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The What and How of Becoming "Co-Conspirators of Social Justice" in Computing Education: Perspectives From and For High School Computing Teachers

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Abstract: Teachers play a crucial role in shaping learning opportunities within classrooms, and yet their voices are often missing from educational design efforts. Our work resists the normative roles ascribed to teachers in world-making efforts and partners with them to (re)design a justice-oriented high school computing program. We present findings from a collaborative video analysis of a co-design session (~40 minutes) where nine high school computing teachers, two researchers, and a senior designer engaged in a design activity uncovering what it means to center justice within computing classrooms and to support new teachers to teach justice-oriented computing. Teachers resisted language divorced from practice and argued for deepening and clarifying the meaning of equitable teaching practices. They emphasized ongoing professional and personal growth, relatable professional learning experiences, and opportunities for reflection as teachers become "co-conspirators" for social justice. We discuss findings in connection to STEM teacher preparation and solidarity.

Introduction

From encoded racial biases in facial recognition software to environmental harm resulting from AI adoption, STEM applications are continuing to perpetuate and amplify harm to marginalized communities (e.g., Benjamin, 2019). Such harms have led to resisting normative ways of approaching STEM disciplines as abstract and removed from people, communities, and societies, and instead moving towards integrative approaches to teach and design learning opportunities for learners and teachers (e.g., Bang & Vossoughi, 2016; Greenberg et al., 2024; Ko et al., 2024). Particularly, computing education has recently witnessed an uptick of culturally responsive and sustaining efforts such as theoretical and design frameworks and pedagogical approaches (e.g., Kafai & Proctor, 2022; Kapor Center, 2021; Vakil, 2018) and critically conscious computing programs for teachers (Ko et al., 2024).

Despite increasing interest to center justice within STEM education, teachers' role in these efforts often replicate the hierarchical power relationships between teachers, researchers, and designers—relegating teachers to a position of receiving pre-designed materials for classrooms (Philip, Martinez, Lopez, & Garcia, 2016). While theories that are guiding justice-centered work advocate for equitable STEM education, on the contrary, teachers are kept from influencing the design of tools that have implications for their professional practice, exercising agency, and having power over their professional experiences (Severance, Penuel, Sumner, & Leary, 2018; Philip, Pham, Scott, & Cortez, 2022). Furthermore, design efforts miss opportunities to learn from teachers' wisdom from classroom practice and work towards fostering sustainable relationships (Bang & Vossoughi, 2016). Co-designing with teachers lead to newer forms of activities and relationships between themselves while supporting "alternative forms of learning and knowledge development, and contributing to the intellectual thriving and well-being of students, teachers, families, and communities" (Bang & Vossoughi, 2016, p. 175). While teachers can potentially bring in a wealth of experience and wisdom, design efforts barely consider their perspectives, partly due to the perceived social value of the profession (Philip et al., 2016) and normative positionality of teachers in relation to educational design work (Philip et al., 2022).

Inspired to develop and sustain equitable partnerships with teachers, we (the first three authors) partnered with a group of high school computing teachers (five of them also co-authors) to co-(re)design a widely adopted introductory high school computer science program, Exploring Computer Science (ECS). Comparable to earlier efforts to partner with teachers and educators to understand justice-centered practices (Greenberg et al., 2024), we examined a co-design activity where teachers along with researchers and a curriculum designer designed a teacher professional development map (PD Map) for ECS. While analyzing an activity authentic to teachers' practice within this particular ECS community, we asked the research questions: (1) What does it mean to center

justice within computing classrooms? (2) What does it mean to prepare teachers to teach a justice-oriented high school computing program?

Theoretical framework

Our design and research work are guided primarily by two lines of inquiries: what it means to orient STEM education towards justice and what are equitable ways of involving teachers in the design process.

