Computer Science Teachers as Change Agents for Broadening Participation: Exploring Perceptions of Equity

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Abstract

In this paper, the authors share findings from a qualitative analysis of computer science teachers' perspectives about equity within the context of an equity-focused professional development program. Drawing upon a framework emphasizing educator belief systems in perpetuating inequities in computer science education and the importance of equity-focused teacher professional development, we explored how computer science teachers understand the issue of equity in the classroom. We analyzed survey data from a sample of participants in a computer science professional development program, which revealed that teachers have distinct ways of framing their perceptions of equity and also different perspectives about what types of strategies help to create equitable, inclusive classrooms reflective of student identity and voice.

Purpose

Recent research on computer science (CS) education in Chicago and Milwaukee high schools indicates that the districts are making substantial progress in expanding access to and broadening participation in CS courses for Black and Latinx students (Barrow, Freire, & de la Torre, 2020; McGee et al., 2018). This progress has been supported by two research-practice partnerships: Chicago Alliance for Equity in Computer Science and PUMP-CS in Wisconsin. These two partnerships have been leaders in the burgeoning movement to expand access to CS in the K-12 sector. The narrowing of the opportunity gap in Chicago and Milwaukee has been largely driven by the implementation of *Exploring Computer Science* (ECS), which is an introductory-level high school CS course. Equally important as providing access to CS courses such as ECS are efforts to help educators develop an understanding of equity issues within CS as well as an understanding of specific teaching practices and strategies that create more equitable CS classrooms (Goode, Margolis, & Chapman, 2014; Zhou, Cao, Jacob, & Richardson, 2020).

Equity is a core component of ECS, both in terms of broadening access to CS through enrollment in the course itself and in terms of creating an equitable, culturally responsive space within the ECS classroom. The ECS curriculum is coupled with a year-long professional development (PD) program for teachers, which seeks to "address CS content, pedagogy, and belief systems (including stereotypes about which students can excel in CS)" (Margolis et al., 2012, p. 73). The PD model for new ECS teachers includes an initial week-long summer workshop, quarterly one-day workshops during the school year, and a second week-long summer workshop after the first year of teaching ECS. The PD is specifically designed to address issues of equity and inclusion in CS (Goode, Margolis, & Chapman, 2014). For example, all ECS PD participants read and respond to sections of the book *Stuck in the Shallow End: Education, Race, and Computing*, which highlights how existing structures, practices, and belief systems in three Los Angeles

high schools perpetuated inequities in CS education (Margolis et al., 2008). Participants also engage in journaling during the PD and respond to prompts intended to foster critical thinking about equity in CS.

In this paper, the authors share findings from a qualitative analysis of ECS teachers' perspectives about equity in CS within the context of an equity-focused PD program. The analytical approach drew on the concept of equity in CS as specified by the ECS curriculum and professional development and also applied framing theory to understand the particular conceptualizations of equity as described by teachers. Given the importance of ensuring that CS teachers are well-positioned to create equitable, inclusive classrooms, the research questions that frame this study are 1) how do teachers describe equity within the context of CS education? and 2) what pedagogical strategies do teachers describe as being equitable in a CS classroom?

Theoretical Framework

This work is grounded in an understanding of the importance of belief systems (specifically, teachers' assumptions and expectations for students) and how these systems have led to the production and maintenance of inequitable learning opportunities in CS. In a foundational study of CS education in high schools, Margolis et al. (2008) found that educators had expectations about what type of students will succeed in CS and that this contributed to the racial divide in CS classrooms. In the years since that research, there have been various professional learning programs for CS teachers with an explicit goal of creating more equitable CS classrooms by explicitly addressing teachers' perceptions of equity and inclusion (Che, Kraemer, & Sitaraman, 2019; Codding et al., 2020; Goode et al., 2020).

In addition to this grounding in the centrality of belief systems, we also position this research within the conceptual work on equity that is specific to the ECS curriculum and PD. The developers of ECS have described the dimensions of equity that are emphasized in ECS, including building on students' funds of knowledge (drawing on backgrounds and interests), deepening engagement through learning situated within familiar cultural contexts, establishing a culture of caring, and facilitating teacher reflection (Margolis et al., 2012).

Finally, this research is informed by the concept of frames and framing theory. Framing theory is based on the premise that an issue can be viewed from various perspectives. The process of framing refers to developing a particular conceptualization of an issue (Chong & Druckman, 2007). In the communication process, framing involves selection and salience. That is, to frame is to "select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (Entman, 1993). According to framing theory, frames can occur in four locations in the communication process: a communicator, a text, a receiver, and the environment or culture (Entman, 1993). At all four of these possible locations, frames can influence discourse, thinking, and belief systems. The research described in this paper focused on CS teacher participants in the ECS professional development (i.e., the receivers of framing in the communication process). We sought to identify the particular conceptualizations of equity as described by teachers and we looked for patterns in these conceptualizations to identify categories for how teachers understand equity within the context of CS education.

