Findings

In this section, we elaborate on our findings. We found that, while the primary goals of the ECS-Remote PD series were to reground teachers in key ECS instructional strategies, the coaching team's main PD adaptations and teachers' most salient takeaways were relational. The coaching team increasingly centered teacher wellbeing and devised multiple opportunities for teachers to engage with coaching and PD. Teachers primarily valued opportunities for collaboration and community-building with other CS teachers, sharing instructional strategies and resources with other teachers, and the personalized instructional and emotional support provided by coaches. Finally, leveraging an ecological perspective on teacher learning (Ehrenfeld, 2022), we found that while the macro-level impact of COVID-19 disrupted teaching and learning on an unprecedented scale, many of the challenges surfaced by teachers and coaches stemmed from school and district institutional contexts (i.e. mesosystem), which predated, though may have been exacerbated by, the pandemic (i.e. macrosystem). Notably, many teachers expressed a disconnect between their expectations for PD and current PD offerings, especially those related to CS content and equitable instruction. While remote instruction created opportunities for PD innovations, challenges in the mesosystem (i.e. district) may inhibit the expansion of those innovations.

Centering instructional and emotional support through professional development

Consistent with their original goals, the coaching team primarily designed the ECS-Remote series to help teachers adapt ECS lessons to the online environment. However, as shown in Figure 3, the coaching team also frequently discussed teachers' wellbeing.

Focusing on a narrow set of instructional strategies

As the district rapidly transitioned to remote instruction in March 2020, one of the instructional coaches reflected feeling "a little bit of panic" given their lack of experience teaching virtually. However, throughout the 2020–2021 school year, the coaching team committed to (re)grounding teachers in the ECS philosophy and supporting teachers in translating key ECS teaching strategies (e.g. think-pair-share and pair programming) to the remote learning environment.

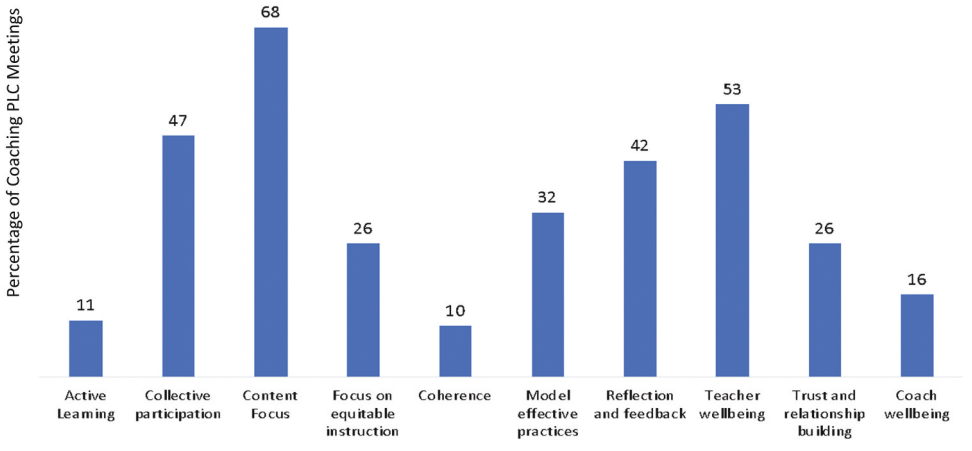

Figure 3. Topics covered in coaching PLC meetings.

Teachers' feedback on the two-day summer workshop in August 2020 was largely positive. All 22 teachers indicated that they were "satisfied" or "highly satisfied" with the workshop, and 95% of participants reported increasing their understanding of inquiry-based strategies during the workshop. In open-ended survey responses, teachers shared that discussing strategies in small groups (breakout rooms), peer reviewing each other's lessons, experiencing activities from the "student perspective" in the online environment, and working with new resources as a group helped prepare them for the upcoming school year. Teachers also reported that the summer workshop informed their approach to teaching remotely by introducing them to resources and concrete examples of how to teach each lesson. One teacher reflected on how the workshop helped them realize that "we don't need to change the curriculum, just figure out how to use different tools to carry out the lessons with students".

However, teacher focus groups and workshops surfaced some teachers' frustrations that the workshops were lacking in teaching "CS content". Responding to this teacher feedback, the coaching team realized they needed to change how they framed and presented key ECS instructional strategies to teachers, which they believed would help students access CS content through an inquiry-driven approach. Planning for the quarterly workshops, the coaching team noted that, when introducing an instructional strategy, they would provide teachers with a pre-reading or some other evidence to provide external validation of the importance of the strategy. They also planned to model the instructional strategy during workshops and coaching sessions and follow up the modeling with a discussion about how participants engaged in the strategy as learners. The coaching team formalized this idea into one of their instructional coaching strategies: "We need to keep focused on the one central goal of a PD session … and let that one goal drive the activities. With that, the activities need to be limited in scope to allow time for modeling of effective questioning and elicitation of response/engagement". (Coaching PLC Meeting Notes, 24 February 2021). By focusing on one key strategy at a time, the coaching team aimed to convey the importance of these strategies to students' success in ECS and provide teachers with enough time to implement and reflect on these activities.

Teacher wellbeing and engagement

In addition to focusing on a narrowed set of instructional strategies, the coaching team increasingly discussed and attempted to address teachers' wellbeing. In an interview, one instructional coach reflected on their main priority at the beginning of the 2020–2021 school year:

> I believe just teacher wellness. Number one, making sure they were okay and their families were okay. And just allowing them the opportunity or just having that safe space to even share with us maybe what they were going through, you know, at that particular time. So really being a good listener, I feel, was extremely important and valuable.

