Expanding Participation in Computer Science Education: A Study of Teachers' Perspectives on Equity

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Abstract:

To better understand how computer science teachers think about equity, the authors conducted a qualitative study in which they surveyed participants about their views on the topic. Using a paradigm stressing educator belief systems in perpetuating inequities in computer science education and the significance of equity-focused professional development for teachers, we investigated how computer science teachers understand the topic of equity in the classroom. There are many various ways teachers think about equity and how to establish inclusive classrooms that represent students' identities and voices, according to the results of a poll of participants in a professional development program for computer science teachers.

Keyword: Equity, Computer Science Education, Teacher's perspective

1. INTRODUCTION

Computer science (CS) education in Chicago and Milwaukee high schools has recently been studied and found to be significantly improving for students of color, particularly those from underrepresented ethnic groups (Cain, 2021). The Chicago Alliance for Equity in Computer Science and PUMP-CS in Wisconsin have been instrumental in this effort. These two collaborations have been pioneers in the growing drive to make computer science (CS) more widely available in K-12 education. ECS, an introductory high school computer science course, has played a significant role in closing the opportunity gap in Chicago and Milwaukee. ECS has been implemented by both cities' school districts. It is equally crucial to help educators gain an understanding of CS equity issues and specific teaching practices and strategies to produce more equitable CS classrooms, as

it is to provide access to CS courses like the ECS (Codding, et al., 2021).

ECS places a high value on ensuring that all students have equal access to the field of computer science, as well as providing a teaching environment that is both equitable and culturally sensitive. Teacher professional development (PD) is part of the ECS curriculum and aims to "address CS subject, pedagogy and belief systems (including stereotypes about which kids may achieve in CS)" over the year-long course (Goode, et al., 2019). The professional development program for new ECS instructors comprises a week-long summer training, quarterly one-day workshops during the school year, and a second week-long summer workshop following the first year of teaching ECS. The PD is aimed to address concerns of equity and inclusion in computer science (Zhou, et al., 2020). Participants in the

ECS PD read and responded to sections of the book Stuck in the Shallow End: Education, Race, and Computing, which examines how existing institutions, practices, and belief systems in three Los Angeles high schools-maintained imbalances in CS education (Ryoo, et al., 2021). In addition to journaling and responding to prompts designed to elicit critical thinking about equity in CS, participants are encouraged to participate in the PD.

Researchers provide their findings from a qualitative study of the views of ECS teachers on equality in CS as part of a professional development program with an equity focus in this publication. Analysis focused on the ECS curriculum and professional development's definition of equity, as well as framing theory in order to understand teachers' specific concepts of equity. The research questions posed by this study are 1) how do instructors explain equity in the context of CS education? and 2) how can CS teachers be better prepared to construct equitable, inclusive classrooms? What are some of the pedagogical approaches that CS teachers feel are fair in their classes?

TheoreticalFramework
Based on this idea, this research is focused on how teachers' beliefs about students and their expectations for them have led to and perpetuated inequitable learning opportunities for CS students. Educators had preconceptions about what type of students would achieve in CS, and this led to the racial difference in CS classes, according to Cho, et al., (2021). Several professional development programs for CS instructors have been developed since that study was conducted, with the express purpose of addressing CS teachers' attitudes of equity and inclusion in order to create more equitable CS classrooms (Goode, et al., 2021).

With this foundation in belief systems, we also place our research within the broader conceptual work on equity done specifically for ECS education and training. They have stated that the aspects of equity that are stressed in the ECS curriculum include utilizing students' own knowledge (drawing from their experiences), increasing student participation through culturally relevant learning, and encouraging teachers to reflect on their own practices (Kim, 2020). As a final point, this study is based on the theory of frames and framing. According to framing theory, there are several ways to look at an issue. Framing refers to the process of coming up with a unique interpretation of a problem (2018). Selection and prominence are two of the most important aspects of framing in the communication process. To "choose specific parts of a seen reality and make them more apparent in a communicative text, in such a way as to support a particular issue description, causal interpretation, moral judgement, and/or treatment prescription" is what it means to "frame" (Siddigua, et al., 2020). Frames can be found in four places in the communication process: the communicator, the text, the receiver and the culture or environment (McNealy, 2021). Frames have the potential to affect the way people talk, think, and hold beliefs in all four of these contexts. CS teacher participants in the ECS professional development were the focus of this study (i.e., the receivers of framing in the communication process). For this study, we looked for patterns in the many ways teachers conceptualize equality within the framework of computer science education in order to categorize their ideas.

