

## **Culturally Relevant Science Pedagogy as an Impetus for Teacher Leadership**

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In this article, we describe our work with a teacher collaborative focused on enhancing elementary teachers' conceptualization of culture, culturally relevant pedagogy, culturally relevant science pedagogy and the process of developing culturally relevant science curricula. Using culturally relevant pedagogy as inspiration for equitable science teaching, we observed elementary teachers develop into science teacher leaders. These teachers, described using comparative case study analysis, stepped into informal and formal leadership positions that pushed for district-wide and school-wide equitable science teaching and curricula.

**Keywords:** Teacher leadership, culturally relevant pedagogy, collaborative, science

### **Introduction**

Equitable science education in schools has been an elusive goal for decades (Emdin, 2016; Leonardo, 2009; Picower, 2009). Scholars and practitioners have explored ways to confront inequities by gaining a better understanding of exemplary teaching. As a result, critical frameworks such as culturally relevant pedagogy (CRP; Ladson-Billings 1995, 2014), culturally responsive teaching (Gay, 2002) and culturally sustaining pedagogies (Paris & Alim, 2014) emerged. However, these pedagogies, despite being supported by teachers, are generally not widely implemented in schools and rarely appear as the focus of school-wide professional development opportunities (Yolcu, 2019). Teachers committed to equity-oriented approaches to teaching are not necessarily included in grade-level pedagogical and curricular decisions and school-wide initiatives (Zeidler, 2016). If the goal of science instruction is academic success, cultural competence and critical consciousness for students (Ladson-Billings, 1995), culturally relevant pedagogies need to be a part of science teacher professional development.

In this article, we describe our work with a teacher collaborative focused on enhancing teachers' conceptualization of culture, CRP, culturally relevant science pedagogy (CRSP) and the process of developing culturally relevant science curricula (CRSC). Using CRSP as inspiration for equitable science teaching, we observed elementary teachers develop into science teacher leaders. These teachers, described using comparative case study analysis, were inspired by CRSP and subsequently developed into informal and formal teacher leaders who pushed for district-wide and school-wide equitable science teaching and curricula.

## Literature Review

Historically, science curricula and teaching have not been representative of, nor designed, with culturally diverse learners in mind. Science curricula and teaching in the U.S. – like most other aspects of schooling and society – were borne from a white, Euro-centric lens (Gough, 2014; Le & Matias, 2019). To improve access, engagement, and success for all learners, but especially for those traditionally excluded from science spaces, scholars and practitioners have been attempting to center cultural diversity and to incorporate the ideas of historic systemic oppression into the science curriculum (Emdin, 2016). This kind of teaching and curricula are not typically sanctioned by schools in the U.S. and, have been referred to as teaching “against the grain” (Cochran-Smith, 1991). For culturally relevant science teaching and curricula to become systemically valued and employed, the leadership in schools must advocate and support it. Given the pedagogical nature of these changes, teacher leaders are central to influencing these kinds of shifts schoolwide. Otherwise, despite the professed desire for all students to be academically successful, groups of students remain left out of science in schools.

### **Culture, Culturally Relevant Pedagogy, and Culturally Relevant Science Teaching**

Building a culturally relevant science practice starts with a deep understanding of culture and how cultural norms exist in schools and often orchestrate curricular and pedagogical decisions. We view culture as not only the visible attributes that define a group of people’s way of life, but also their outlook on the world and how they engage in transactions to survive and thrive (Esteban-Guitart & Moll, 2014). As discussed above, treating culture as irrelevant in teaching and learning has led to the disparities in opportunities and outcomes achieved by racial and ethnic groups. When schools that serve predominantly children of color are “blind” to cultural considerations (Bonilla-Silva, 2015), and/or when schools default to cultural ways of being among the dominant (white) group, then disparities in access and achievement are likely to follow. Scholars have long cited this dynamic as a symptom of inequity in schools. González and colleagues (2001), for example, worked collaboratively with teachers to identify the ways families transact (culture) with others and the world – their funds of knowledge – and examined how teachers leveraged these funds of knowledge in classrooms to create rich, meaningful learning experiences. In science contexts, scholars (Philip & Azevedo, 2017; Milner, 2013; Schenkel et al., 2019) showed how embedded school structures and national reforms (e.g. NGSS) work to keep specific groups of students out of science. When historically oppressive practices are discussed, the racist and damaging results are often softened, seen as not currently occurring and/or are viewed as apolitical (Milner, 2013). Such practices work to keep cultural awareness superficial. Culture is accepted as holiday celebrations and food – not as ways of knowing and learning.

In our work with preservice and in-service teachers, we have used the iceberg of culture (Hall & Hall, 1976) to help illuminate the various ways culture defines our lived experiences. The iceberg demonstrates the more apparent cultural traits (above the surface) and the invisible cultural traits that underlie families’ and communities’ ways of being. Certainly, the iceberg metaphor is a simplified depiction of culture, but it is one that we have found useful as a solid starting point for meaningful discussions about what culture is and how stereotypical definitions of culture often lead to inequities in schools. Consistent referral to the iceberg can support teachers as they develop a deeper and more sophisticated understanding of what cultural

practices are and how they are at work in teachers' decisions and choices in the classroom (Magee & Willey, 2024).

Culturally relevant pedagogy (CRP), captured in three tenets, is a liberatory pedagogy developed by Ladson-Billings over 25 years ago (Ladson-Billings, 1995). The first tenet is that all students will experience academic success. While this may seem obvious, all students should be successful academically, the reality is that many students, often students from marginalized groups, are often failed by schools where they are seen and labeled as broken and/or unable to learn (Ladson-Billings & Tate, 1995; Milner, 2017). Recognizing this was connected to cultural norms in schools, Ladson-Billings was interested in understanding what *successful teachers* of African American students did and how they did it. What she found out was that the teachers did not take "no" for an answer when it came to academic success. The teachers did whatever was necessary to create environments, lessons and experiences that would honor and support their students. It was the teacher's *default* belief that the students are brilliant and waiting to be taught (Ladson-Billings, 1994). This definition of academic success is not limited to grades, compliance or simply doing well on exams, but rather it requires that students learn academic content in ways that matter to them and to their communities.

