Radical STEM Teacher Activism:

Collaborative Organizing to Sustain Social Justice Pedagogy in STEM Fields

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Abstract

Teacher activism is developing throughout the country with an expanding research base, but little research addresses teacher activism specifically in STEM fields. Using critical race feminism, intersectionality, and TribalCrit this qualitative study focuses on four STEM teacher activists, who founded a social justice STEM organization, to explore how they became involved in grassroots organizing and how they conceptualize STEM teacher activism (STA). Findings indicate that firsthand experiences of marginalization sparked their engagement in teacher activism and that participants have a strong understanding of structural oppression. STA becomes a vehicle for their own healing as well as a means toward addressing the inequities they witness and experience in their communities. Participants define STA as attending to community health and ancestral knowledge to humanize STEM education for their communities.

Introduction

Teacher/educator activism[1] has been described as working toward

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social justice both inside and outside the classroom (Picower, 2012). Inside the classroom, teacher activists use Social Justice Pedagogy in their instructional practices. Social Justice Pedagogy (SJP) is a teaching approach that aims to develop students' academic proficiency *and* students' sociopolitical consciousness, or *conscientização* (Freire, 1970), to critically analyze and change the world (Apple, Au & Gandlin, 2009; Ayers, 2009; Picower, 2012). SJP has been applied to the fields of STEM education, such as mathematics (e.g. Gutiérrez, 2002; Gutstein, 2006; Kokka, 2015, 2017), science (Dimick, 2012), and engineering (Riley, 2003). Outside the classroom, teachers may work within teacher unions (Johnson, 2002; Levine, 2002) or with grassroots organizations (Catone, 2017; Picower, 2012).

Grassroots teacher activism has gained traction as evidenced by organizations such as Teachers 4 Social Justice in San Francisco, Teachers for Social Justice Chicago, Teacher Action Group Philly, Teacher Activist Group Boston, New York Collective of Radical Educators, People's Education Movement, Young People's Project, and the Black Teacher Project. In addition, several conferences and events cater to educator activists such as Free Minds Free People Conference, nationwide Black Lives Matter in Schools week (Dixson, 2017; Mayorga & Picower, 2017; Teaching for Change, n.d.), Teachers 4 Social Justice Conference, Teacher Activist Group Boston Conference, and the Northwest Conference on Teaching for Social Justice. Some of these conferences focus on social justice and STEM education like the Creating Balance in an Unjust World Conference and the Data for Black Lives conference.

Despite the involvement of STEM[2] educators in grassroots teacher activism, most research on teacher activism has focused on teachers who are elementary, English, or social studies teachers. For instance, Montaño, López-Torres, DeLissovoy, Pacheco, & Stillman (2002) study of five alumni of UCLA's teacher education program included two elementary teachers and three social studies teachers. Similarly, Collay (2010) studied graduate students in an urban teacher leadership MA program, who taught in elementary schools.[3] Matias and Liou (2015) investigated an urban social studies teacher's enactment of critical race teacher activism. Picower's (2011) study of six urban teachers' participation in a social justice critical inquiry project included four elementary school teachers and one early childhood teacher.

Of those studies about teacher activism that include STEM teachers, Marshall and Anderson's (2009) study of 52 educator activists only included two identified as mathematics or science educators. Picower's (2012) study included one mathematics teacher of the nine participants, and Catone's (2017) study included one mathematics teacher out of four participants. The present study aims to address this gap in the litera-

ture to focus on STEM educator activists to learn more about how and why they become involved and how they conceptualize STEM teacher activism (STA[4]).

Study Purpose

This study focuses on four STEM teacher activists who are founding members of a STEM teacher activist organization to investigate the following research questions: (1) What sparked their interest in organizing and activism work? and (2) How do they conceptualize STEM teacher activism (STA)? These questions aim to uncover more about what teacher activism looks like for STEM educators and what sparks, motivates, and sustains STEM educators' engagement in activism. These findings are significant because current opportunity gaps in STEM education and achievement may limit opportunities for girls, students of color, and students from under-resourced communities (National Science Foundation, 2017). Performance in STEM subjects often serve as gatekeepers to grade promotion, college entrance, career options, as well as students' overall academic experience and ability to find joy and community in school. Teacher activists often work to address such disparities and studying STA may help the field learn ways to increase equity and reimagine STEM education to achieve social justice in STEM fields.