Methods
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In what ways did the PD help you better comprehend the concept of equity? When teaching, how will it benefit your students?

Take a moment to reflect on the numerous equity strategies that you seen in action throughout the workshop. Is there a way that you can incorporate these ideas into your classroom?

Two surveys in Chicago and Milwaukee asked about these topics at various points in time. Two times in the 2013-14 academic year, Item 1 was administered, whereas Item 2 was administered five times from 2016 to 2018. During the time period from 2014 to 2016, Milwaukee saw eight administrations of item 1, and five administrations of item 2 between 2016 and 2017. Chicago and Milwaukee respondents were merged for each question.

A series of iterations of a theme analysis was performed on the data collected. A paradigm for coding equity in ECS was initially devised using information from the literature. An inductive coding method was utilized to refine our interpretation of the data as we reviewed responses to the questionnaires using this framework (Ivanova&Elsawah, 2021).

Data

Open-ended survey items about teachers' understanding of equity (Item 1) and implementation of equity methods (Item 2) were used in this study to gather information (Item 2). Some of the questions on the survey, which was given to instructors at the end of the ECS PD sessions, were replaced with others as the survey evolved over time. Educator demographics for this study were gathered from multiple administrations of the ECS Professional Development Survey, which meant that we had to look at them separately for each item that was examined (see Table 1). Despite the fact that most of the teachers in the sample had never taught computer science before, they had an average of around 11 years of teaching experience overall. When compared to the high numbers of Black and Latinx children enrolled in Chicago Public Schools (37 percent) and Milwaukee Public Schools (54 percent) for the 2018-2019 school year, there was a noteworthy lack of

diversity among those who took part.

Findings
Each item is analyzed separately, and the results are shown below. We observed that teachers used three distinct frameworks to describe their understanding of equity in Item 1, which focused on conceptualizations. Two significant elements emerged in our analysis of teachers' conceptions of fairness in relation to ECS's components. Three types of teaching tactics were highlighted by a large number of respondents in Item 2, which focused on instructors' explanations of equitable teaching methods.

Equality in the Classroom: Teachers' Perspectives (Item 1)

Teachers' understandings of equity are shaped by how they define their beliefs. Teachers' views on racial fairness in computer science fall into one of three categories, according to our research. When teachers were asked to describe how they felt about equity, 44 percent of the responses focused on students (such as their prior exposure to CS and different origins). Teacher A said: "I have a wide range of children in my class with various abilities. I've learnt how to help all of the students." Pedagogy was the second most common frame used by teachers, accounting for 39 percent of the replies to this question. Respondents were asked to provide specific examples of classroom practices that they believed helped create a more equal and inclusive learning environment. As one teacher put it, "Using communication and the navigator/driver technique will assist maintain equity in the classroom." Teachers primarily used the third frame, which was about the teacher, to construct their responses. Educators who framed their discussions in this way talked about the importance of considering equity when designing lesson plans or implementing techniques to increase student engagement. Teachers, for example, say, "As I plan each unit, I'll ask myself how the activities I'm planning would encourage students to participate."

Teachers' views on equity and how it relates to the ECS. Additionally, we discovered two significant themes in the way instructors presented their concept of equity, which were consistent with the ECS elements of equity. First, the knowledge and concern of pupils (received 25% of the responses) (21 percent of responses). The first theme is in line with the ECS emphasis on utilizing students' prior experiences and interests as sources of inspiration. As one teacher put it, "every student comes to us with a different basis of knowledge and home situation. With a range of instructional styles, we can ensure that they have an equal opportunity to succeed. "It reminded me about the necessity of learning everyone's narrative and integrating those tales into my classroom," another teacher said. "There are unique opportunities where one can connect pertinent material to each student's life," said a third teacher.