The second tenet, students will experience cultural competence, requires that students continue to learn to appreciate their own culture as well as the culture of other students in their class. Ladson-Billings' ideas extend beyond posters in the room of underrepresented scientists and holiday celebrations to recognizing the deep cultural norms at play in schools and classrooms. Norms that often position one cultural group (white Anglo-European) as better than others (Milner 2015); one way of knowing and learning as better than other ways and leave specific cultural groups (e.g., African American and Indigenous) out of the curriculum (Bang et al., 2013). Teachers who actively look for ways to honor marginalized groups and incorporate diverse cultural values into the curriculum are building a culturally relevant practice. The last and most difficult tenet to achieve demands critical consciousness. This requires that students learn with the goal of actively making their world a more just and equitable place. Critical consciousness is action oriented and pushes teachers to rewrite curricula to support the development of students as social justice and equity advocates. It asks teachers to look towards families and communities as experts and to work with them to achieve equity in the community (Adjapong & Emdin, 2015).

Fundamentally, CRP requires teachers to move away from traditional school practices (e.g., traditional discipline practices, direct instruction, focus on skills, etc.) and values that favor the dominant (white) group (e.g., compliance) (Ladson-Billings, 2014). Teachers can do this by developing a deep awareness of cultural norms and expectations, reworking how they talk about students who are struggling in school and seeking out professional development opportunities that center equity-based and anti-racist teaching (Leonardo, 2009).

## **Teacher Leadership**

For decades, scholars have acknowledged that leadership is distributed across educational organizations and expands beyond formal leadership roles (Harris & Spillane, 2013; Hopkins et al., 2013). It is no surprise that during this same time, teacher leadership has developed as a significant area of research and practice. Wenner and Campbell's (2017) review of literature on teacher leadership research provides an updated landscape of the field by exploring theoretical underpinnings of empirical studies on teacher leadership, specifying definitions of teacher leadership across the literature, articulating the enabling and hindering contexts of teacher

influence, as well as identifying a gap in literature related to a focus on social justice and critical consciousness. Teacher leadership research that is situated subject matter expertise has also informed the specific organizational dynamics that impact both positionality and influence among teacher leaders (see Hopkins, et al., 2013).

Teacher leadership is often distinguished from other forms of leadership in educational settings, such as administrative or classified staff leadership. Due to the nature of the teacher leadership (i.e., maintaining a core connection to the classroom), the influence teacher leaders have on organizational objectives (the definition of organizational leadership according to Yukl [2012]) can span influencing instruction, school policies and procedures, as well as boundary-spanning roles (school-community/-family relations). Opportunities for teachers to assume leadership roles in schools proliferate, in some cases due to an increased need for instructional support for new teachers during a time of high turnover. In elementary school settings, teachers may be tapped to assume formal roles such as: instructional coaches, formal mentors to new or struggling teachers, team leaders, department heads, committee leaders, providers of professional development, department heads, etc. They may also emerge as informal leaders, taking on projects of interest and enlisting colleagues to collaborate, informally mentoring colleagues, or informally leading grade level projects, due to their expertise, charisma, or ability to secure resources. Regardless of the nature of the leadership role, the enabling or hindering conditions in schools for teacher leaders persist depending on the congruence of their influence with that of the other leaders in the organization. In many schools, teacher leaders who are promoting CRP practices that fall outside narrow objectives defined by district evaluation rubrics and related mechanisms of audit culture, see their actions marginalized by narrow, apolitical, scripted approaches (Horsford et al., 2018). Thus, the contexts in which teachers develop, learn, and grow as leaders are critical (both vital and critically educative) for fostering the knowledge, skills and dispositions necessary to influence practices that support marginalized students and center otherwise marginalized knowledges.

It is widely agreed that teacher leadership must also be contextualized within the subject matters taught. Scholars argue that different disciplines draw on different techniques and approaches and are differentially valued in institutional contexts (Spillane & Hopkins, 2013; Ball & Lacey, 2012; Scribner & Bradley-Levine, 2010; Spillane et al., 2003). As a result, a case that focuses on the development of critically conscious, culturally relevant science teacher leaders through a community of practice focused on culturally relevant curriculum development is a timely and vital contribution to the literature on teacher leadership. Identifying pedagogical practices that build a CRP practice, and a network of like-minded teachers who can collectively make sense of and strategize how to implement and spread the practice across school settings, is essential to this body of knowledge.

## Methodology

This study was designed to answer the following research question:  
*How does the teacher collaborative and a focus on culturally relevant science pedagogy contribute to science teacher leadership in urban contexts?*

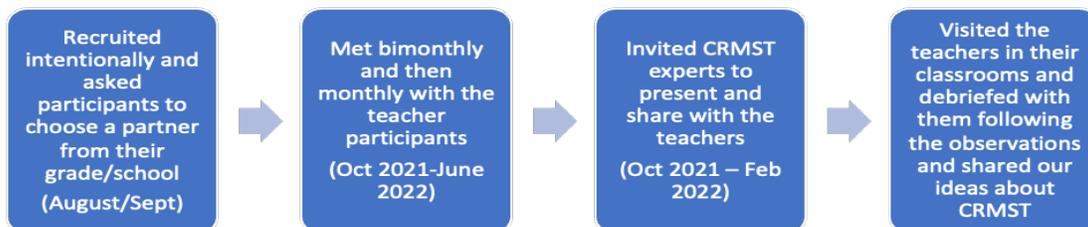
## Context

The study originated from a project, the *Teacher Collaborative for Culturally Relevant Mathematics and Science Curricula (CR-MASC)*, which had ten elementary teacher-participants.

The collaborative experience (“the collaborative”) is important to describe because it played an essential part in the teachers developing into equity-focused science teacher leaders (see Figure 1).

### Figure 1

#### *Schedule for Teacher Collaborative for Culturally Relevant Mathematics and Science Curriculum*



The collaborative took place in a large urban midwestern city in the U.S. The teachers worked in the same district but in two different elementary schools. Both schools predominantly served families of color (mostly African American and Latinx) with a variety of socio-economic levels represented. All the schools qualified for free- and reduced-price lunch.