While the pandemic created unprecedented challenges for teachers' mental and physical health, focusing on teacher wellbeing was not new for the instructional coaches. In an interview, the other instructional coach described their takeaways from attending a PD prior to the pandemic on instructional coaching as partnership (Knight, 2010):

> One of the things that was high on our list was, first, you know, meeting the teacher, learning about them, and trying to build that trust. And there are sometimes where, you know, I would go to a school and with the intent on, okay, we're going to learn – we're going to focus on the binary numbers lesson and think of some strategies to get students more engaged … [but] I ended up in the session just letting the teacher talk and we didn't talk about binary numbers. We talked about, you know, what's happening in the school or with them … sometimes I felt like a therapist [laughs] … and [as coaches] we were completely okay with that.

This example shows how instructional coaches understood their roles as encompassing both instructional and emotional support for teachers and adapting their coaching strategies to teachers' specific needs. This became essential to their work during the pandemic.

Shifting to remote instruction and dealing with uncertainties of the pandemic were enough to focus coaches' attention on teacher wellbeing. This focus became even more critical as CPS began discussing plans for the return to in-person instruction in 2021, a decision met with strong responses (for and against) from parents and community members and intense opposition from the Chicago Teachers Union (CTU) (Koumpilova, 2021). Since students could opt to return in-person or continue learning remotely, teachers were required to simultaneously deliver instruction in-person and virtually (i.e. hybrid). The PLC meeting notes documented the coaching team's awareness of teachers' anxiety about returning to their buildings and learning how to teach in a hybrid format. In early December, the team articulated that "there is a noticeable combination of fatigue and worry regarding the prospect of teaching simultaneously in-person and remotely … there is no perfect solution and it's taxing for teachers to manage both audiences at once". Although high schools were the last to reopen in April 2021 given the additional challenge of managing crowded hallways during transitions (Kunichoff, 2021), the coaching team noted throughout January and February that teachers appear "very exhausted and stressed" and that "all feels very overwhelming".

The coaching team took teachers' stress into account when planning PD. Looking ahead to the final workshop, the team discussed their priorities of infusing the strategy of pair-programming into the workshop but also keeping teacher wellbeing front of mind. In the spring, the PLC notes included this discussion: "If we can do something constructive

and at the same time emphasize that survival is the number one goal . . . What are some ways we can help each other with this and acknowledge that perfection is not the goal?" (Coaching PLC meeting Notes, 9 April 2021). In this case, the coaching team adapted their approaches to designing and facilitating PD in response to multiple, intersecting contexts: the pandemic (macrosystem), tensions over reopening schools between the district and teachers union (mesosystem), and teachers' new responsibilities to deliver hybrid instruction (exosystem).

In addition to addressing teacher wellbeing during the unprecedented context of the pandemic, the coaching team confronted the challenge of declining participation in ECS-Remote workshops (from 22 teachers in August 2020 to 6 teachers in April 2021) and declining email response rates from teachers throughout the year. Concerned about not reaching enough teachers, the coaching team devised several ways of communicating with and providing instructional support to teachers, including newsletters, virtual classroom visits, virtual one-on-one check-ins, and small group coaching sessions.

Since teacher feedback on post-workshop surveys was generally positive, it is possible that teachers' declining attendance indicated something other than disliking the workshops. One teacher explained,

> We just get so overwhelmed, you know, as teachers. . . . we just have so much going on, and so much to do constantly. And so, it's you know, it's like nice during summer, you meet some people, you talk to them. But when the school year really gets going, you know it's just a couple emails here and there, and then optional sessions that I don't even really feel like I have the time for. (Kyle, ECS teacher)

Throughout the Coaching PLC meetings, the team acknowledged that despite participating teachers' positive feedback, many ECS teachers were not engaging with any instructional coaching or PD opportunities.

Professional development innovations

In response to challenges shaped by the intersecting contexts of the pandemic, district structures, and varied needs of CS teachers, the coaching team devised several innovative PD strategies, some of which persisted beyond the 2020–2021 school year. For example, noticing a lack of teacher interest in one-on-one meetings, the instructional coaches developed for small-group virtual coaching sessions called "Coaching Café". The goals of Coaching Café were to discuss and model instructional strategies, talk through a challenging upcoming lesson, and provide a space for teachers to talk to each other and coaches about problems of practice. Although the coaches were dissatisfied with overall levels of teacher engagement in virtual PD, they noted that Coaching Café helped improve teacher participation in instructional coaching. Participation improved even further when the district used leftover funds from the grant to provide stipends for teachers who attended PD.

The coaching team also innovated by initiating virtual classroom visits. Before 2020, CPS purchased video equipment and a cloud service for teachers to record their instruction and share videos with their coaches, but few teachers took advantage of the opportunity. However, teachers became more open to the idea of virtual classroom visits during the pandemic, which allowed the coaches to address several preexisting PD challenges. In the past, the coaches noticed that teachers were often reluctant to schedule

in-person meetings given the time commitment, and in-person classroom visits often required coaches to drive from one end of the city to another to meet teachers at different schools. Virtual visits became a more efficient and logistically easier option for coaches to observe classroom instruction and meet with teachers and increased teachers' willingness to meet with coaches.

Virtual classroom visits, coupled with Coaching Café, also helped coaches understand teachers' challenges in the remote environment. As one coach explained:

> We had never taught virtually before, you know. So it was an opportunity for us to grow and to see how things were developing and happening in their space. And as a result of that to be more solution oriented around how can we best support them in this space.

