

Implementing Culturally Relevant Pedagogy in Computing Classrooms: Voices and Experiences from Public School Teachers

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Abstract— This study focused on teachers' experiences in implementing culturally relevant pedagogy (CRP) in grade 6-12 computing classrooms. We developed a series of computing courses and trained public school teachers from participating middle and high schools during the Summer of 2020. More than 60 school teachers were trained to teach CRP infused computing courses. All teachers are from districts with high percentages of underrepresented racial minority (URM) students in a Southern State in the U.S. The data collection process is two-fold. First, we conducted interviews with the teachers after the summer training. Second, we are in the process of conducting classroom observations and the second round of interviews with teachers regarding their post-training teaching experiences. The CRP theory, White racial frame, and colorblind racism are used as theoretical frameworks to interpret the data. Preliminary results revealed that some teachers tend to understand cultural differences from a color-blind perspective. The understanding of CRP may be influenced by teachers' backgrounds and characteristics. Due to the limitation of resources, teachers often find it difficult to enrich their teaching by adding individualized culturally relevant components beyond what is included in the curriculum. Our study will make theoretical contributions as well as policy implications benefiting CRP implementation in computing classrooms. Our findings will reveal critical challenges teachers face when teaching CRP infused computing courses to URM students; thus will generate practical recommendations to design and improve relevant curriculum development and professional training.

Keywords—culturally relevant pedagogy, computer science education, computing classroom, teacher perceptions, teacher professional development

I. INTRODUCTION

Black and LatinX people are underrepresented in the field of Science, Technology, Engineering, and Mathematics (STEM). Underrepresented minority groups were historically

considered biologically and culturally unfit for jobs in STEM fields. According to a recent report published by the Pew Research Center [1] Black and LatinX workers in STEM experience higher rates of discrimination in the workplace and a lack of encouragement to pursue STEM jobs at an early age.

To ensure diversity in the STEM workforce, it is imperative to address disparities in postsecondary and secondary schools. Currently, less than ten percent of bachelor's degrees in science in engineering are awarded to Black students and this figure has not changed in 20 years [2]. Some historically underrepresented groups face challenges entering STEM fields well before they enter college. Studies have shown that Black and LatinX students have less access to STEM-related courses in high school. For example, in California, school districts with relatively high percentages of underrepresented racial minority groups (URM) offered Computer Science courses at nearly half the rate of schools with the lowest percentages of underrepresented minorities [3].

Any effort to address racial and ethnic disparities in STEM fields must address the multilevel and multidimensional nature of the problem at an early stage, beginning with expanding access to STEM courses for URM students in middle/high schools. To promote URM student success in STEM, the STEM curriculum must be designed as culturally relevant; the teachers must be trained with culturally relevant pedagogy. Culturally relevant pedagogy (CRP) has been discussed as one of the effective strategies to facilitate learning among URM. In STEM fields, multiple projects have focused on culturally responsive computing among particular URM sub-populations [4], [5], [6]. However, there is still a lack of effort toward implementing CRP in public schools with higher percentages of URM students. In particular, developing CRP-infused STEM curriculums and training culturally relevant teachers are much needed.

Recently, a research-practitioner partnership team, namely, the BRBytes team, was formed between an interdisciplinary group of scholars from a four-year research university and educational leaders from public school districts located in one of the Southern States in the U.S. With the support of multiple federal funds, this partnership team aims at expanding and improving opportunities in computational thinking and Computer Science in several public school districts with a high percentage of URM students. The BRBytes team developed CRP infused computing courses for middle/high school students and trained public school teachers to teach these courses in the 2020-2021 school year. The teachers received training via a virtual Summer Institute in Summer 2020. The main content of the Summer Institute includes: 1) the curricula of the CRP infused computing courses, and 2) CRP workshops that provide CRP-related lessons, presentations, as well as small group discussions with CRP experts.

To fulfill the research gap of CRP implementation in STEM fields, a group of researchers from the BRBytes team is motivated to study how culturally relevant teachers and culturally relevant curriculum may influence URM student success in public middle and high schools. In particular, we are interested in answering the following research questions.

1. How do BRBytes teachers understand culturally relevant pedagogy?
2. How do BRBytes teachers describe their experiences of implementing culturally relevant pedagogy in computing classrooms?