The collaborative launched with a series of speakers who were STEM scholars and classroom practitioners from across the country. The speakers, all science and mathematics teachers, shared their work enacting culturally relevant science and mathematics pedagogy. This offered the teachers the opportunity to see the tenets in practice in a science setting. For example, one speaker spoke of a place-based project that supported teachers to understand the systemic inequities in marginalized communities through a science lens (Crabtree & Stephan, 2023). The overall goal with the speaker series was to deepen the teachers’ understanding of culture and CRP while also providing images of culturally relevant science curricula (CRSC). The tenets of CRP as described by Ladson-Billings (1995, 2014) were used to develop a framework for CRSP and for the teachers to become experts in identifying and documenting culturally relevant practices in their own teaching. This framework (Magee & Willey, 2024) uses the CRP tenets, visualization tools developed by the authors and identified teacher practices (curricular materials, instructional decisions and teacher dispositions) to expand teachers’ knowledge of what CRSP looks like in actual classrooms.

During the collaborative, the teachers met 1-2 times per month for two years for four hours at a time. As described above, a deep understanding of culture and how that influences what teachers do pedagogically is a cornerstone to understanding CRP and CRSP. This project provided extended time for the teachers to reflect, question and think deeply about the theoretical and practical implications of CRP and CRSP.

After the speaker series, monthly work time was dedicated to developing CRSC units, a collaborative task involving a solid understanding of grade level curriculum, an assortment of external resources, and a commitment to supplementing school/district curriculum with place based (i.e., local) curricula that helps children make sense of complex scientific and mathematical ideas.

## Participants

All the collaborative project participants were selected intentionally. Teachers receiving initial invitations knew one or both authors through their teacher preparation program or other projects grounded in culturally relevant pedagogy. All teachers who agreed to participate were asked to recruit a like-minded colleague. This was an intentional strategy to build grade-level and building-wide support for the teachers. While the larger collaborative project involved ten teachers, the analysis presented here uses data collected from three teacher-leaders specifically: Ms. Walters, Ms. Green, Ms. Lanford. All three participants are Black women with distinct personal and professional experiences which we describe briefly below in the next paragraph. All three assumed formal and/or informal teacher leadership roles throughout their careers as educators. It is important to recognize, because this is often *not* the case, that while the teachers in the collaborative identified with different racial groups (Black, White and Latina), they all came to the project believing that schools are often unjust places for their students of color, most severely for Black boys (Cole-Lewis et al., 2023). Like previous research has shown, the teachers here, regardless of their racial identification, were conscious of the risk that their students of color faced regarding low expectations for success and more severe disciplinary treatment than their white counterparts (e.g., Lindsay & Hart, 2017).

**Ms. Walters** is in her third year of classroom teaching. Prior to becoming a teacher, she worked in a classified staff position at an elementary school for several years. Ms. Walters was inspired to enroll in an alternative certification program her district provided in partnership with a local university. During the year that she was earning her teaching license Ms. Walters was a 6<sup>th</sup> grade classroom teacher working on an emergency permit. **Ms. Green** was the most experienced teacher with five years of teaching experience. She, too, earned her license through an alternative pathway but not in partnership with the university. She was seen as a mentor in the collaborative and was recommended to participate by Ms. Lanford. Ms. Green had already been tapped to be a teacher leader in her building by agreeing to serve in a formal role that was part classroom teacher and part instructional leader. In the district this role was referred to as “D3.” **Ms. Lanford**, in her third year of teaching, is also a D3 teacher in her school. Like Ms. Walters she completed the university alternative certification program. Ms. Lanford and Ms. Green are enrolled in the university principal preparation program, and all three teachers earned their master’s degrees in elementary education.

## Data Sources and Analysis

Data was specifically collected to help the authors understand 1) how teachers developed an understanding of culture, CRP, and CRSP; 2) how these understandings showed up in curriculum and pedagogy; and 3) how the collaborative, rooted in CRSP, shaped teachers’ lenses and capacity to lead.

The data sources we draw upon include: audio and video recordings of speaker and curriculum-making sessions; collaborative curriculum planning documents (e.g., unit plans written by teachers); written and oral reflections about implementing CRSP in the classroom; field notes and video from classroom observations; audio recordings of debrief sessions following classroom observations; and audio recordings of focus groups with teachers after the completion of the project. A year after the project, the teacher leaders participated in an hour-long focus group session discussing their teacher leadership roles during and after the project.

The data was examined through the lens of CRP, specifically how the discourse and curricula represent the tenets of CRP and what impact the teachers’ experiences in the

collaborative would likely have on developing science teacher leaders. In this analytical process, we looked specifically for ways in which teachers were moving beyond superficial notions of culture (e.g., incorporating obvious symbols of culture like names, foods, and pastimes), incorporating critical pedagogy, and moving towards advocacy for equitable science teaching. Data was first analyzed individually, identifying references to, and instantiations of, culture, CRP, and CRSP. Then, each researcher identified episodes with a high density (i.e., many instances per hour) of CRP or CRSP practices. These episodes were analyzed again collaboratively to distill themes. We used documentational tables (Anfara et al., 2002) to help organize the data and move from individual codes to more substantial themes. Appendix A depicts the code mapping process and how each of the themes emerged from a cluster of codes.

An explicit goal of the project was to help teachers identify barriers to equitable CRSP and to build a network of like-minded colleagues. The rationale was that this would encourage teachers to commit to writing CRSC and to teach in culturally relevant ways. What we also found was that teachers developed into both formal and informal science teacher leaders.

## Findings

Our analysis of the data has led to findings that show how science teacher leaders (STLs) serve in a variety of formal and informal leadership roles influencing activities in their schools and how their equity-focused science teacher leadership develops. The findings indicate that the teachers' experience in a collaborative focused on culturally relevant science and mathematics teaching and curriculum inspired them to grow as culturally relevant STLs. Learning about CRSP in the collaborative strengthened their capacity to see themselves as advocates and experts in CRSP and encouraged them to push their own CRSP. Seeing how actual practitioners use CRSP in their classrooms (during the collaborative project's professional development sessions) enabled them to create pathways for their own development as culturally relevant science teachers and STLs.