Orienting STEM education towards justice

Drawing from sociocultural, sociopolitical, and critical theories of teaching and learning, scholars have resisted the historical narrative of STEM as removed from people and communities and have raised questions such as "for what", "for whom" and "towards what ends" we teach STEM (Philip, Bang, & Jackson, 2018; Vossoughi & Vakil, 2018). Across these works is a call to attend to the social, cultural, and political contexts of teaching and learning, and their implications for the historically marginalized communities and members within them. Pushing back against theory-building as the sole intention of our design and research work, an orientation towards justice movements requires the work to be consequential (Barton & Tan, 2018) and to have implications for the lives of people that we work with (Philip, Bang, & Jackson, 2018; Bang & Vossoughi, 2016). In contrast to simplistic interpretations of justice work as moving marginalized communities towards assimilating with dominant ways of doing, knowing, and being, scholars have called for careful consideration of cultural and linguistic plurality among learners. They have also suggested consideration of the underlying power dynamics while adopting teaching practices that respond to, sustain, and revitalize cultural and linguistic practices of learners (Guiterrez & Rogoff, 2012; Paris, 2012). At the same time, they highlight the need to clarify the political vision of the discipline as we take on educational projects within it (e.g., Vakil, 2018).

Several design efforts have recently emerged within STEM education, particularly computing, to bring to life theories and ideas outlined above to attune STEM teaching and learning with social justice movements. For instance, the Kapor Center (2021) proposed a culturally responsive and sustaining pedagogical framework which involved "validating and embracing students' interests, identities, and cultural backgrounds, developing strong computing identities, and abilities to engage in larger socio-political critiques about technology's purpose, potential and impact" (p. 5). Along similar lines, several theoretical frameworks guiding these efforts (e.g., Kafai & Proctor, 2022; Yadav, Heath, & Hu, 2022) provide guidelines go beyond access (Greenberg et al., 2024) and examine entailing design work to center people, their intersecting identities, and their implications for computing teaching and learning. Despite attempts to connect the key tenets of these frameworks with teacher practice in classrooms and emphasis on pedagogy, most of them perpetuate the contentious relationships between teachers, educators, and researchers and designers, as these frameworks are generated from extant theories and research with little voice and perspectives from classrooms (with rare exceptions such as Greenberg and colleagues' (2024) work).

Teachers' role in furthering justice-oriented STEM education

Teachers can inform design efforts with critical historicity and reflexivity to disrupt the inequities for which STEM fields such as computing are notorious (Bang & Vossoughi, 2016; Engerström & Sannino, 2010). The particularly recent turn within computing education towards criticality has missed an opportunity to work in solidarity with teachers and engage them as intellectuals with wisdom from practice and lived experiences to contribute (Philip et al., 2016; Giroux, 2018). Co-designing teaching and learning opportunities with teachers is one way to address the historic deprofessionalization that teachers experience as they are relegated to peripheral roles in the design process (Philip et al., 2021). Such a participatory design approach that partners with teachers starts by recognizing the collective wisdom within teacher communities and creating opportunities for teachers to inform changes or reorientations consequential to their practice (Bang & Vossoughi, 2016; DiSalvo, Yip, Bonsignore & Carl, 2017; Philip et al., 2016; Severance et al., 2016).

Although recent within computing education, co-designing with teachers has been adopted as a design approach towards equity and educational justice broadly across STEM education (e.g., Philip et al., 2022; Greenberg et al., 2024). However, most co-design efforts that have included teachers in design efforts have done so to create opportunities for teacher learning and a more comfortable adoption of co-designed objects such as lessons or curricular materials (Kelly et al., 2019; Penuel, Roschelle, & Shechtman, 2007). Very few have approached it from a critical perspective discussed above, where co-design is explored as a design methodology to challenge the deprofessionalization of teaching, question and disrupt inequities within existing systems. One notable exception is teacher solidarity co-design, which specifically calls attention to the need to work towards educational justice and teachers' complex landscape. This approach acknowledges the power relations teachers navigate professionally while fostering mutual learning between teachers, researchers, designers, and the

communities around them (Philip et al., 2021). Such efforts include teachers as contributors and make a material difference against deprofessionalization of teachers by "highlighting teaching as a complex practice that requires growth over time" (Philip et al., 2016, p. 9). They imply a potential to learn from teachers about the support new teachers would need to further justice through STEM teaching, which is ripe for investigation.