II. THEORETICAL FRAMEWORK

The theoretical framework of this study contains three major components: culturally relevant pedagogy (CRP), the White racial frame, and the colorblind racism. CRP [7], [8], [9], [10], [11], [12], [13] is “pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes” [14]. A culturally responsive teacher links social contexts to their vision of teaching. One of their ultimate goals is to prepare their students, especially those who are poor and URM, to be highly competent and critically conscious about social inequality. Further, a culturally responsive teacher considers the students capable, resilient, and full of possibilities as opposed to needy, deficient, or “at-risk”. They adopt differentiated pedagogical approaches to tailor learning to support student excellence in culturally appropriate and socio-politically connected ways.

Culturally relevant teaching rests on three principles: 1) establishing significant teacher expectation for student achievement; 2) engaging in cultural competence of the teachers’ own identities as well as students, and 3) socio-political engagement [13]. The CRP training in the BRBytes Summer Institute focused on the first principle: raising significant teacher expectations for student achievement. Once accomplished, teachers and students can be partners in working toward cultural competence and socio-political connectivity within the BRBytes computing curriculum.

Additional theoretical components include the White racial frame [15] and the colorblind racism [16]. White racial frame

focuses on the virtuous of whiteness, in where whiteness is always seen as good and there is no consciousness, or awareness, of race and the role of White people in perpetuating racial inequality. Bonilla-Silva describes this as racism without racists [16]. Additionally, because whiteness is centered in the White race, a denial of racism and the magnitude of its impact are often minimized. Bonilla-Silva explains what he is calling a new racial ideology, which originated in the late 1960s, and enhances our understanding of current racial inequalities as outcomes of dynamics that are considered nonracial [16]. Colorblind racism does not rely on such things as name-calling but treats people as others in less overtly offensive ways. Both White racial frame and colorblind racism involve negative stereotyping of people of color. The impact of the White racial frame and colorblind racism may affect teaching and learning in public schools; and therefore, may be used to interpret negative thoughts and confrontational attitudes about CRP.

III. METHODOLOGY

This study is a multi-case study involving thirty-three (33) public middle/high schools located in one of the Southern states in the U.S. We intend to obtain an in-depth understanding of teachers’ perceptions and experiences of CRP and how CRP implementation influences students’ learning.

A. Participants

Fifty-seven (57) public school teachers from the thirty-three (33) participating middle/high schools have agreed to participate in the study. All teachers participated in the BRBytes Summer Institute in 2020. The Summer Institute offered virtual training of contents from CRP infused computing courses as well as CRP workshops. All participants are scheduled to teach at least one of the CRP-infused computing courses during the 2020-2021 academic year.

The participants included 41 females (72%) and 33 non-White individuals (58%). There were 43 high school teachers and 14 middle school teachers. Forty-two (42) teachers (74%) had not previously taught a Computer Science course.

B. Data Collection

The data collection contains two phases. Phase one data collection was conducted during Summer 2020. Participants were recruited through the BRBytes Summer Institute. All participants were contacted by the researchers to participate in either an individual interview or an exit survey, or both. In both the survey (open-ended questions) and interviews, participants were asked to share their experiences of the CRP workshops in the Summer Institute and perceptions of CRP.

Phase two of data collection began in Fall 2020 and is currently ongoing in Spring 2021. We observed classrooms with a focus on how trained teachers implement CRP in teaching CRP infused curriculum. The researchers observed the classrooms without participating (i.e., as outsiders) [17]. Observation rubrics and researchers’ reflective field notes were collected. We also conducted individual interviews with teachers to examine their experiences with implementing CRP. These individual interviews were conducted directly after the classroom observation.

The interviews (both the initial and the second-round interviews) lasted approximately 30 minutes each. Completed interviews were audio-recorded and transcribed verbatim. We used semi-structured interview protocols. Due to the COVID-19 pandemic, all completed interviews and observations were conducted via Zoom.

C. Analytical Plan

We conducted two rounds of coding with the interview and the observation data. First, we conducted an initial open coding process to obtain a general understanding of teachers' perceptions and experiences. Second, we conducted axial coding to analyze the underlying categories among different codes. Finally, through the lens of the theoretical framework, we generalized themes that revealed the role of CRP-trained teachers in promoting STEM success among URM students.

To ensure the trustworthiness of the data, we triangulated the data through different resources, such as student assignments and projects. We will also collect relevant materials such as training materials from the Summer Institute and teachers' lesson plans when available.