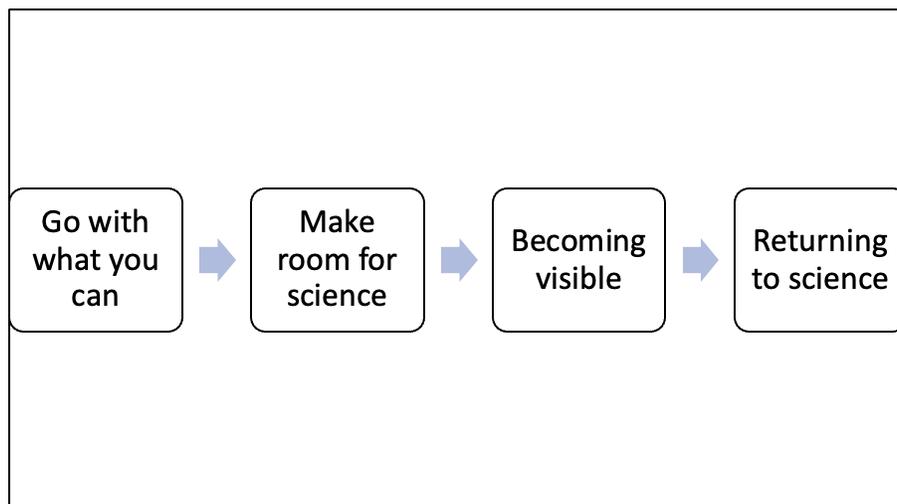
### **Becoming a Culturally Relevant Science Teacher Leader**

The teachers enacted science teacher leadership in different ways depending on their experiences and school context, but there were consistent milestones in how they developed. While all three teachers taught in elementary schools in the same school district, they taught different grades, had different years of experience and held different roles in the district before becoming teachers. Importantly, the teachers were already on board with the ideas of culturally relevant pedagogy and were interested in expanding their skill set to focus on science and mathematics. The teachers did not need to be convinced that CRSP was important; they already believed that and, to some extent, enacted it in practice, although they would not have used the term *culturally relevant pedagogy* to describe their instruction prior to participating in the collaborative. They joined the project to be in a collaborative, to learn more about what culturally relevant instruction looks like, and, specifically, to build their skillset in developing culturally relevant mathematics and science curriculum.

While the teachers taught in different contexts and leveraged different strengths, we did see similarities in how they grew their capacity to include – and center – culturally relevant activities and lessons in their practice. The following sections show one of our central findings from this longitudinal study: the trajectory and nuances of developing a culturally relevant science praxis. We take care to demonstrate how the teachers' practices represent each of the

tenets of CRP: academic success, cultural competence, and critical consciousness. The main steps on their trajectory are highlighted in Figure 2 below.

**Figure 2**  
*Main Steps on CRSP Trajectory*



### ***#1 Developing a Culturally Relevant Science Praxis - Go with What You Can!***

As we worked with the teachers and invited them to create culturally relevant mathematics or science curriculum, we saw them all reach for mathematics activities first. In this section we highlight Ms. Walters, but all teachers looked to mathematics as a place to begin working their own culturally relevant science muscles. For example, Ms. Walters wrote and taught a lesson called “Men Lie, Woman Lie, Numbers Don’t.” In this activity, aimed at teaching 6<sup>th</sup> graders about data representation and graphs, Ms. Walters used a video clip of Jay-Z accepting an American Music Award. At the end of his acceptance speech, Jay-Z says, “Men lie. Women lie. Numbers don’t.” At that point Ms. Walters turns to the class and says, “What do you think he meant?”

With this action Ms. Walters does two important things. First, she engages the students by incorporating a current cultural icon into the lesson: Jay-Z. The students all know Jay-Z and were riveted by this acceptance speech. It is important to note that this is *usual behavior* for Ms. Walters. She connects to the students constantly. Watching the recording of her teaching, there are explicit connections to her students, their likes, and their lives every few minutes. With these consistent actions she built a level of trust and rapport with the students. They know that she means it. This is not lip service – this is who she is.

Second, Ms. Walters connects the mathematics content to the students by asking them where and how they use mathematics in their lives. When Jay-Z uses his own lyrics at the end of the acceptance speech, he is elevating mathematics and letting the viewers, and his listeners, know that mathematics is power. In essence, Jay-Z is saying, “Math is something important and you should use it to examine your world.” In the remainder of the activity, Ms. Walters and her students analyzed different graphs that show record sales for different recording formats for

multiple artists over different periods of time. She includes different rappers before and after their deaths to engage the students in thinking about record sales posthumously. Ms. Walter's lesson represents the types of ways we saw the teachers work to insert culturally relevant curricula into their day. Mathematics made sense as a starting point. The teachers had to teach mathematics and there was a designated time for it in the school day. As they developed confidence in CRP, and were encouraged by each other, the teachers recrafted their mathematics curricula and developed the stamina to reach for science.

## ***#2 Developing a Culturally Relevant Science Praxis – Making Room for Science***

Since all three of the teachers teach at schools where science is not on the daily schedule, they were aware that figuring out how “to do” culturally relevant science teaching would be more challenging. Not only did the teachers need to consider the curriculum but they had to find time in their schedule to add in science. The teachers approached this by making room for science during a time when they had some flexibility. For example, after participating in a collaborative session on inquiry teaching with Mr. Shaker, an elementary science specialist, Ms. Walters decided to do Mr. Shaker's inquiry activity on a Friday afternoon with her students. Ms. Walters called this “Science Friday.”

To better understand the development of the teachers' capacity to do science in culturally relevant ways it is important to share a bit more about the content of the science professional development sessions that the teachers experienced during the collaborative. In addition to multiple sessions on culturally relevant science pedagogy and curricula from the authors, there were two, science-focused sessions led by former classroom teachers. The first session was the inquiry-based activity that Ms. Walters used. This student-centered inquiry activity used matchbox cars, rulers, ramps, etc. to encourage the students to test things out (force, motion, speed, etc.), generate questions, and collect data. This session was a great example of how to include the students' questions in a lesson and use their curiosity to drive science.