Methodology

Context and relationalities

Our work is situated within a teacher community built around teaching an introductory high school computing program, Exploring Computer Science (ECS, https://www.exploringcs.org/). The program, launched in 2008, centers equity, inquiry, and CS concepts, and consists of teacher-facing curricular materials with six required units: human-computer interaction, problem-solving, web design, programming, computing and data analysis, and robotics, and two elective units--electronic textiles and artificial intelligence. More importantly, the program offers a two-year community-driven teacher professional development (PD) program spread across two summers and four quarterly sessions. Teachers engage with texts such as *Stuck in the Shallow End* (Margolis et al., 2017) that allow several opportunities to engage in conversations about race- and gender-related disparities in computing education (Goode, Ivey, Johnson, Ryoo, & Ong, 2021). Upon completing the PD, interested teachers are recommended for a facilitator development program which involves participating in a workshop and being mentored to facilitate teacher PDs locally and nationally. The teacher-facilitator development model has led to the evolution of a robust teacher community around the ECS program with politicized trust (Goode, Margolis, & Chapman, 2014; Jayathirtha, Chapman, & Goode, 2024).

The second and the third authors, who identify as White cis-women, were the original designers of ECS and have since developed long standing relationships with teacher-facilitators. The third author facilitated several teachers' PDs within ECS in partnership with and as a mentor for many teachers in their first years of facilitating PDs. The curriculum designers met the teacher-facilitators regularly during the annual facilitator workshop, taking some of these relationships back over a decade (depending on teacher engagement within the program; more details below). The first author, a South Asian cis-woman, was introduced to the context in Summer 2022 as a researcher interested in furthering justice-centered computing education in partnership with teachers.

In Summer 2022, the first three authors sought volunteers among the twenty-one facilitators attending the annual Facilitators Workshop to serve as co-designers and redesign the ECS program. Twelve teachers, from diverse teaching contexts across the US (see Table 1), volunteered to redesign the program based on their own teaching and facilitating experiences, and the ongoing discussions around computing tools and their implications for historically marginalized communities. As seen in Table 1, they had a range of experience teaching the program and facilitating teacher PDs within the community. The three authors and the co-design teachers attended eight online brainstorming sessions during the academic year 2022-23. The sessions were designed based on the Cultural Competence in Computing program (Washington, 2020). Starting Summer 2023, the co-design teachers worked as four groups of three members each, and iteratively co-authored, reviewed, and revised the four curricular units of the program. The revised program consists of four units: Human-Computer Interaction, Problem-Solving, Programming, and Data and Computing. Each of these units included revised visions and lessons and activities that reflected commitments to center justice while introducing computing to teachers and learners (see Table 2). We have, as reported elsewhere, examined how teachers experienced the co-design process (Jayathirtha, Chapman, & Goode, 2024), how they demonstrated collective transformational agency among teachers while creating tools for co-design and co-creation (Jayathirtha, Chapman, & Goode, 2025), and how they shifted disciplinary boundaries by weaving broader histories into computing and envisioning lessons and activities (Jayathirtha, Chapman, & Goode, 2023). This paper reports on the analysis of a co-design session at the end of the second year of co-design efforts, when the team designed a PD Map, an object of shared significance for the ECS community, in an in-person session during Summer 2024.

Nine of the twelve co-design teachers met for a two-day in-person workshop with an aim to design teacher PD for the revised ECS program (see Table 1; three others were unavailable). During the two days, teachers examined the structure and content of the PD sessions and discussed ways to support new teachers to learn and teach the revised program. They created documents with tentative session designs and teacher PD Maps that lay out the key ideas of the program and the teacher PD for new teachers. Redesigning the teacher PD involved focusing on teacher professional learning and supporting new teachers to develop attunements to justice-oriented computing. The research questions guiding this analysis were generated as we continued to work on the PD Map after the session and viewed the session video together. Therefore, the research emerged as a consequence instead of guiding the design work. Further, categories of "researcher," "designers," and "teachers" continued to blur as we designed the PD Map and analyzed it to answer the research questions.

Table 1
Co-Design Teacher Details.

Teacher name* (group #)	Racial and gender identity	ECS Teaching experience (years)	ECS Facilitating experience (years)	Teaching geography in the US	Student racial composition in descending order#
Taylor (1)	White, female	5	2	Midwest urban	Latinx, Black, White
Elaine (1)	White, female	11	8	Northeast suburban	Mostly White
John (1)	White & Latino, male	8	0	West coast suburban	Latinx, Black, White, Polynesian
Tangela (2)	Black, female	5	4	South rural	Mostly Black
Kerri (2)	White, female	3	1	Northeast suburban	White, Black
Don (2)	White, male	11	11	Midwest urban	South Asian, Latinx, Black, White
Floresa (3)	Black, female	11	7	West coast urban	Mostly Black
Kristi (3)	White, female	7	6	East coast urban	Latinx, Black, Asian
Taghrid (3)	Middle-eastern, female	5	2	Westcoast, suburban	White, Latinx
Faythe^	Black, female	10	5	Midwest urban	Black, Latinx, White
Jennifer^	White, female	5	0	Midwest urban	All Black
Libbyada^	Black, female	5	1	South, rural	Black, Hispanic

* Teachers chose names that would represent them; # Student demographics as described by the teachers
^ Teachers who couldn't attend the in-person session that was analyzed for this submission.
Co-author teacher names bolded.