Although CS teachers and coaches confronted numerous and unexpected challenges during the pandemic, remote instruction created a window of opportunity for the coaching team to devise new ways of engaging teachers in PD and building their own skills as instructional coaches.

Teachers primarily valued collaboration and community

Above all else, teachers primarily valued the relational aspects of the ECS-Remote PD series, which included opportunities to collaborate with other CS teachers and build a professional community. Figure 4 shows the PD elements teachers described in interviews and focus groups as being the most valuable.

While content focus was also highly valued, many teachers shared that they learned the most about different instructional strategies and resources from collaborating with other teachers.

In addition to the instructional benefits of sharing resources and ideas with other teachers, five teachers discussed gaining a sense of community with fellow CS teachers and coaches throughout the workshops and/or coaching sessions. As one ECS teacher explained:

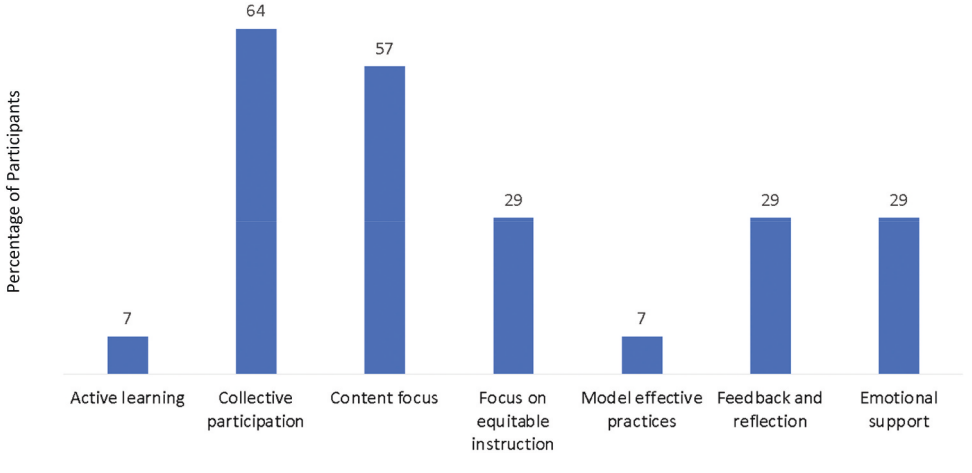

Figure 4. Most valued PD elements described by teachers in interviews and focus groups.

> It's just being able to hear other people's approaches to problems you're dealing with . . . And part of it is just the emotional connection of being able to connect with other teachers and share the struggle . . . I remember sitting down to [the last meeting] and being like I just really don't want to do this today but then really enjoying the meeting itself. Like, the hardest part is just like hitting the button to join. But then once you're there, you know, you remember. You're like, I like these people (Aaron, ECS Teacher)

Notably, many teachers described being the only CS teacher in their schools and thus relied on PD to build community and collaborate with other CS teachers in the district.

Teachers also valued developing strong relationships with their coaches and receiving individualized and emotional support during coaching sessions. As one teacher explained:

> I've come into it stressed, like it's been a hard week, I'm not sure what I am going to do. And they would always [be] just kind of very professional, supportive. They would deflate any tension. And they, on more than one occasion, made, like, trips out to [my school] to plan with me . . . it made me feel like, okay, they are there for me beyond just like a transactional "I'm your coach". Like, they developed a lot of relationships (Jay, ECS teacher)

This teacher's perception of his coach being there beyond a "transactional" relationship shows how the coaching team's extensive discussions about teachers' emotional needs and efforts to lead with empathy were evident to teachers. While ECS-Remote workshops focused on key instructional strategies, small-group and one-on-one coaching allowed for targeted, personalized support.

Interaction of COVID-19 pandemic and institutional contexts

When COVID-19 emerged, it overhauled schooling and created countless challenges for educators, affecting their PD needs, teaching challenges, and capacities to attend PD. These challenges also compelled the coaching team to develop innovative ways of supporting teachers, including small group coaching and remote classroom visits. Nonetheless, despite the unique and unprecedented challenges of a global pandemic, many of the PD challenges raised by CS teachers and the coaching team transcended the COVID-19 context. Although amplified and (re)surfaced by the context of the pandemic, the following PD challenges mentioned by participants appeared to stem from conditions in the school and district institutional context (mesosystem) and broader challenges associated with the CS teacher workforce (exosystem).

Mismatch of teachers' expectations and professional development offerings related to computer science content

In the four years following the enactment of CS as a high school graduation requirement in CPS (2016–2020), the district tripled the amount of incoming CS teachers each year, with more teachers attending PD to teach CS than earning a CS endorsement (McGee et al., 2022). While the increase in CS teachers helped to significantly expand the number of schools offering CS (Barrow et al., 2020; McGee et al., 2022), teachers' PD needs also expanded.

Though teachers held generally positive views of ECS-Remote workshops and coaching, some teachers expressed disappointment about the lack of specific CS content included in the workshops. As Shawn, a teacher with two years of ECS teaching experience, said

> A lot of the PDs focus so much on the inquiry and equity strands that we don't ever get that third [content] strand . . . we do need those three strands, but I feel like the PDs a lot of times ignore the CS concept strand because they're like "oh, well you can Google it".