What was missing was the connection to something more critical in the content. Unlike the first science session, the second session (offered just a month later) focused on a science unit that was grounded in revealing “...the impact of systemic inequities on marginalized communities” (Crabtree & Stephan, 2023). The teachers were deeply inspired by this presentation and talked about it for the remainder of the project, but they struggled to see how they could do it themselves. Given this, it is not surprising, then, that Ms. Walters reached for the more traditional and accessible inquiry unit first.

At our project meeting Ms. Walters shared her experience of the inquiry session and described how engaged the students were. Ms. Walters explained that the force and motion activities focused on getting the students to develop questions, test ideas and report their results. While the group of teachers in the collaborative rarely had behavioral issues with their students that they could not handle, Ms. Walters commented that the students were all engaged with no behaviors that required redirection. During the collaborative meeting we discussed how encouraging the students to ask questions and using those questions to collect data demonstrated cultural competence in Ms. Walter's practice. The teachers were generally surprised that something not typically considered cultural (having students ask questions) could be used as evidence of building cultural competence. The teachers also recognized that the students were more likely to learn and retain the information (academic success) when they were engaged in the activity. Despite the lack of critical consciousness, the Science Friday experience propelled Ms. Walters to be an advocate for science and to commit to making time for it more regularly.

Ms. Walter's experience also influenced the other teachers. Following Ms. Walter's description of Science Friday during a teacher collaborative meeting, Ms. Lanford decided to modify an existing lesson from the Project Lead the Way (PLTW) curriculum, mandated by the school for 5<sup>th</sup> grade, to include information about COVID-19. The original PLTW lesson spotlighted the transfer of germs through casual interactions with friends, family, strangers, etc. Ms. Lanford was underwhelmed by this PLTW lesson. Now, however, she was inspired by Ms. Walters and looked for ways to modify the curriculum and make it more relevant and engaging for her students. During this time the COVID-19 pandemic was still disrupting most facets of life. Using this to connect to her students, Ms. Lanford revised the curriculum to include information about COVID-19 and its impact on the community. By doing this, Ms. Lanford leveraged her students' experiences and connected the science lesson to a critical and current issue. Ms. Lanford's attention to student engagement and relevance supported her goal of both academic success and cultural competence.

### ***#3 Developing a Culturally Relevant Science Praxis – Becoming Visible***

As the teachers moved into the end of the first year of the collaborative, they began to stretch their experiences with CRP. We saw the teachers reach out to content areas other than science and mathematics and to take their work outside their own classroom. For example, Ms. Walters began having conversations with her students (who are almost all African American) about segregation and what it means to them to be Black. Ms. Walters used videos and books to support the conversations and had the students explore artistic expression by making "What Being Black Means to Me" murals. These murals were then hung up in the school cafeteria. Ms. Walters described the art as "... beautiful and like graffiti, it really warmed our hearts." Following this the students studied the Negro Baseball League and used art materials to make baseball pennants. They also placed these up in the cafeteria and "so the whole wall was an ode to Black history." Following these projects' completion, there was a buzz in the school. Teachers began to come to Ms. Walters and others in the project and ask, "What was going on?" And not only were the teachers intrigued, so were the students. Ms. Walters teaches 6th grade, but students from all grade levels would ask about the art projects and when they could do them.

Black History Month was happening then, and we saw the teachers connect to the professional development sessions' content as they expanded their influence on others in their schools. For example, Ms. Green decorated her door when her school had a contest for the best Black History Month Door. During the collaborative session Ms. Green shared how she started a conversation with the staff in her school about which local business would provide the pizza award for the best door. In the past a national chain such as Domino's would provide the pizza. Ms. Green, having participated in a collaborative professional development session on "mathematics in the community and locally owned businesses," lobbied for a Black-owned pizza shop to provide the pizza for the award. While this action wasn't directly connected to instruction in the classroom it was an example of how the professional development sessions influenced the teachers in all aspects of their work. Ms. Green said, "I had never questioned Domino's before. After the St. Paul session I knew that there had to be a better answer to support our Black community." The "St. Paul session" was a workshop presented by leaders from St. Paul (MN) Public Schools, where they designed their own K-12 culturally relevant mathematics curriculum. The reference was to a particular unit in the primary grades focused on the economic impact of spending and keeping money in the community.

#### ***#4 Developing a Culturally Relevant Science Praxis – Returning to Science***

During the collaborative's first year, the teachers read, listened, talked and tried out new things. In their classrooms, they experimented with writing culturally relevant activities and lessons. In their schools, they began to advocate for their students and communities. Most importantly, they shared with each other their struggles and successes. Each collaborative meeting was an opportunity for the teachers to see through their eyes and ours how they were enacting CRP and building a CRSP practice. During the second year of the collaborative, feeling empowered, prepared and supported by each other, they wrote their own culturally relevant curricula.

By the beginning of year two, the teachers were even more committed to teaching in culturally relevant ways. During the collaborative's first meeting of the second year, the teachers decided to write science units collaboratively, despite teaching in different grade levels. Ms. Lanford said, "Our students need science, and we need to do it." They all agreed. They had been successful with mathematics and language arts. The teachers had been invited to present their work from Year 1 at a district summer professional development, and they were ready to keep pushing ahead. The teachers represented various grade levels (kindergarten, 1<sup>st</sup>, 3<sup>rd</sup>, 5<sup>th</sup> and 6<sup>th</sup>), and it was important for them to find a topic that each grade level could engage with, and to connect to, the state standards. They began talking about how important it was for all grade levels to experience CRSP and culturally relevant science curricula. The teachers took several meetings to decide on the topic and they finally selected, "Human Impact on the Earth."

The teachers were driven by academic success for all students and took connecting to the standards seriously. Despite the challenge of fitting science into the day, they did it and engaged their students in student-centered, equity-focused science lessons. An excellent example of this, is the 3<sup>rd</sup> grade unit written by Ms. Green and another 3<sup>rd</sup> grade teacher in the collaborative called "Where is All the Green?" This unit focused on understanding what a green space is, where green spaces are and are not, and what environmental factors contribute to the reduction of green spaces in communities. The unit included resources that focused on understanding green spaces (DiSalvo-Ryan, 1994) and highlighted the work of Black activists such as Marjie Richard, who exposed the insidious practices of Shell Oil in what became known as "Cancer Alley" in Louisiana. Ms. Green was attentive to current events while she was teaching the unit. For example, during the week that she was teaching the unit there was a fire at a large plastics factory about two hours east of the school. Ms. Green shared the news story with the children and included the opportunity for the students to discuss the impact of the fire on the communities, including their own.