Table 2
Revised ECS Unit Titles, Example Key Topics, and New Lessons Co-Designed by Teachers

Unit	Key topics	Example lessons
Human-Computer Interaction	• Computers, the Internet, & Artificial Intelligence/Machine Learning (AI/ML) • Intersectional, multidimensional identities and their (dis)connections with computing	• Technologies & environmental sustainability • Critical introduction to AI/ML approaches
Problem-solving	• Connections between community problem solving, mathematics and computer science • Societal impacts of computing	• Search algorithms and their implications • Social problem-solving
Programming	• Programming and connections with self and communities • Algorithms and abstractions	• Programming as self-expression: names & cultural meanings • Programs and decision-making
Data & Computing	• Societal impacts of computing & the role of data and Artificial Intelligence systems	• "Big data," visualization, and community problem-solving

Data collection and analysis

We conducted collaborative analysis of a video recording (Erickson et al., 2017) of a 40-minute-long session that followed the design of the PD Map. The video captured teachers' work in groups of three (see Table 1) while the researchers and the designer (the first three authors) participated as a co-design group. During this session, a representative from each group shared their PD Map design with the whole group, which included artistic representations and articulation of salient features and meanings. This video-taped session, situated in an authentic design context for teachers, afforded opportunities to examine their perspectives on justice-centered computing and teacher supports. Previous teacher interviews and analysis of the co-design process reported elsewhere and the redesigned curricular materials provided the contextual information for a deeper qualitative analysis.

We adopted Pierson et al.'s (2024) ethical validity to engage teachers as co-researchers in video analysis. The context of finalizing the PD Map design provided an authentic context for teachers to rewatch the video from summer during Fall 2024 and contribute as co-analyzers of the video. The first author prepared multimodal copies of the transcript for the co-viewing session. Inspired from interaction analysis (Jordan & Henderson, 1995; Erickson et al., 2017), six teachers and the two researchers collaboratively watched the video while commenting on copies of the transcript. The group met twice, for three hours in total, to watch the video jointly. Each time, the first author facilitated the co-viewing session by pausing the video at roughly 5-minute marks to take time to complete comments and reflect on noticings and wonderings. The co-viewing sessions allowed for teachers to

engage with their expertise and contribute from their perspectives and experiences from diverse contexts and identities (Erickson et al., 2017). These commented transcripts were then analyzed by the first three authors to generate themes in response to the research questions. The themes were presented to the teachers for clarification and expansion, which they confirmed by adopting them for their future discussions. Five of the teachers further co-authored this submission (identified in Table 1).

Findings

Teachers called for equitable teaching practices as central to doing justice work within computing classrooms. However, they argued for deepening and clarifying the meaning of equity work—one that centers students' identities and resists the pressure to assimilate students into dominant cultural norms. Further, the teachers articulated their role as "co-conspirators of social justice" and highlighted supports that new teachers would need to further justice in their teaching contexts: continuous opportunities for their ongoing growth, learning experiences tied to their teaching contexts, and opportunities to develop as a reflective practitioner.

Reviving "equity"