The coaching team was familiar with this common point of teacher feedback. During the 28 October 2021, PLC meeting, the coaching team noted: "There is always tension between teachers always wanting more 'content' and not wanting to focus on ECS-philosophy instructional strategies (equity/inquiry)". This theme mirrors findings from concurrent research, which found that ECS teachers often expressed feeling overwhelmed by the "equity" component of ECS and that they need to become more component in CS content before infusing equitable teaching practices (Blazquez et al., 2023b). Together, both studies point to the need to provide teachers with guidance around teaching CS content in equitable ways to address the needs of the diverse student population in CPS.

The coaching team interpreted this common critique from teachers wanting more "CS content" as possibly indicating a lack of confidence on their part, in that teachers may feel more confident in their teaching practice overall but less confident teaching CS content. While this perception from the coaching team might characterize newer ECS teachers, several experienced ECS teachers appeared ready to move beyond what ECS PD provided. In teacher focus groups and interviews, three teachers expressed their desire for PD to accommodate the needs and interests of experienced ECS and to motivate newer CS teachers to expand their CS content knowledge. They hoped that future PDs could offer support and collaboration for teachers who are ready for more advanced CS knowledge and want to teach AP CSP. As one teacher articulated, designing PDs for teachers who are ready to move forward with more advanced content could "help build the confidence of those teachers to say that I want to do more than just ECS . . . I think that we really still haven't defined like what is a transition to AP CSP". This teacher's sentiment – that some ECS teachers are interested in attending PD that deepens their CS content knowledge and prepares them to teach more advanced CS courses – was shared by other participants and highlights some ECS teachers' desires to engage in more advanced CS teacher PD opportunities. While these challenges (stemming from the microsystem, mesosystem, and exosystem) predated 2020, COVID-19 and remote instruction amplified teachers' frustrations that PD opportunities did not fit their specific needs or interests.

Teachers' perceptions of equity and support needed to deliver culturally responsive education

Although some teachers believe that ECS-Remote PD and other ECS PDs focus too much on inquiry and equity at the expense of content, others were concerned that their PD experiences did not fully prepare them to prepare or deliver equitable and CR instruction. The ECS-Remote PD series attempted to reground teachers in the ECS philosophy (namely, inquiry and equity) and help them translate ECS instructional strategies into the remote environment. Some teachers valued how the ECS-Remote series reminded them of the equity-driven teaching strategies baked into the ECS model. As one teacher explained, "I don't have to reinvent the wheel. I just need to get better at how I'm using the curriculum to make those things happen".

However, other teachers expressed frustration that they did not learn specific strategies for equitable instruction during the ECS-Remote PD series, and were, instead, prompted to come up with their own strategies without facilitator support. Most participating teachers discussed equity in terms of access to resources and opportunities and often referenced resource disparities across CPS tied to students' racial and socioeconomic characteristics. At the same time, teachers recognized that increasing students' access to CS education was not enough; they also needed to adapt the ECS curriculum to their students' backgrounds, interests, and lived experiences.

Emphasizing the unique needs of different CPS schools and communities, some teachers expressed wanting more support with tailoring the ECS curriculum to meet their students' needs and identities. As Elena, an ECS teacher, explained:

> Every school in CPS is not the same. So we all need to adjust for the needs of not just the students, but the community . . . what I got was that, from the PDs, is that they really want us to stick to this curriculum and go through, like, problem-solving, Google applied skills, all that stuff, but they don't really, like, tell us as well as, like, but make sure that when you're doing this, try to do something that is more relevant to your students.

Interestingly, Elena's and other teachers' perceptions of ECS PD contradict the aims of the ECS PD series – to model equitable and CR practices, such as structuring collaboration, validating student ideas, drawing on students' cultural knowledge, and modifying lessons for students with special needs (Goode et al., 2014). It is possible these teachers would have received more support with CR strategies in an individual or small-group instructional coaching session. And yet, their perceptions of PD highlight the persistent challenge for PD facilitators to ensure that all teachers' needs are being met, particularly related to CRE. Overall, while teachers' discussions of their PD needs related to content and equity surfaced in the context of the pandemic, these concerns illuminate the broader challenge faced by PD providers to support teachers with varied teaching backgrounds, school contexts, professional interests, and needs.

Coaching innovations and institutional barriers to expansion

The coaching team attempted to mitigate some of these challenges surfaced by teachers with innovative PD approaches (e.g. small group coaching and virtual classroom visits). However, despite seeing some success with these newer approaches, the coaching team named several institutional barriers at the district level that could inhibit these innovations from expanding. Chiefly, the coaching team remained small, and the future of the coaching program was often in-flux, a theme that surfaced throughout the Coaching PLC meetings. Feeling uncertain about the instructional coaching program's future, one coach described a lack of "opportunities to work together as a team", because "we are short staffed, so we don't necessarily have a group of or a team of instructional coaches". They were unable to continue offering the small group coaching sessions that were highly valued by teachers during the pandemic, because "I just don't have the bandwidth to do all of that and so pretty much what we have done is to, we had to find another way to support new teachers".

With almost 50 new teachers, the coaching team developed PLCs and relied on veteran teachers to lead these groups. However, this raised an additional challenge of not having the capacity to train these teacher leaders. The instructional coach explained:

> Although we've identified teachers who could be in those leadership roles, it's hard to just throw teachers in the role without training teachers . . . you still need to build their capacity. They need to have a space to learn, to grow, and to really reflect.