Methods

Since the summer of 2012, CAFÉCS has been supporting and researching ECS PD in Chicago. PUMP-CS initiated ECS PD in 2014 (this project was initially open to teachers across Wisconsin and narrowed the focus to Milwaukee in 2016.) We collected survey data from first- and second-year ECS teachers who participated in the ECS PD. Surveys were administered to ECS teachers in Chicago and Milwaukee public schools at the conclusion of week-long summer PD workshops as well as quarterly day-long workshops during the school year. We report only on a subset of items from the surveys that measured teachers' perspectives on equity and equitable teaching practices in CS. Specifically, the responses to the following survey items were analyzed for this study:

- Item 1: How did the PD expand your understanding of equity? How will you apply this to your classroom?
- Item 2: Consider the various equity strategies that you saw implemented during the workshop. How will you implement those equity strategies in your classroom?

These two items were included on surveys that were administered at different time periods in Chicago and Milwaukee. In Chicago, Item 1 was administered twice in the 2013-14 school year and Item 2 was administered five times between 2016 and 2018. In Milwaukee, Item 1 was administered eight times between 2014 and 2016 and Item 2 was administered five times between 2016 and 2017. Responses from Chicago and Milwaukee were combined for each item.

We conducted an iterative thematic analysis of the responses. We initially developed a prespecified coding framework informed by the literature on equity in ECS. During the data analysis process, we examined responses using this framework while simultaneously refining the framework using an inductive coding process focused on interpretive codes (Miles, Huberman, & Saldana, 2020).

Data

The data for this study included 117 responses to the open-ended survey item about teachers' understanding of equity (Item 1) and 356 responses to the open-ended item about implementing equity strategies (Item 2). The survey, which was administered to teachers at the conclusion of the ECS PD workshops, changed over the years, with some items that were on the original version of the survey being replaced with others. Because the items analyzed for this research were included on different administrations of the ECS PD survey, we include demographic characteristics of the teacher respondents for each item separately (see Table 1). Although the majority of teachers in the sample did not have any prior CS teaching experience, teachers had, on average, about 11 years of total teaching experience. There was a notable lack of racial and ethnic diversity among the respondents, particularly given that these districts enroll large percentages of Black and Latinx students (in the 2018-2019 school year, Chicago Public Schools' student enrollment was 37% Black and 47% Latinx and Milwaukee Public Schools' student enrollment was 54% Black and 27% Latinx).

Findings

We present findings from our analysis of each item separately. For Item 1, which focused on conceptualizations of equity, we found that teachers used three distinct frames in articulating their thinking about equity. We also found two broad themes for how teachers understand equity that aligned to the

dimensions of equity in ECS. For Item 2, which focused on teachers' descriptions of equitable teaching strategies, we found that three types of strategies were mentioned by large percentages of respondents.

Teachers' Conceptualizations of Equity (Item 1)

How teachers frame their understandings of equity. We found three distinct frames in teachers' statements about equity in CS. The first framing of equity in teachers' statements centered on students (such as their varying previous exposure to CS and diverse backgrounds) and was the primary frame in 44% of the responses. For example, a teacher noted, "I have a wide range of students with different abilities in my class. I learned ways to provide assistance to all students." The second frame used by teachers was a focus on pedagogy, which was the primary frame in 39% of the responses to this item. This framing often included specific examples of teaching practices that respondents understood as contributing to an equitable, inclusive classroom. For example, a teacher stated, "Using communication and the navigator/driver strategy will help keep equity in the classroom." The third frame used by teachers focused on the teacher themselves and was the primary frame in 17% of the responses. Teachers who used this framing were often commenting on the need to be reflective about equity when planning lessons or incorporating strategies to foster participation. For example, a teacher stated, "As I set up each unit and break it down into lessons and days, I will actively question how the choices I'm making for each activity will increase participation."

How teachers' perceptions of equity align with ECS. In addition to using different frames to think about equity, we also found two broad themes for how teachers articulated their understanding of equity that aligned with the dimensions of equity in ECS described earlier: 1) students' funds of knowledge (25% of responses) and 2) culture of caring (21% of responses). The first theme aligns with the ECS focus on drawing on students' backgrounds and interests. For example, one teacher noted that "every student comes to us with a different base of knowledge and home environment. We can do things to make sure they get an equal playing field with a variety of teaching strategies." Another teacher articulated the importance of privileging students' life stories, stating, "It reminded me about the importance of learning everyone's story and bringing those stories into my classroom." Similarly, a third teacher described connecting CS to students' lives, "There are unique opportunities where one can tie in relevant information to each student's life."

The second major theme was establishing a classroom culture of caring and belonging, which is another dimension of equity that is emphasized in ECS. Teachers often articulated this theme by describing the importance of inviting all students into learning CS. For example, a teacher stated, "Everyone is a participant. It is important to make sure all students feel their contributions are worthy and will be heard." Another teacher similarly noted, "Equity is about feelings and motivation. Students feel they can jump right into the fun stuff because they are not turned away for what they don't know. This makes them feel empowered to learn more." Another aspect of creating a culture of belonging identified by teachers was the importance of considering topics that are inclusive. As one teacher stated, "One way to address equity is making sure the lessons are not excluding some groups based on the topic or example used. In the case of sports, not everyone is interested in sports, so using that as a lesson topic might lose some students."