Another aspect of equality that ECS emphasizes is creating a classroom culture where students feel included and cared for. All pupils should be given the opportunity to learn computer science, according to many educators. A teacher, for example, said, "Everyone is a participant. As a teacher, it is critical to ensure that all children feel their voices are heard and valued. "Equity is about feelings and motivation," another teacher opined. As a result of the lack of judgment on the part of the instructor, students feel free to dive right into the interesting material. This encourages them to continue their education." Teachers also emphasized the significance of including inclusive subjects into their classrooms. Some teachers believe that ensuring that classes do not exclude certain groups because of the topic or example they employ is one method to address equity. If you're teaching a lesson

on sports, you may lose some students since they're not interested in sports.

Teaching Methods That Are Equitable (Item 2)

Equity strategies are on the minds of teachers. Collaborative learning, building inclusive classrooms, and student journaling were all highlighted by a significant number of teachers in their descriptions of teaching practices for creating equitable CS classrooms.

Collaboration. Teachers overwhelmingly cited collaborative learning as their preferred method of instruction (40 percent of responses). Collaborative teaching has often been cited by teachers as a way to introduce children to a variety of viewpoints. According to one teacher, "assigning groups at random will level the playing field so that pupils can learn from each other and obtain diverse views. " People are more aware of their responsibility for the class's education when whipping about, thinking in pairs, and sharing ideas is employed.

An inclusive education. Teachers also frequently referred to methods for establishing inclusive classrooms that promoted student choice and student voice (21 percent of responses). "By incorporating everyone and carefully organizing the classes, I hope to establish an environment of shared ideas, and to foster confidence in my pupils that they can deliver without any worry." Respondents cited the use of driver/navigator code pairings and a variety of evaluation alternatives as ways to make CS classrooms more inclusive.

Journaling. Individual student journaling was a practice frequently suggested by survey participants as a way to boost student involvement and provide students a chance to reflect on their own learning (16 percent of responses). Using journaling as an example, a teacher said,

"Make sure all kids get a chance to voice thoughts, whether it is orally or by journaling."

2. DISCUSSION

It is critical to learn about CS teachers' perspectives on equity and pedagogical practices that can help create inclusive CS classrooms in light of the increasing development of introductory-level CS courses in K-12 schools and districts across the United States. According to this study, CS teachers have a variety of methods of conceptualizing equality (such as emphasizing students, pedagogy, or the teacher), as well as varying views on the kinds of strategies that can be used to achieve equity in the classroom (e.g. grouping strategies or individual student journaling). In order to create professional learning experiences that center equality and support teachers' development in equity linked to CS, it is vital to understand how teachers in the field of computer science think about it. In light of their role as change agents in the national drive to increase the number of students participating in computing education, teachers' perceptions of equity in CS are crucial to consider.

Responses to the poll questions lacked any mention of racial injustice. Teachers usually mentioned their students, but race was hardly spoken up. Due to its emphasis on this particular facet of educational imbalance in computer science, the results of the ECS Postdoctoral Research were unexpected. As an illustration, all instructor participants are expected to study the chapter on the race gap between swimmers and computer scientists in Stuck in the Shallow End. Teachers who focused on student equity in computer science were renowned for not making direct references to racial disparities. It will need more investigation to figure out why this is the case, but this conclusion appears to support previous studies on the subject of colorblind discourse in CS instructors'

professional development (Becker, et al., 2021).

As previously stated, framing can take place at a variety of points throughout the communication cycle. The research discussed here focused on the recipients of framing, not the framing itself (in this case, the teachers who participated in the equity-focused PD). How communicators and texts frame equity as an issue is just as crucial, yet often overlooked. As a result of this, future study should focus on how teachers' professional development workshops are framed around the subject of equity. Teachers participating in the workshops could be asked by researchers to explain how they define equity, and what components of equity are highlighted in the workshops. Additional research would help us better understand the extent to which participating teachers' attitudes about equity are in line with the message about equity that is contained in the PD curriculum.

Teachers of computer science were also asked about their views on equity as part of this study. The importance that instructors place on their beliefs about equity could also have an impact on classroom practice. People's beliefs can be influenced by the way they are framed, according to previous studies on the subject (Shehata, et al., 2021). CS teachers who are aware of the relevance of equity in the field but don't prioritize it are less likely to change their teaching methods. Next-generation research that examines teachers' awareness of the importance of equality in CS will shed light on the extent to which a professional development program (PD) improves their grasp of this issue.