Here, we see instructional coaches grappling with a both district or mesosystem issue – insufficient and inconsistent investment in CS instructional coaches – and common challenge associated with CS4All initiatives (i.e. exosystem) – the increase in CS teachers outpacing the means to support them (Bruno et al., 2022; Ni et al., 2021; Yadav et al., 2016). Such challenges preceded and transcended the pandemic, despite the many strategies developed by the coaching team during remote PD.

District and community-level challenges

The coaching team's noticing of teachers' stress is consistent with reports of teachers' increased working hours, stress, and feelings of burnout across U.S. schools throughout the pandemic (Diliberti et al., 2021; Gicheva, 2021). However, the uncertainties of the pandemic and the return to in-person instruction were not the only stressors the coaching team noticed and attempted to address. The Coaching PLC notes revealed the team's concern for teachers' feelings of isolation sparked by the pandemic coupled with the trauma associated with recent incidents of community violence. During a Coaching PLC meeting in March 2021, the team noted:

> This has been a dark week for everyone. We have teachers and students who have limited to no connection or interaction, and this is damaging. Not being able to process things is unhealthy. Additionally, two ECS teachers - one local and one national – passed away and this has added layers. To experience another shooting/tragedy just adds to the massive loss (layers of loss) for people this year (Coaching PLC Notes, March 25, 2021)

These observations continued as the team planned the final ECS-Remote workshop for April 2021. The team noted, "this is a very hard time for everyone right now, especially teachers. Being mindful of emotional health is critical". They acknowledged how these circumstances can impact people "differently and we must be respectful of that".

Overall, the salience of these challenges – teachers' unmet PD needs related to content and CRE, instructional coaches' lack of capacity to expand valued PD structures, and trauma associated with neighborhood violence – shaped teachers' experiences of PD during COVID-19 but were not caused by the pandemic or the shift to remote instruction. In that way, teachers' specific PD experiences (microsystem) were shaped by multiple contexts, including the pandemic (macrosystem), the district and community context (mesosystem), and the range of teachers' CS PD experiences and professional needs (exosystem).

Discussion and implications for research, policy, and practice

This study investigated how teachers and instructional coaches navigated remote PD during COVID-19. We found that, consistent with the aims of the grant, the instructional coaching team designed the ECS-Remote PD series to reinforce key instructional strategies; and, throughout the year of remote instruction, they increasingly noticed and attended to teachers' emotional needs. Teachers reported that focusing on key instructional strategies helped (re)ground them in the ECS framework and build community with

their students in the remote environment. Teachers also expressed feeling emotionally supported by their coaches and gaining a sense of community with other CS teachers throughout workshops and small-group instructional coaching. Notably, we found that even though this study was situated in the context of COVID-19, pandemic-related challenges were less salient to participants than other teaching and PD challenges inherent to the district and broader CS education contexts. Thus, the pandemic amplified preexisting challenges for CS teacher PD throughout CPS. In this section, we discuss implications of our findings for research, policy, and practice.

Investigating multiple contexts of teacher learning

Leveraging an ecological framework in our analysis (Bronfenbrenner, 1992; Ehrenfeld, 2022) illuminated how multiple, intersecting contexts shaped teachers' experiences with and access to CS PD. First, the broader context of CS education – namely, its recent expansion and demand for new CS teachers – created several PD challenges for CPS teachers. Consistent with the research on CS teacher PD in the past decade (Mouza, Codding, et al., 2022; Ni et al., 2021), many participating teachers were the only CS teachers in their schools and/or did not have CS backgrounds. Thus, "instructional isolation" (Patrick et al., 2023) and wide-ranging PD needs were part of the exosystem shaping CS teacher learning during the pandemic.

Additionally, the local district and community context (i.e. mesosystem) shaped teachers' experiences and the need to support students through crises long before COVID-19. CPS is the fourth-largest school district in the nation and first to enact a high school graduation requirement for CS (Barrow et al., 2020), making it a unique context to study both the expansion of CS education and PD and how those initiatives were impacted by the pandemic. At the same time, many conditions in the school and district instructional contexts (i.e. the mesosystem shaping CS teacher learning) stem from broader social, economic, and political structures in the macrosystem, such as the short and long-term effects of COVID-19, rising economic and political uncertainty, and incidents of gun violence.

While this study focused mostly on the pandemic context, our analysis surfaced many challenges that teachers and coaches faced before, during, and after the pandemic. Some of these challenges are tied to macro-level conditions and history of a large urban district characterized by segregation, concentrated poverty, school closures, disenfranchisement, educational inequities, and teacher turnover (Allensworth et al., 2009; Darling-Hammond, 2014; Ewing, 2018; Ladson-Billings, 2006; Milner & Lomotey, 2014; Papay et al., 2017; Scallon et al., 2021). Although research shows that many teachers desire to work in urban and high-poverty schools, they also face numerous challenges related to school instability and insufficient resources to meet students' diverse cultural, linguistic, academic, and socioemotional needs (Andrews & Donaldson, 2009; Frankenberg et al., 2010; Kraft et al., 2015; Olsen & Anderson, 2007; Quartz, 2003; Simon & Johnson, 2015). Thus, the pandemic was a unique crisis, but one of many ongoing crises shaping teachers' working conditions and interactions with students. These challenges highlight the need for both students and teachers to receive socioemotional support, as well as the importance of CS courses helping students critically understand the role of technology in reproducing inequalities and see themselves as change agents – key components of CRE in CS (Madkins et al., 2020; Morales-Chicas et al., 2019).