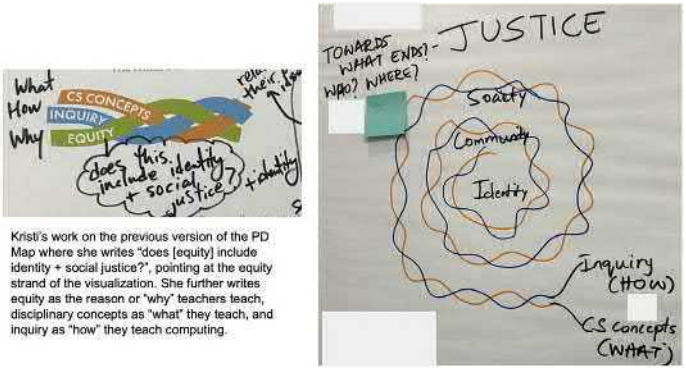
With equity a central tenet of the ECS program, teachers revisited the construct and reasoned what it meant to do equity work while teaching a justice-oriented computing program. Teachers grappled with the different terms and resisted reinventing language and instead saw "equity," when concretely tied to liberatory teaching practices, as moving towards justice. For instance, Kristi emphasized the need to clarify how equity is specifically defined in the context of the revised ECS program. While discussing how to communicate the key tenets of the program, she said "[the term equity] has been so muddied in a lot of people's brains in terms of how it's defined and what it really is and not what it looks like." She pondered if equitable teaching practices, the "why" of teaching computing in her context, included "identity [work] + social justice?" (Fig. 1, left). Similarly, her team members, Taghrid and Floresa pointed at how "equity" rings hollow if it is not connecting to "students' identities and making content relevant to them and their contexts." They further discussed terms such as "relevance" as being too abstract and removed from practice, as Floresa surfaced the tension in her sharing from her group's discussion that "relevance is one of those words.. like resilience, like, what does that mean?" Teachers collectively wanted to move away from the notion of equity as giving equal opportunities or access to resources, one that does not take into account historic inequities they witness in their teaching contexts. Overall, the group called for deepening and clarifying what we mean by equitable teaching practices.

Deepening equity to center learners

Teachers consistently argued to ground equity in learners' identities, communities, and their lived experiences in several ways throughout the discussion. They called for expanding the disciplinary boundaries to discuss broader societal impacts of computing. This was represented in both teachers' discussions and their visual representations of what justice-centered program should entail. Taylor, while reporting from her team, proposed to add a sentence to clarify that learners "are empowered to change the world for the better, instead of focusing just on CS fields or computer science fields," at the end of a justice-centered computing program. A similar sentiment to deepen concretely what it means to do justice-oriented work was evident in their rearticulation of equitable practices as ones that enable "teacher and students will explore CS topics and make it relevant to their own lives through reflective application, focusing on their own identities and communities." Don, Tangela, and Kerri graphically represented a similar sentiment by drawing concentric circles with students at the center and conceptual learning circling around students' lives (Fig. 2, right bottom-left). Later in the discussion, Tangela attempted to recreate another group's spiral representation to communicate what equity entails (Fig. 1, right). She suggested a digital visualization with the word "equity" in the background while foregrounding the words "identity, community, society, and justice." That way, she said that equitable practices were clearer to her and that she "gets it and understands it now," especially coming from her background as a Black woman born and raised in the southern part of the US where equitable computer science education "was not accessible to her."

Figure 1

Kristi's Notes Calling to Center Learners' Identities, Communities, and Societies (Left); A Visualization That Tangela Adopted to Highlight Equitable Teaching Practices (Right).



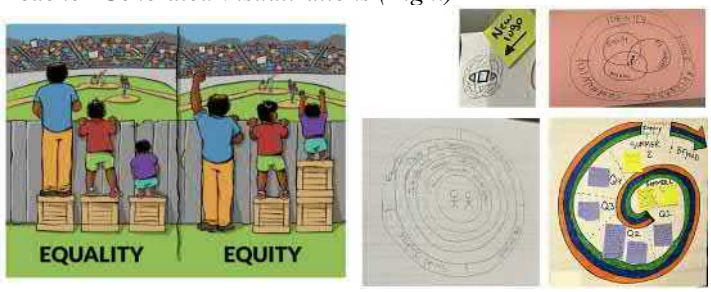
Kristi's work on the previous version of the PD Map where she writes "does [equity] include identity + social justice?", pointing at the equity strand of the visualization. She further writes equity as the reason or "why" teachers teach, disciplinary concepts as "what" they teach, and inquiry as "how" they teach computing.