D. Researchers' Role

The leading researcher is an Assistant Professor of Education who is motivated to promote successful STEM pathways for URM students. The second researcher is a Professor of Sociology and African American studies who has long-time research interest and expertise on race and ethnicity as well as CRP. The third researcher has 17-year teaching experience in K-12 public schools and currently serves as the instructional STEM Specialist for BRBytes partner school district. He utilizes CRP in teaching and has received a Ph.D. in Educational Research and Methodology.

The research team also included a professor of Physics and a computer science education researcher who developed the CRP infused curriculum and hosted the Summer Institute, as well as two Education doctoral students.

IV. PRELIMINARY RESULTS

Currently, Phase One data collection is completed and Phase Two data collection is ongoing. We analyzed data collected in Summer 2020 (Phase One) and Fall 2020 (Part of Phase Two). Preliminary results revealed different patterns of teachers' perception of CRP.

A. Changing Perceptions of CRP

All teachers participated in the CRP workshops during the Summer Institution. Most of them demonstrated a comprehensive understanding of CRP immediately after the Summer Institute. Many participants teach in classrooms with high proportions of Black students and/or schools with a high percentage of free/reduced lunch students. During the exit interviews after the summer training, most teachers recognized that different, innovative teaching methods should be adopted in the classroom to recognize and accommodate the cultural backgrounds of URM students. For example, an experienced teacher believed that CRP was needed for some of his colleagues who struggled with students and have yet to recognize cultural differences between themselves and their students. Participants were also excited about adopting CRP in their teaching. For

example, a new teacher thought CRP gave her a different perspective of "what I want to do next school year".

However, when interviewed again during the fall 2020 semester, teachers' understanding of CRP tend to be color-blind and more geographically focused. For example, William, a White male teacher who teaches in a school with a high percentage of Black students, emphasized the "rich culture" of the state. Similarly, Caroline, a female minority teacher who teaches in a school with a high percentage of Black students, referred to "the new way of living" under the current pandemic. Adam, a former history teacher who now teaches the computing curriculum with a racially diverse classroom, emphasized the socio-economic differences among the population and their tie to U.S. history. Noticeably, almost all teachers who participated in the second round of interviews mentioned recognizing and respecting cultural differences. But none of them explicitly described the cultural differences within a racial context.

Research showed that many people, including educators, claim not to see race. Sociologists, such as Eduardo Bonilla-Silva and Joe Feagin explained how this happened in their work on color-blind racism and the White racial frame [15] [16]. Bonilla-Silva and Feagin made arguments of the unwillingness of many Americans to account for race, similar conclusions were also made by legal and education scholars like Derrick Bell [16] [18] [19]. Feagin defined the White racial frame as including stereotypes, images, emotions, language, and narratives that operated in everyday life in the U.S.; he addressed resistance to the White racial frame, which includes counter-frames [18]. Counter-frames, as part of critical race theory, illuminates the roles of race and racism in the law and education, whereas race and education are often understood as race-neutral. These perspectives point to the need for greater cultural competency, hence, the significance of culturally relevant pedagogy which calls for supplementing course contents, developing multi-cultural competency, and linking course contents with social justice.

B. Influential Factors of Teachers' CRP Perceptions

Teachers' understanding of CRP could be influenced by various factors at both macro and micro levels. For example, the Summer Institute was operated during a time when the continuation of violence and injustice against Black people were observed. Many teachers believed the CRP discussion was very relevant and important given the political and social contexts during that time. One Black, female teacher shared that she felt more "comfortable with my class and instructor [in the Summer Institute]" because the CRP talks helped deal with "the messes... emotionally and mentally... after the protests and the killing of George Floyd happened". Others believed that school administrators should be included in the CRP discussion to ensure effective implementation.

However, multiple teachers felt that it was "too much" to include the CRP discussions in a Summer Institute focusing on a high-demand computing curriculum. They felt it "took time away from the content" and that they would rather "focus more toward the classroom" or, "spend more time on 'one-on-one assistance with coursework [of the Summer Institute]'. Part of this feeling can be explained by the under-preparedness among teacher participants: forty-two (42) teachers or 74% of the

participants had not previously taught a Computer Science course.