The unit ended by asking the students to take action (critical consciousness). The students had studied state parks, explored their own green spaces, and questioned the equity associated with green spaces. They had read about why green spaces were important and what factors hindered green spaces in certain communities while supporting them in others. The students were tasked with figuring out how to increase the green spaces in their community. Using templates provided by Ms. Green they developed plans by brainstorming in groups and writing out action steps.

All the teachers in the collaborative wrote and developed units like "Where is All the Green?" and everyone taught their units (see Table 1 below for a list of unit titles and brief descriptions). When we talked with the teachers the following year, they identified writing and teaching the units as a profound experience. Being able to develop curricula and have the stamina to teach it was empowering.

**Table 1**  
*Year 2 Science Units*

Grade Level	Unit Title	Descriptions
3 <sup>rd</sup>	Where is All the Green?	Students investigated local and national areas, focusing on marginalized communities, where the environment was being threatened and destroyed. Students learned about the health benefits of green spaces and created plans for supporting local green spaces. The unit included videos, news clips and trade books highlighting activists of color.
5 <sup>th</sup>	Environmental Effects of Earth Systems	Students learned about the geosphere, biosphere and hydrosphere and made connections to how these are impacted by their own use and the use of people in the community. Students developed plans for protecting the various systems.
6 <sup>th</sup>	Human Impact on Pollution	Students investigated pollution in the community. Introduction activities included analyzing music lyrics by Marvin Gay. Students developed plans for educating others on the effects of pollution and how to contribute to taking care of the environment.

### **Culturally Relevant Science Teacher Leadership Takes on Multiple Roles**

While it was not a part of the initial project, it was impossible to miss seeing how the teachers developed into science teacher leaders having participated in the teacher collaborative. Through both formal and informal roles, the teachers led equity-driven innovations in science curricula and instruction, and they also promoted culturally relevant mathematics and science teaching in school-wide culture and academic initiatives. In addition to science, we saw the teachers advocate for their students and communities in areas unrelated to science. While all the teachers were determined and urgent leaders seeking to influence their students, colleagues and the school culture, we use narrative vignettes below to highlight the ways we saw their teacher leadership enacted.

#### ***The Advocate***

Ms. Walters was the newest teacher in the collaborative. She had just completed her certification program and was new to the school where she was teaching. Due to her novice status, Ms. Walters enacted more informal teacher leadership in her school. What she lacked in experience she made up for in determination. Ms. Walters was a constant cheerleader and advocate for culturally relevant pedagogy and often spoke about the necessity of the collaborative as a professional learning space, and its influence on her as a teacher. Whenever we met as a collaborative the first hour or so was always a debrief/catch up so the teachers could share what was happening in their classrooms and schools. During these sessions, Ms. Walters would often say, “Without everyone here [the teachers], I would not make it,” and “...this program is my heart. Without you ladies, I would not be teaching.”

One way that Ms. Walters influenced others outside of the teacher collaborative was through recruitment. She consistently identified and recruited new classified staff who showed potential to the alternative certification program she had recently completed. She said, “Understanding CRP is fundamental to teaching mathematics and science. We need more teachers who go through your [the university’s] program so that they know what CRP is and how to do it.” In addition to recruitment, Ms. Walter’s “walked the walk” (Beasy et al., 2021 p.196) and influenced teachers by what she did in the school. As discussed earlier, Ms. Walters made her students’ culturally relevant work visible. She posted student artwork on the walls in the cafeteria and speaks here to how she influences others in the building

Anything that the kids can hang on to. So not only do we have coworkers coming. The kids come from all over the building. They wanna go come in my room. They wanna come see what's going on. They have questions. Especially during [what] we did Hispanic heritage, women's history and black history where we're talking about the mathematicians and the scientists and what not and the inventions and you have little kids that are venturing way across the building. We think it's just to... Or they think initially, there's just to get a snack for the right answer. But they're learning.

While Ms. Walter’s leadership actions came from an informal leadership position rather than a formal (quasi-)administrative appointment, her influence and impact on her colleagues is undeniable and adds to what we know matters for advancing culturally relevant science experiences for students (Ball & Lacey, 2012). She humbly but urgently leads her colleagues by visibly exemplifying CRP tenets and influences school level practices in the context of culturally relevant science and mathematics.

Ms. Walters was inspired by the collaborative and the discussions that were held before each session. At the beginning of the project, we anticipated the discussions at the beginning of each session would be a 15-minute warm-up. We quickly realized that the teachers needed to talk. During these often one-hour sessions, the teachers shared what they had experienced during the weeks between sessions and how they handled challenges and successes. These discussions were critical to their community building with each other, emotional well-being, their development of culturally relevant science pedagogy and their confidence as emerging teacher leaders. Ms. Walters and many of the others referred to these discussions as “life-saving” and made sure that we included them. We saw the teachers supporting each other, empathizing with each other and encouraging each other. Their stamina for culturally relevant teaching grew despite the obstacles they faced at their schools (scripted curricula, racist disciplinary policies, etc.). As such, the collaborative became a rare reflective practice space necessary to nurture teacher leadership development in addition to their expertise as CRP practitioners.

### ***The Determined Leader***

Ms. Green was soft-spoken, but the most experienced teacher in the collaborative. She held a formal teacher leadership role as an instructional coach in “split position” while also remaining classroom teacher for part of the time. In the collaborative, she was seen as an (informal) mentor and often reminded the other teachers that all students are brilliant and that they look to be inspired *by their teachers*. During our recent focus group discussion on culturally relevant science teaching, Ms. Green described this when she said, “All of these students are

excited by the topics, but YOU [the teachers] position them as critical thinkers who can use the information to make change in their lives.”

Ms. Green was a natural advocate for her students and strongly focused on academic success and cultural competence. During our focus groups and collaborative sessions Ms. Green talked about how students are engaging in complex science topics and how these academic topics relate to broader social phenomenon (e.g., human’s impact on earth; how climate issues affect local communities). Ms. Green consistently focused on student learning saying, “That is what gets ignored ...that the kids are learning and that is at the core of CRP. Are the students learning?”