"Not just remove barriers but create your space"

Just as teachers argued to deepen what equity meant by grounding it in students' lives, they also discussed how "equity" should resist assimilation and instead enable students to create their own spaces for who they are. Resistance to assimilatory practices was most pronounced when one of teachers, Kerri, brought up the popular meme that is used to represent and discuss terms such as equity and justice (Fig. 2, left). Teachers ruled out the possibility of equity to mean equality and cautioned equity work to not be about just "removing barriers" and instead questioning "why some of them [in the meme] are behind the fence at all." John, in response to the meme, discussed how justice work should be about "not just removing barriers (referring to the fence in the picture)" but for students to create their own spaces. Led by the senior designer, teachers discussed the meme and clarified that doing justice work is "not like we're inviting [students from historically marginalized communities] in so that you can become just like the rest of the people in the room." Instead, it is about creating "new rooms for [students] to contribute to that with their identity and their view of community and their view of society, and, you know, learn from each other." Teachers further critiqued the assimilatory meanings that popular terms such as "broadening participation" hold within computing education, and argued how computing classrooms should support learners for who they are and what perspectives they bring, comparable to the cultural and linguistic plurality that previous theories have pointed at. Floresa emphasized that teachers should ask "who are my students? How can I support who they are? How can I help them be a part of the room to make up the room, right? What community am I serving?," in order to do equity work within their classrooms.

Figure 2

The Popular Meme Used to Engage With Terms Such as Equity and Equality (Left); Teacher-Generated Visualizations (Right)



Teacher supports to do justice work

Teachers saw their role as "co-conspirators of social justice" while teaching a justice-centered computing program. While envisioning the representation of the program's teacher PD, teachers articulated the need for specific support for new teachers to grow as a co-conspirator of justice movements while teaching computing. They highlighted the need to recognize teachers' continuous learning trajectories throughout and beyond the teacher professional learning opportunities, grounding professional learning in concrete, relatable practices, and enabling opportunities to develop as reflective practitioners.

Recognizing ongoing growth

Teachers emphasized the ongoing nature of teacher learning, through their drawings and in articulations of their meanings. Through various graphical representations across different groups—intertwined circles, concentric circles, and spirals (Fig. 2, right), teachers highlighted the non-linear and continuous nature of teacher professional learning within and beyond PD sessions. For instance, Floresa shared her group's rationale behind choosing a

spiral model to represent teacher learning during PDs as "all the things that you learn, you never really stop learning, right? That's the idea" (Fig. 2, right bottom-right). Their spiral started with the Summer 1 session at the center with quarterly sessions distributed along the curve and ending with Summer 2. She specifically noted the "& Beyond" after the Summer 2 on the poster in addition to the arrow facing outward indicating the ongoing nature of teacher professional learning that may start within a PD but be ongoing in practice. They also shared how they were considering intertwined circles, like Taylor, John, and Elaine's group (Fig 2., right top-left), to highlight how teachers' learning will be ongoing just as the circles that "come back and keep going at the same time." An emphasis on continuous teacher learning, particularly when learning to become "co-conspirators of justice" was noted in how the designer described their spiral model (Fig. 1, right) as a representation that teachers are "constantly going back to [their] own identity and then reaching out to the community and that and going on. And, that way [they're] always growing and changing and thinking about and or becoming comfortable with [their] own identity in this." As a whole group, teachers discussed other cyclical representations such as the engineering cycle which could demonstrate their commitment to highlighting the ongoing teacher learning.

Relatable professional learning

Teachers highlighted relatable teacher professional learning experiences as another important aspect to their journeys as "co-conspirators of social justice." For example, Floresa emphasized on knowing "here's what it means to me" while attending teacher PD sessions. Referring to the second authors' comment on providing concrete examples of teacher practices for inquiry and supporting equitable learning within their classrooms within the PD Map, Floresa highlighted the role of professional learning opportunities that enable teachers to ask specific questions about their practices as related to their contexts and learners as she articulated it as:

> "I made the lesson equitable for all my students, but in order to do that, you have to ask yourself those questions, who are my students? How can I support who they are? How can I help them be a part of the room to make up the room, right? What community am I serving? Right? So you have to ask yourself those questions in order to do equity, is what I would say."

Teachers highlighted the need to clarify the meaning of terms such as equity within any teacher learning context so that they enable opportunities for "good debriefs and better dialog" among teachers during the PDs (Kristi). Kristi further discussed lessons and activities within the revised ECS program as yet another way of providing examples of concrete ways of connecting computing concepts to learners' lives while "reshaping the definition of the word [equity]." Along similar lines of supporting teacher learning with relatable experiences, Taghrid proposed including teacher voices in the PD Map as she proposed gathering detailed quotes from teachers who participate in ECS PDs to capture their perspectives and share them with prospective and new teachers.