The use of language by some non-Black teachers could be interpreted as coded and anti-Black. Together with the desire for more culturally relevant pedagogy by the Black teacher, this data supported the arguments set forth in the White racial frame, colorblind racism, critical race theory, and culturally relevant pedagogy. The comments by the Black teacher reflect a desire to change the way schools function to be more inclusive and culturally relevant, while the comments from the non-Black teachers are examples of how proxies are used to maintain the status quo. For example, the idea that improving the racial climate in the classroom is a distraction is coded language that reflects persistent anti-Black sentiments. The non-Black teachers clearly see education as racial neutral while the Black teacher sees race as central.

Moreover, teachers' cultural backgrounds added another layer to the scenario. Caroline, an experienced math teacher who is also a first-generation immigrant from the Philippines, explained her struggles with teaching high school students in her current school. In a classroom with 65 students, where Caroline taught in the Philippines, there were well-established "classroom rules" and protocols to discipline and punish misbehaved students. In the Philippines, Caroline would refer a misbehaved student to a "guidance counselor", who would talk to the students outside of the classroom and report to the principal if necessary. This way, the student's behavioral issues will not "disrupt" the class instruction. Caroline found that there was no "guidance counselor" or similar protocols to help her "discipline" the students in the current school. Apparently, Caroline is facing challenges brought by international cultural differences in teaching and learning. In many Asian countries, the teacher-student relationship reflects the cultural norms of Confucianism and collectivism, which expect students to respect teachers as a guru and never challenge or present negative behaviors towards them [20]. This additional cultural background complexed Caroline's perspective about CRP.

C. Challenges of CRP Implementation

During the exit interviews from the Summer Institute, teachers shared their concerns regarding implementing CRP in the fall. Some teachers felt it would be challenging because they would not be teaching any "historical or societal facts" in a computing classroom. They needed more guidance to find the "direct connection to the STEM content".

In the follow-up interviews, teachers further emphasized the limited resources for CRP implementation. Due to the COVID-19 pandemic, all teachers who participated in Fall 2020 interviews had to adjust to virtual or hybrid teaching formats. Some teachers also had to adjust their teaching schedules due to missing days because of hurricanes. Others were teaching the newly learned computing course in addition to other courses (e.g., Caroline is teaching multiple calculus classes simultaneously). When asked if they used any outside resources in their class to connect to various cultures, all teachers gave negative answers.

When asking how teachers established relationships with students and their parents/guardians, many teachers mentioned

the negative impact of the pandemic. For example, Ann, a White female teacher, said she missed having the opportunity to interact with her students before school starts and in the cafeteria. There were no open houses nor sporting events in Fall 2020 for Ann to connect with parents. Other teachers indicated various difficulties in contacting and communicating with parents.

Without question, the COVID-19 pandemic has had tremendous effects on teaching and learning. However, concerns about the implementation of culturally relevant pedagogy could be understood as a convenient excuse for not incorporating it into the practice of teaching. Ensuring that the curriculum is taught in a way that is culturally relevant should not be seen as a burden but as fundamental and central to the course content. Through the lenses of the White racial frame, colorblind racism, critical race theory, and culturally relevant pedagogy, one should be cautious not to rationalize the absence of culturally relevant pedagogy. Some perspectives, especially from non-Black educators, could be evidence of general resistance to improve the overall climate of the traditional and/or virtual classroom.

V. CONCLUSIONS

The findings of this study have theoretical, practical, and policy implications. Implementing culturally relevant computing courses will expand opportunities for URM in STEM fields, change dominant narratives about who belongs in STEM fields, and promote the recruitment and retention of qualified workers from diverse backgrounds. This study revealed challenges and obstacles teachers face regarding implementing CRP in computing courses. Theoretically, future studies about racial and ethnic disparities in STEM fields should consider how the White racial frame and colorblind racism inform teaching and learning. A multi-layer theoretical framework that considers classroom climate, teachers' perceptions, school/school district resources, and cultural/political contexts are warranted. Additionally, future studies and intervention designs should consider the gap between CRP theories and their implementation in computing classrooms. Finally, CRP implementation requires supports and inputs from parents/guardians, schools, and school districts. The findings of this study can help school district administrators, school leaders, and other institutional agents to make informed decisions regarding CRP implementation and promoting equity in academic success among URM youth.

ACKNOWLEDGMENT

This research project is funded by the NSF Computer Science for All: Researcher Practitioner Partnerships program (CNS-1923573) and the U.S. Department of Education, Education Innovation and Research (EIR) program (U411C190287).

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