Equitable Teaching Strategies (Item 2)

Teachers' thinking about equity strategies. We examined teachers' descriptions of teaching strategies designed to create equitable CS classrooms and found that three types of strategies were mentioned by large percentages of respondents: collaborative learning, fostering inclusive classrooms, and student journaling.

Collaboration. Collaborative learning was the most prevalent type of strategy mentioned by teachers (40% of responses). Often, teachers noted that collaboration helped create a learning environment in which students would be exposed to a diversity of perspectives. For example, one teacher suggested that "randomly assigning groups will level the playing field so that students will be able to learn from each other and gain different perspectives. Using whip around, think-pair-share, etc. helps people realize that they are accountable for the instruction in the class."

Inclusive classrooms. Strategies for fostering inclusive classrooms that emphasized student choice and student voice were also relatively frequently mentioned by teachers (21% of responses). For example, a teacher stated that they could work toward an equitable classroom "by including everyone and carefully planning the lessons to create an environment of shared ideas and building confidence in my students that they can present without any stress." Respondents mentioned strategies such as using driver/navigator coding pairs and providing multiple options for assessments as ways to build inclusive CS classrooms.

Journaling. Individual student journaling was a specific strategy that respondents mentioned and was often described as a method for increasing student participation and providing an opportunity for students to reflect on their learning (16% of responses). In an illustrative response that highlights the use of journaling as a means to ensure that all students express their thinking in some form, a teacher noted the need to "make sure all students have a chance to share ideas whether it is vocally or through journaling."

Discussion

With the ongoing expansion of introductory-level CS courses in K-12 schools and districts across the U.S. and the specific emphasis on broadening access to CS, it is important to understand CS teachers' perceptions of equity and pedagogical strategies that can contribute to creating inclusive CS classrooms. This research suggests that CS teachers have different ways of framing their perceptions of equity (centering students, pedagogy, or themselves) and also different perspectives about what types of strategies help to create equitable classrooms (e.g. grouping strategies or individual student journaling). Understanding how CS teachers think about equity is a necessary step toward creating professional learning experiences that center equity and foster teachers' developmental growth in equity related to CS. It is critical to understand how teachers perceive equity in CS given their role as change agents in the national effort to broaden participation in computing in high school, higher education, and the computing workforce.

Absent from the responses to the survey items were explicit connections to racial inequities. Although teachers frequently mentioned their students, they almost never referenced race directly. This finding was surprising given that the ECS PD has a specific focus on this critical aspect of inequity within CS education. For example, one of the chapters in *Stuck in the Shallow End* that all teacher participants are required to read is a comparison of the race gap in swimming with the race gap in computer science. And yet, even among those teachers who framed equity in CS as a student-centered issue, there was a notable absence of

direct references to racial inequities. Additional research is necessary to further understand this notable absence, but this finding seems to corroborate research on the issue of colorblind discourse in CS teachers' professional learning (Goode, Johnson, & Sundstrom, 2020).

As noted above, framing can occur at several locations in the communication process. The research reported on here focused on the receivers of framing (in this case, the teachers who participated in the equity-focused PD). However, equally important is how the communicators and texts in the communication process are framing the issue of equity. That is, future research should examine how the issue of equity is framed by the facilitators and texts during the professional development workshops for teachers. For example, researchers might ask how equity is defined in the workshops, if this definition is jointly constructed by participating teachers, and what aspects of equity are emphasized during the workshops. This additional research would provide a more complete understanding of the extent to which the beliefs about equity among participating teachers are aligned with the message about equity that is embedded in the PD.

Additionally, this research focused on the *content* of beliefs about equity among CS teachers. Another aspect of these teacher beliefs that might impact classroom practice is the level of *importance* that teachers attach to their beliefs about equity. Previous research on framing has found that framing can affect the importance that individuals attach to beliefs (Nelson & Oxley, 1993). If teachers understand equity in CS but attach very little importance to this issue, they will be less likely to alter their teaching practice. Future research measuring the importance that teachers attach to equity in CS prior to the PD and again after completing the PD would provide insights into the extent to which the PD increases teachers' understanding of the importance of equity in CS.

A limitation of this work is that teachers may be providing responses to these survey items that reflect what was communicated in the PD workshops but that may not necessarily have affected their beliefs in a way that changes their teaching practice. To validate these beliefs, further research might examine the extent to which teachers are implementing the strategies that they highlight as being important for creating equitable, inclusive CS classrooms.

Acknowledgement

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Table 1. Demographic Characteristics of Teacher Respondents

	Item 1	Item 2
Average teaching experience	11 years	10.6 years
No prior CS teaching experience	51%	68%
Female	45%	46%
Race/Ethnicity		
Asian	2%	7%
Black	14%	20%
Latinx	7%	14%
White	71%	64%