Growing as a reflective practitioner

Yet another aspect that teachers highlighted as significant to their growth to teach a justice-oriented computing program is to have opportunities to reflect on their learning and their teaching practices as they grow. Teachers, in discussion and in imagining new visualizations, highlighted the need for opportunities for deep reflection. Kristi and Floresa, for example, contrasted "regular PDs [where teachers] learn about a curriculum" where teachers usually respond to prompts such as "Did you like this workshop?" or "how you are organizing folders in your room," they highlighted how connecting STEM disciplines such as computing will be a "huge leap, especially if you've never experienced any equity related PD." The teachers, as a whole group, discussed opportunities such as the second summer of ECS PD to reflect on their practice to think about "discussion techniques" within classrooms and their role in supporting learners across diverse racial and gender categories.

Teachers further represented their commitment for reflection through their drawings and their meanings. Taghrid, Floresa, and Kristi, when presenting their spiral model of teacher learning (Fig. 2, right, bottom-right), discussed how they tried to show some "depth, like stairs" along the spiral to highlight teacher growth with deep reflection. They recommended adding a drop shadow to the spiral when digitizing it as a way to keep alive the critical role of deep reflection for teacher learning throughout the PD. Similarly, the third author discussed their spiral model (Fig. 1, right) to represent how teachers are "always growing and changing and thinking about and or becoming comfortable with your own identity in this [work]... by reading and reflecting on *Stuck in the Shallow End: Education, Race, and Computing.*" She stressed on the sub-title *Race, Education, and Computing* as "part of the equity becoming [pause] equity."

Conclusion and discussion

Overall, teachers resisted abstract and simplistic ways of understanding and addressing justice within STEM education. Unlike ongoing efforts within the STEM education research community creating multiple terms and

definitions, teachers argued for clarifying the meaning of an existing term–"equity," to concretely ground in teachers' practice and professional identity development. The teachers sought to deepen and clarify what equitable practices mean in STEM teaching-learning contexts like computing classrooms and emphasized centering their students' identities, communities, and cultural backgrounds. Such a call not only aligns with theoretical frameworks that argue for centering student identity development in classrooms (e.g., Vakil, 2018) but also concurs with Philip and colleagues' (2016) call for educational research through teacher solidarity lens despite challenges to involving teachers as co-designers such as teachers' busy schedules. Teachers, in taking on their roles as "co-conspirators of social justice," centered their efforts towards addressing and mitigating historical injustices to students from marginalized communities and sought this opportunity to advocate for furthering their interests within their classrooms. The teachers' commitment to resist assimilatory projects and instead create spaces for students to thrive as themselves aligns with Paris's (2012) argument for spaces that sustain and revitalize students' cultural practices. This stands in contrast to typical STEM education contexts, where disciplinary practices are often prioritized as 'core' while justice-related discussions are marginalized (Philip et al., 2019). Instead, through the spirals and layers within representations, teachers argued against the siloed approach to orienting STEM learning towards justice. Further, in enabling interactions and designs, co-designing served as yet another opportunity for professional sense making and learning. Though the analysis and the context is couched within ECS teacher co-design context, findings from the analysis broadly speaks to similar efforts to co-design with teachers and to orient STEM education towards justice and support teachers.

The co-design teachers, when envisioning professional support for their fellow teachers to grow as co-conspirators of social justice, emphasized the need to counter the deprofessionalization of teaching through sustained investment in teachers' professional and personal growth. This perspective once again echoes teacher solidarity scholarship that emphasis on viewing teacher professional growth as a continuous, evolving process. Teachers surfaced the importance of connecting professional learning directly to teachers' classroom contexts and sought opportunities to examine who their students are, what it means to teach them effectively, and most importantly, to reflect on and learn from their practices. This finding around the urgency of connection to classroom context is significant since, unlike current frameworks whose proposed ideas may seem abstract and removed from classroom practices. Being in solidarity with teacher communities while co-designing (Philip et al., 2022), opened the space to surface tensions within current ways of understanding and defining justice-oriented STEM teaching and learning. Further, it amplifies teacher perspectives on what justice-oriented STEM education means in practice and how to prepare teachers for this work. Our study demonstrates that the process of partnering with teachers in education co-design can and should embody the same justice-related principles we seek to implement in STEM education.

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