As the collaborative project wrapped up, Ms. Green shifted to a district level position as a curriculum specialist. This was not surprising given her mentor status and her strong commitment to content. In this role Ms. Green leveraged her position to advocate for a middle school high ability mathematics class for Black students – the students usually left out of high ability classes in the district. Ms. Green described tremendous pushback from other teachers in the building who argued that the students could not do the work. When the students selected excelled and qualified for high school level mathematics in middle school the dissenting teachers finally supported the initiative.

After the collaborative project Ms. Green spoke to what she was learning about the accepted, racist practices in schools. She said in one meeting, “I knew that things weren’t right [in my school], but I didn’t really know how to talk about what I was seeing and feeling.” The experiences that Ms. Green had in the collaborative supported her to call out and label what she knew intuitively was unjust. This level of sophistication in naming and disrupting inequitable, unjust practice is a crucial skill for any educational leader focusing on CRP and educational justice.

### ***The Urgent Leader***

Before Ms. Lanford was a certified classroom teacher, she worked as an instructional assistant and as the lead teacher in the alternative classroom for struggling elementary school students. It was during her time in these roles that she saw how inequitably the students were treated and began looking for an approach to teaching that supported her students. This was the main reason she joined the project. As she described it, “My babies are sent to me, and I try to restore what was taken from them.”

During the collaborative project and with only two years of teaching under her belt, Ms. Lanford was tapped to take on a formal leadership role as a “D3” (teacher and instructional coach) for the district. She took this opportunity and committed to working with other teachers. While the focus was on mathematics and reading, Ms. Lanford used this opportunity to encourage teachers to include science wherever possible. Teachers responded to Ms. Lanford because she was successful in the classroom. She was successful regarding academic success but also with classroom management. Ms. Lanford was often asked to mentor new teachers and to share her strategies with them. Ms. Lanford’s instructional practice was designed to help students expand their knowledge and skills associated with multicultural interactions and to establish a community where cultural wealth is celebrated and revered. These actions promote a school-wide interest in learning about culture and student-centered ways of being in the world.

Based on her experience in the collaborative and her accumulation of formal and informal leadership responsibilities and actions in the school, Ms. Lanford was inspired by CRSP and enrolled in the university’s educational leadership program. She talked about “spreading the

word” and was selected for the district’s leadership academy program which she also completed. Ms. Lanford’s leadership crosses boundaries. She is an informal teacher leader and a formal leader as an instructional coach.

### **Discussion**

Through their time together in the CR-MASC project, collectively processing their experiences in their schools and their learning within the CR-MASC space, the teachers developed increasingly sophisticated understanding and skills for enacting CRP in the context of mathematics and science teaching and thus increased their capacity to lead toward more systemic acceptance of CRP in their schools. As a result of the collaborative activities honing their skills in observing and reflecting on instructional practice, the teachers were able to identify and further develop their own culturally relevant practices and to name what they had previously sensed were inequitable school practices (e.g., lack of connection to students in the curriculum). The focus on culturally relevant pedagogy – and specifically on the tenets (Ladson-Billings, 1995) – encouraged the teachers to examine their science teaching practice within a framework and to develop a shared discourse for doing so. Having a common language for CRP practices in the context of science teaching and learning allowed teachers and teacher educators to make connections, build trust, and work collaboratively towards a common goal of helping children achieve academic success, cultural competence, and critical consciousness. In our role as project facilitators, we were able to illuminate and validate impactful science teaching practices that were often undervalued and/or unrecognized by the teachers (and onlookers).

Together, the teachers were able to imagine a different type of science classroom, one where students worked and wondered together, where meaning-making was centered, and where the health of the community was prioritized. Moreover, the study of CRP galvanized teachers’ principles and commitments to children. Even though they all entered the teacher collaborative with dispositions that honored children’s knowledge and valued the local communities, the camaraderie ignited within the collaborative provided reassurance that they were doing good work, especially when the stresses of teaching and leading began to wear them down. Over time, teachers were inspired to fight for the use of equitable teaching practices, and for the inclusion and expansion of a culturally relevant science curricula. Extended opportunities for the teachers to build relationships with like-minded colleagues, who encouraged each other to “teach against the grain” (Cochran-Smith, 1991), supported the teachers to see themselves as equity leaders and advocates for their students and each other. The impact of an emerging collective identity as CRP practitioners and equity advocates cannot be understated as a source of stamina for the individual teacher leaders and the potential sustainability of their influence. This collective identity was critical to their development as teacher leaders, both in informal and formal roles.

It should be noted that through this work we have consistently noticed that exemplary teachers of color are often overburdened and taxed to be mentors for struggling colleagues. They are “asked” to take on a disproportionate number of struggling students and they are often held up as classroom management models. This overburdening came up frequently in the teachers’ discussions when they would share their own experiences, and the expectations others had of them in their schools. Because “good” teaching is often conceptualized as something that one is “just born being able to do,” (much like being seen as a “born leader”), teachers are left with little understanding of their own practice. For these teachers, this often resulted in administrators giving instructional feedback with comments such as “you are doing a great job” and “I don't

know how you make it look so easy.” We challenged this idea throughout the project by offering teachers ways to analyze and understand why and how their practices are culturally relevant. In doing so, teachers began to appreciate the complexity of culturally relevant pedagogy enacted well and to deconstruct how teachers learn to be good CRP practitioners. The increased understanding and practice in identifying and building a CRP practice became the foundation for a culturally relevant teacher leadership that could advocate, model and support CRP in science (and mathematics) in their schools. Demystifying their own practice was fundamental to their capacity as teacher leaders to influence the practice and culture of other classrooms in their schools.

### **Conclusion**

Three major outcomes of the teacher collaborative provided a strong foundation for leadership development in the teachers highlighted in this article: 1) a sophisticated understanding of culture, and the politics of culture in schools; 2) a deep learning and demystification of culturally relevant pedagogical practice in science; and 3) a collective stamina for teaching and leading against the grain. All three elements, together, shaped a discipline-specific and culturally relevant teacher leadership that these teachers enacted in their schools and districts. Demystifying CRP practice through becoming an ‘expert observer’ in addition to creating space to be critically reflective of both classroom practices as well as organizational, socio-cultural, historical and political contexts that intersect with classroom practices, were/are, in our view, fundamental to developing culturally relevant teacher leaders.