Overall, adapting an ecological framework of teacher learning (Ehrenfeld, 2022) to studying the ECS-Remote PD series illuminated how the intersection of COVID-19 and preexisting conditions in the district and broader CS education field influenced teachers' PD experiences during the pandemic. By adapting this framework into the CS context, our study makes a novel contribution to the literature on CS teacher PD and indicates that future education research studying the impacts of COVID-19 should consider the multiple contexts of student and teacher learning. Further, this framework helped illuminate several implications for policy and practice, which we discuss below.

Integrating teacher wellbeing into models of effective teacher PD

The pandemic, which amplified preexisting challenges in the school and district contexts, sparked the coaching team's concerns for teacher wellbeing and attempts to address teachers' instructional and emotional needs through PD. Attending to the multiple contexts affecting teachers' experiences, this study illuminated multiple stressors for teachers and coaches that transcended the pandemic context. Given the constant challenges brought to Chicago teachers' physical and mental health by meso- and macrosystem contexts (i.e. gun violence, economic and political conditions, etc.), we suggest that teacher wellbeing should remain a focus in PD and coaching approaches in post-pandemic times. Building on emerging research on remote teacher PD during the pandemic (Crick et al., 2021b; Mouza, Mead, et al., 2022; Skuratowicz et al., 2021), our study highlights the need to account for the humanistic side of PD, as both teachers and instructional coaches discussed the importance of providing and receiving emotional – in addition to instructional – support.

The Coaching PLC team's frequent discussions of teacher wellbeing raise questions about where an explicit focus on teacher wellbeing fits into the typical model of effective PD (e.g. Darling-Hammond et al., 2017; Desimone & Garet, 2015). While the Curriculum-Based Professional Learning (CBPL) framework acknowledges different stages of teachers' concerns in response to curriculum change (Short & Hirsh, 2020, p. 35), a focus on wellbeing is not often named explicitly in models of effective PD. Our study highlights the need for PD providers and facilitators to factor teacher wellbeing into the design and implementation of teacher PD, particularly during times of crisis, in which teacher burnout and stress are more prevalent (Diliberti et al., 2021) and in other high-stress contexts for teachers (e.g. curriculum and policy reforms; Datnow, 2018; Hargreaves, 2004; Zembylas, 2010).

The various coaching models designed and implemented by the coaching team, and teachers' perceptions of instructional coaching, show that PD should be designed to attend to teachers' emotional and instructional needs. Recent evidence suggests that, across contexts, teachers experienced increased stress, feelings of burnout, and intentions to leave the profession during the pandemic (Diliberti et al., 2021; Gicheva, 2021; Pressley, 2021; Steiner & Woo, 2021), but positive working conditions and feeling a "sense of success" with students sustained some teachers' commitment to teaching (Kraft et al., 2021). Further, a teacher-level randomized study found significant and positive associations between an instructional coaching program and teachers' levels of enthusiasm about the teaching profession and their future in it (Wayne et al., 2023), showing PD can support teachers' emotional and instructional needs.

Additionally, though teacher wellbeing is more likely to be recognized during times of crisis, crisis situations often amplify, rather than create, the emotional load teachers carry in their day-to-day work (Hargreaves, 1998). While the challenges brought by times of crisis might be shared among teachers, they are also tied to the teachers' individual experiences and identities, and the specific contexts in which they live and work (Hodgen & Askew, 2007; O'Connor, 2008; Schutz & Lee, 2014, 2014). Adding systematic ways to address teacher wellbeing to teacher preparation and support is important to ensure that teachers are supported in their work as they face day-to-day challenges (i.e. within the microsystem) that often overlap with other stressors that coexist in their teaching environment (i.e. within the exosystem, mesosystem, and macrosystem). Overall, our findings suggest that PD should be designed to focus both on instruction and teacher wellbeing and provide multiple opportunities for teachers to build community, which is crucial in the context of rising teacher burnout and turnover (Bacher-Hicks et al., 2023; Diliberti & Schwartz, 2023; Goldhaber & Theobald, 2023).

Centering culturally responsive and equity-oriented pedagogies in computer science curriculum and professional development

The COVID-19 pandemic exacerbated longstanding socioeconomic and racial disparities in the U.S., which were also heightened by protests against racial injustice in Summer 2020. These macro-level events emerged in teachers' and coaches' understandings of the challenges of engaging high school students in remote instruction and the instructional coaches' commitment to centering teacher wellbeing. However, while conversations around racial justice enhanced and sparked new movements for CR pedagogies and curriculum in all subject areas, including CS, our findings suggest that the ECS-Remote PD remained more focused on broadening participation than engaging teachers in other aspects of CRE, such as critically examining the intersection of race, technology, and equity (Madkins et al., 2020).

As CPS works to move beyond increasing access and focusing on improving the experiences and outcomes for historically marginalized students, CS PD and curriculum development should leverage recent CRE frameworks, such as Culturally Responsive Computing (Scott et al., 2015) and Culturally Responsive-Sustaining Computer Science Education (Davis et al., 2021). Doing so could help teachers feel more confident delivering CR instruction in CS, since these frameworks seek to thoroughly integrate CS content and CRE. For example, since 2021, a supplemental, CRE-focused program has supported a small group of CPS teachers with making culturally responsive adaptations to their ECS lessons to help students feel more connected to course content and learn CS in meaningful ways (see: Blazquez, McGee, McGee-Tekula, & Yanek, 2023). Refining and expanding this program throughout the CS department could enhance opportunities for all CS teachers in the district to receive PD that explicitly focuses on CRE. These efforts align with the district's Curriculum Equity Initiative, which seeks to provide teachers of all grades and subject areas access to high-quality, CR curriculum as one strategy for seeking racial justice and educational equity in Chicago (Chicago Public Schools, 2023).