It is possible that teachers' responses to the survey questions mirror what they heard in the professional development workshops, but this does not guarantee that their beliefs have changed in a way that affects their teaching. To support these findings, more study may evaluate how instructors are adopting the methods they identify as critical for developing fair, inclusive CS classrooms.

3. REFERENCES

1. Becker, T. D., Leffler, K. A., & McCarthy, L. P. (2021). Individual Characteristics Associated With Color-Blind Racial Attitudes in Master of Social Work Students. *Journal of Social Work Education*, 1-14.https://doi.org/10.1080/104377 97.2021.1942352

2. Brousselle, A., &Buregeya, J. M. (2018). Theory-based evaluations: Framing the existence of a new theory in evaluation and the rise of the 5th generation. *Evaluation*, *24*(2), 153-168.https://doi.org/10.1177%2F13 56389018765487

3. Cain, C. C. (2021). Establishing a research agenda for broadening participation of Black men in computing, informatics, and engineering. *Technology in Society*, *67*, 101790.https://doi.org/10.1016/j.te chsoc.2021.101790

4. Cho, J. Y., Premachandra, B., Kizilcec, R., & Lewis Jr, N. (2021). Classroom Contexts, Student Mindsets, and (In) Equity in Computer Science: A National Longitudinal Study.https://doi.org/10.31219/osf. io/9k8pw

5. Codding, D., Alkhateeb, B., Mouza, C., & Pollock, L. (2021). From professional development to pedagogy: Examining how Computer Science teachers conceptualize and apply culturally responsive pedagogy. *Journal of Technology and Teacher Education*, *29*(4), 497-532.https://www.learntechlib.org/ primary/p/219931/

6.   Goode, J., Ivey, A., Johnson, S. R., Ryoo, J. J., & Ong, C. (2021). Rac (e) ing to computer science for all: how teachers talk and learn about equity in professional development. *Computer Science Education*, *31*(3), 374-399.https://doi.org/10.1080/08993408.2020.1804772

7.   Goode, J., Peterson, K., & Chapman, G. (2019). Online professional development for computer science teachers: Gender-inclusive instructional design strategies. *International journal of gender science and technology*, *11*(3).https://par.nsf.gov/biblio/10191724

8.   Ivanova, K., &Elsawah, S. (2021). Iterative Refinement of Multi-Method OR Workshop Designs through Boundary Critique: An Analytical Framework and Case Studies in Technology Utilisation. *Systemic Practice and Action Research*, 1-30.https://doi.org/10.1007/s11213-021-09576-7

9.   Kim, D. (2020). Learning language, learning culture: Teaching language to the whole student. *ECNU Review of Education*, *3*(3), 519-541.https://doi.org/10.1177%2F2096531120936693

10. McNealy, J. E. (2021). Framing and Language of Ethics: Technology, Persuasion, and Cultural Context. *Journal of Social Computing*, *2*(3), 226-237.https://doi.org/10.23919/JSC.2021.0027

11. Ryoo, J. J., Morris, A., & Margolis, J. (2021). "What Happens to the Raspado man in a Cash-free Society?": Teaching and Learning Socially Responsible Computing. *ACM Transactions on Computing Education (TOCE)*, *21*(4), 1-28.https://doi.org/10.1145/3453653

12. Shehata, A., Andersson, D., Glogger, I., Hopmann, D. N., Andersen, K., Kruikemeier, S., & Johansson, J. (2021). Conceptualizing long-term media effects on societal beliefs. *Annals of the International Communication Association*, *45*(1), 75-93.https://doi.org/10.1080/23808985.2021.1921610

13. Siddiqua, A., Shabir, G., Ashraf, A., & Khaliq, A. (2020). Media Framing of Pandemics: A Case Study of the Coverage of COVID-19 in Elite Newspapers of Pakistan. *Journal of Business and Social Review in Emerging Economies*, *6*(4), 1267-1275.https://doi.org/10.26710/jbsee.v6i4.1410

14. Zhou, N., Cao, Y., Jacob, S., & Richardson, D. (2020). Teacher perceptions of equity in high school computer science classrooms. *ACM Transactions on Computing Education (TOCE)*, *20*(3), 1-27.https://doi.org/10.1145/3410633