To build systemic support for the development of culturally relevant science teacher leaders, teachers and administrators need the skills necessary to identify components of a culturally relevant practice. The time working together in the CR-MASC collaborative enabled the teachers to move from wanting academic success for all students to creating and enacting a curriculum that allowed students to be social justice problem solvers. This was not insignificant, as it also allowed teachers to build an increasingly sophisticated CRP practice in their classrooms, while also accumulating the skills and experience informing their capacity to influence the practice (and in some cases, careers) of their colleagues and staff at the school. One of the most important building blocks of teachers’ instructional and leadership skills was the development of project specific tools supporting teaching learning about how to be an ‘expert observer’ of teacher practice. Teachers applied this learning with a goal of helping themselves and others build on strengths and critically reflect on areas impeding the enactment of CRP tenets in the classroom. Throughout this process, they also learned to provide meaningful feedback, a vital aspect of effective instructional leadership.

The project data also highlights how teachers were empowered, enriched and encouraged by each other to develop the expertise, stamina and commitment to be grade level, building level and district level science teacher leaders focused on building capacity for culturally relevant pedagogy in science and mathematics. Again, given the narrowing of curricular objectives and the increasing intensification of work in professions such as education (Fraser, 2023), amid reduced funding, teachers’ efforts to lead in areas outside of expressed strategic priorities can be met with hostility or indifference. That these teachers developed a collective sense of responsibility toward students and communities in the context of teaching science enabled them to envision making changes schoolwide and to build stamina to influence such changes.

In sum, dissecting the teacher collaboration in the CR-MASC project and its associated learning to understand how the participants emerged as teacher leaders can inform approaches to professional development, particularly leadership development, aimed at achieving equitable learning processes and outcomes in diverse science classrooms. Given that instructional leadership is distributed across school organizations (Harris & Spillane, 2013; Spillane & Hopkins, 2013; Spillane et al., 2003), a project that addresses the complexity of cultural relevant instruction while also cultivating solidarity among the participants provide valuable insights for advancing anti-racist, culturally relevant and equity-oriented teacher leadership.

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## Appendix A

### Narrative Analysis Process

Research Question	Initial Codes (First Iteration)	Axes (Second Iteration)
1. How does the teacher collaborative and a focus on culturally relevant science pedagogy contribute to science teacher leadership in urban contexts?	<ul style="list-style-type: none"> <li>• <i>Mathematics first</i> <ul style="list-style-type: none"> <li>○ <i>Supplemented commercial curriculum</i></li> </ul> </li> <li>• <i>Connections to students' lives</i> <ul style="list-style-type: none"> <li>○ <i>Resonance with students</i></li> </ul> </li> <li>• <i>Mathematics in real-world contexts</i></li> </ul>	Making use of the time allowed (for math) in master schedule and resources at hand  Start with small adjustments to math curriculum
	<ul style="list-style-type: none"> <li>• <i>Consider available and potential science curriculum</i> <ul style="list-style-type: none"> <li>○ <i>Modify PTLW lesson</i></li> </ul> </li> <li>• <i>Find time for science</i></li> <li>• <i>Try inquiry-based science activity</i> <ul style="list-style-type: none"> <li>○ <i>Students develop questions</i></li> <li>○ <i>Test ideas</i></li> <li>○ <i>Report results</i></li> <li>○ <i>Driven by curiosity</i></li> </ul> </li> <li>• <i>Critical dimensions of CRSP missing</i></li> </ul>	Making room for science  Inspired by collaborative speakers and teacher-participants
	<ul style="list-style-type: none"> <li>• <i>Developing critical consciousness and social action in (and outside of) the classroom</i></li> <li>• <i>Leaning on the humanities and integrating science with other subjects</i></li> <li>• <i>Direct learnings from content from the collaborative</i></li> </ul>	Science can be connected to school life  Becoming visible

	<ul style="list-style-type: none"> <li>• <i>Showed preference to work collaboratively in development of major CRP science unit</i></li> <li>• <i>Racial/cultural reflections in curriculum</i> <ul style="list-style-type: none"> <li>○ <i>Black activists</i></li> <li>○ <i>Trade books with racial/cultural affirmations</i></li> </ul> </li> <li>• <i>Curriculum included local touchpoints and current events</i></li> <li>• <i>Units included critical action steps aimed at equity</i></li> </ul>	<p>Returning to science</p> <p>Leveraging new science knowledge; accentuating critical, social action</p>
	<ul style="list-style-type: none"> <li>• <i>Informal teacher leader</i></li> <li>• <i>Strong grasp of the expansive role of teacher</i></li> <li>• <i>Drew on strength of colleagues</i> <ul style="list-style-type: none"> <li>○ <i>Reciprocally provided strength for others</i></li> </ul> </li> <li>• <i>Recruited teachers</i></li> <li>• <i>Intuitive sense of CRP and its benefits for children</i> <ul style="list-style-type: none"> <li>○ <i>“Walks the walk” - showcases CRP science</i></li> </ul> </li> </ul>	<p>Teacher Advocate</p>
	<ul style="list-style-type: none"> <li>• <i>Noticeable leadership skills</i></li> <li>• <i>Mentor</i></li> <li>• <i>Understands and centers students’ strengths</i></li> <li>• <i>Knows how instrumental teachers can be for (vulnerable) children</i></li> <li>• <i>Acutely focused on academic success and cultural competence</i></li> </ul>	<p>Determined leader</p>

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	<ul style="list-style-type: none"><li>• <i>Critical Supplemented commercial curriculum</i><ul style="list-style-type: none"><li>○ <i>Aware of how schools can be injurious to some children</i></li></ul></li><li>• <i>Showed leadership qualities</i></li><li>• <i>Encouraged teachers to do right by children</i></li><li>• <i>Mentor</i></li><li>• <i>Highlights and builds cultural wealth in classroom community</i></li><li>• <i>Wants to influence systems to achieve more equitable outcomes for children</i></li></ul>	Urgent leader
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