Investing in adaptable and flexible professional development for computer science teachers

Our findings provide insight into how PD and instructional coaching structures, particularly those designed to support teachers both instructionally and emotionally, are key

aspects of teachers' working conditions that could improve their practice and commitment to teaching during challenging circumstances. Consistent with prior research on CS teacher PD (Goode et al., 2020; Mouza, Codding, et al., 2022; Ni et al., 2021; Pollock et al., 2017), our study showed that remote CS teacher PD could effectively convey CS-specific pedagogical strategies, build community among CS teachers, and provide opportunities for teachers to share resources.

However, interviews and focus groups surfaced teachers' varied PD needs and expectations and that some teachers' PD needs were unmet. Specifically, some teachers were frustrated by a lack of opportunities to deepen their expertise with programming or learn other areas of CS, and others felt unprepared to make CR adaptations to their ECS lessons. Persistent teacher turnover rates in urban schools, the popularity of the ECS course, and continued need for CS teachers indicate that there will always be a need for introductory CS teacher training in CPS. However, our findings suggest that some experienced ECS teachers seek opportunities to expand their knowledge of CS content and additional training around CR and equitable CS instruction. Thus, during times of crisis and beyond, CS teachers of all experience levels could benefit from PD opportunities that are flexible and adaptable to their specific needs.

The Coaching PLC notes and interviews showed that the instructional coaches were aware of and able to quickly adapt to meet teachers' needs and benefited from reflecting on their own coaching practices. Given teachers' needs for differentiated PD and the instructional coaches' capacities to meet teachers' personalized needs, districts should consider developing or expanding the role of CS instructional coaches to help teachers tailor lessons to their specific school populations, an expectation of the ECS curriculum (Goode et al., 2014), and ensuring that teachers are allotted time throughout the school day and school year to access PD. Though challenging to scale, instructional coaching is recognized as a highly effective strategy for improving instruction and implementing new educational policies (Blazar et al., 2023; Woulfin, 2015, 2018), insofar as coaches are given adequate time and resources to work with teachers (Cummings et al., 2023). Further, research suggests that instructional coaches could provide the type of support that may mitigate teacher burnout (Wayne et al., 2023). As our findings suggest, coaches who are adept in supporting teachers' emotional and instructional needs can be crucial to teachers' motivation to grow their practice and persist through challenging teaching circumstances.

Conclusion

This paper presented CS teachers' and instructional coaches' experiences and adaptations to the remote learning environment during COVID-19. In designing and implementing the ECS-Remote PD series to help teachers adapt ECS to the online environment, the coaching team noticed and responded to teachers' emotional needs and developed several innovative coaching models to increase teacher engagement and support. While it is perhaps unsurprising that teachers highly valued the relational aspects of PD during the pandemic, school and district conditions and the ongoing effects of the pandemic on teaching suggest that PD programs and research should explore how PD can be designed to equally support teachers' instructional practice, development and delivery of CRE lessons in CS, sense of community, and wellbeing.

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Appendix A

Codebook

I. *Structured codes to index major categories or themes, specifically those asked about in interviews:*

(1) **Impact of ECS-Remote workshops on professional growth**: Includes participants' descriptions of how ECS-Remote workshops impacted (or not) their professional growth.
(2) **Impact of coaching on professional growth**: Includes participants' descriptions of how coaching (in SY21 or SY22) impacted their professional growth.
(3) **Impact of other professional learning experiences on professional growth**: includes participants' discussions of how other professional learning experiences (e.g. college or master's-level courses; external PD) impacted their professional growth (not ECS-Remote workshops or coaching).
(4) **Professional growth since beginning of CS teaching/coaching**: Includes participants' descriptions of how they have grown professional since they began teaching/coaching computer science.
(5) **Initial challenges**: Includes participants' descriptions of challenges that they recall facing when they first started teaching (or coaching) computer science.
(6) **Current challenges**: Includes participants' descriptions of challenges they are facing *currently* while teaching computer science.
(7) **Unmet professional learning needs from ECS-Remote workshops/coaching**: includes participants' discussions of what the ECS-Remote workshops or coaching did *not* include that they would have liked to experience during workshops or coaching sessions *must refer specifically to what ECS-Remote/coaching did not offer, not general hopes for PD (use code below for that).
(8) **Unmet professional learning needs (in general)**: includes participants' discussions of additional hopes/needs from professional development in general, not specific to ECS-Remote /coaching (i.e. in response to: "what else might the district have done to support you better?").
(9) **Valued PD Elements**: Includes specific PD structures, practices, or activities named by teachers as being valuable to their professional growth.

II. *Deductive codes aligned to conceptual framework: components of effective PD and multiple contexts of PD*

(10) **Content focus**: Includes PD's intentional focus on discipline-specific content, curriculum, and pedagogy; this includes a focus on instructional strategies, such as those integral to the ECS curriculum (i.e. inquiry).
(11) **Active learning**: Includes PD's opportunities for teachers to design, practice, get feedback on, and experience teaching strategies that they will use with their students; use authentic artifacts, interactive activities, and sensemaking strategies that they will use with their students; *not* passively listening to lectures.
(12) **Coherence**: the PD's content, goals, and activities are consistent with school and district curricula and goals, teacher knowledge and beliefs, students' needs, and school, district, and state policies.
(13) **Sustained duration**: PD activities that are ongoing throughout the school year and provide teachers with adequate time to learn, practice, implement, and reflect upon new strategies.
(14) **Collective participation**: Supports teacher collaboration and provides opportunities for groups of teachers from the same grade, subject, or school to participate in PD activities together and to build an interactive learning community. Includes discussions of sense of community, professional community for safe practice.

(15) **Modeling of effective practices**: PD includes curricular and instructional models that provide teachers with a clear vision of what practices and materials look like, including lesson plans, unit plans, sample student work, observations of peer teachers, videos, and/or case studies.
(16) **Opportunities for feedback, coaching, and reflection**: Teachers have access to coaching and expert support related to content, evidence-based practices, and their individual needs.
(17) **Focus on equitable instruction**: PD develops teachers' understandings of how to prioritize and promote equitable instruction through high expectations for students, culturally relevant instruction; PD includes efforts to builds teachers' empathy for students, challenges their beliefs about what students can do; includes efforts to support students' SEL needs.
(18) **Change management**: The PD is designed to support individual and organizational change by treating teachers as learners, addressing individuals' concerns and group challenges when implementing new instructional materials, and providing opportunities to discuss and troubleshoot issues.
(19) **Mesosystem**: Includes discussions of school and district institutional contexts, such as policies, norms, and practices (e.g. covid/remote instruction policies)
(20) **Exosystem**: Includes discussions of teachers' professional experiences, professional communities, and prior experiences with professional development; includes online (e.g. Facebook) communities if not directly aligned to ECS-Remote workshops/coaching.
(21) **Macrosystem**: Includes discussions of social, cultural economic, racial, and political structures, including the neighborhood and school community context, and larger sociopolitical climate.

III. *Inductive Codes added throughout analysis to attend to emergent themes:*

(22) **Teacher wellbeing**: Includes discussions of teachers' emotional and physical health, job satisfaction, sustainability of work, resilience, and feelings of stress, burnout, and secondary trauma.
(23) **Professional development challenges**: Includes challenges related to designing, implementing and reaching teachers through PD and teachers' barriers to attending/accessing PD.
(24) **Professional development adaptations**: Changes made by PD developers/coaches in response to perceived teacher need or other contextual factors.
(25) **Covid-19 challenges**: Includes discussions of instructional or other challenges specifically related to the pandemic (i.e. remote instruction, childcare, having to quarantine).
(26) **Trust and relationship building**: Includes discussions of intentional efforts to build trust and relationships with and among colleagues, teachers, and students; coaching as partnership.

Appendix B

Coaching Strategies Developed by Coaching Team (compiled in Coaching PLC notes)

(1) Build trust and community as top priority to obtain commitment to PD this year.
(2) Focus on listening/needs-sensing and collaboratively designing PD for teachers since we are amid many "unknowns" related to teaching environments, schedules, etc.
(3) Keep "eye on the prize" which is identifying ways to ensure the experienced ECS teachers fully understand and practice inquiry and equity-based strategies in their classrooms
(4) Regularly organize/prioritize different coaching levels/groups based on visible needs (e.g. general pool of ECS teachers for coaching, PLC, Teachers' Lounge, Coaching Café).
(5) When instructing an instructional strategy, provide *evidence* such as a pre-reading during the PD to emphasize our focus on this instructional strategy, provide validation of the strategy, and gain teacher buy-in to the strategy

(6) Model techniques (strategies) during coaching/PD, for example to elicit volunteers to talk (could do color-coding, counting off, or popsicle stick).

    (a) Model Think/Pair/Share as an instructional strategy during the PD and follow up with a group discussion about the process they engaged in "as learners" and what benefits they see for this type of strategy used with their students.

(7) Use Journaling checklists to allow (and scaffold/support) teachers' reflections on instructional strategies
(8) Establish NORMS (expectations) for participating in breakout rooms/group activities
(9) Have a concrete goal for the teachers that requires they do something between now and the next PD (accountability, productivity, engagement for students)
(10) To engage at the start of class/session: set it up, build, make connections between parts
(11) Student Care starts with Teacher Care. Weave elements from PLC PD Day into Coaching.
(12) Work directly with teachers on three ECS "big strategies" that can and should involve questioning; specifically, how can these strategies be made better by good questioning? (Pair Programming; Think, Pair, Share; Gallery Walk)
(13) Empathy continues to be instrumental in coaching and PD for teachers. COVID has caused at least two deaths of faculty in the district, and it hits home for many students and teachers; find out where teachers are in any moment and honor that in addition to providing appropriate support on content and strategies.
(14) It is critical to not to focus on pushing through activities more than paying attention to making time for rich student conversation; this is where questioning skills come into play.
(15) The choice of technical tool should be driven by the instructional goal, i.e. choose the Right Tool for the Right PURPOSE. Lead with pedagogy and selecting the tool that supports those goals.
(16) LESS is MORE. We need to keep focused on the one central goal of a PD session, e.g. authentic questioning strategies to draw out student engagement, and let that one goal drive the activities. With that, the activities need to be limited in scope to ALLOW time for modeling of effective questioning and elicitation of response/engagement.
(17) It is critical to highlight the work of teachers to provide support and recognition for their efforts – this also builds community and respect among the larger group of ECS instructors and provides models for new ECS teachers. One strategy for accomplishing this is to FEATURE ECS teachers and facilitators in monthly OCS newsletters.
(18) The importance of self-care for coaches is critical. In addition, operating with the mindset of flexibility and adapting to changing circumstances.