Literature Review

Research about teacher activists point to the importance of gender, race, and personal experiences related to their commitment to organizing work. For instance, Weiler's (1988) study of 11 feminist womxn[5] educators highlight the salience of gender identity in activism, noting participants' feminist stance undergirding their use of critical and humanizing pedagogy. Weiler's study also brings to light the struggles of womxn educators' entry to STEM fields. Of the 11 participants (seven teachers and four administrators) who worked in two large urban high schools, four participants discussed how they were deterred from completing their undergraduate science majors, ultimately majoring in the humanities or social sciences, subjects considered more appropriate for womxn. Three others described their withdrawal from STEM subjects before even entering college, despite their desire to pursue STEM degrees (pp. 82–86).

Also underscoring the importance of identity constructs, Crocco, Munro, and Weiler's (1999) feminist life history analysis of six womxn educator activists from 1880–1960 highlights their involvement in movements centered around gender and racial identities, such as womxn's suffrage and securing African American students' access to education.

Similarly, Casey's (1993) life history analysis of 33 womxn teacher activists focuses on gender, religious, and racial identities. Casey's work investigates three distinct groups of teacher activists: Catholic womxn religious teachers, Jewish womxn teachers, and Black womxn teachers. Likewise, Marshall and Anderson's (2009) study of 52 educator activists centers explicitly on race, gender, and sexual orientation, with chapters that explore the experiences of African American teacher activists, activist womxn in educational leadership positions, and teachers working for LGBTQ rights.

These personal identity characteristics, such as gender, race, and sexual orientation were also influential to participants' activism in Collay (2002) and Catone's (2017) studies of teacher activists. Collay's (2002) study of elementary school teachers enrolled in a two-year urban teacher leadership master's degree program found that participants' personal K–12 experiences of marginalization based on race, motivated their commitment to equity and social justice work. Fifteen of the 20 participants were people of color and became educators to serve students and families from similar backgrounds and circumstances as their own. Catone's (2017) portraits of four teacher activists also reveal the importance of personal backgrounds and identities that spark teacher activism. Two womxn of color participants discussed their racial backgrounds and experiences of marginalization as influential to their organizing work. The two white womxn participants both discussed their queer identities and coincidentally were both union organizers before becoming teachers.

In contrast, Montaño et al. (2002) argue that the five participants in their study did not experience marginalization themselves, but through their activist work began to witness the marginalization of their students in urban schools (p. 272). Their participants included one white man, two white womxn, one Chicana woman, and one mixed race man. They sought research participants who were practicing teachers involved in activist organizations and graduates from the University of California Los Angeles's teacher education program because of its focus on equity and social justice for urban schools. Through their organizing work participants learned the need for coalition building with families, teachers, and students of diverse locations and backgrounds (p. 272). Montaño et al. stress the importance of teachers and teacher educators, many of whom may not be members of minoritized communities, to learn from and collaborate alongside minoritized communities.

Like Montaño's study where teacher activist participants had not experienced marginalization themselves or did not speak of its importance in sparking their activism, Picower's (2011) study of six novice teacher activists adds nuance by considering the proximity of marginalization, where (white) teachers were the recipients of disparaging comments

about their students of color from colleagues. For instance, when one participant created activities to explore social justice issues, such as the Jena 6,[6] her colleagues marginalized her ideas expressing their discomfort that "this makes White people look bad" (p. 1117). Rather than witness marginalization like the teachers in Montaño et al. (2002) study, this teacher received negative comments and was an active participant in such dialogues.

Some teacher activist participants experienced violence or marginalization targeted directly at themselves, like those of Collay's (2002) and Catone's (2017) research. Other teacher activists witnessed such violence directed at their students, mostly students of color, as seen in Moñtano et al. (2002) and Picower's (2011) studies. This study aims to investigate STEM teacher activists' firsthand experiences of marginalization, as related to their identities (e.g. gender, race, class), and how it may or may not influence their involvement in and conceptualization of teacher activism.

This study also aims to investigate how teacher activists specifically in STEM fields conceptualize STEM teacher activism, as most studies of teacher activism focus on teachers of elementary school or other subject areas such as social studies or English. For example, Picower's (2012) study of nine experienced teacher activists, one of whom was a math teacher, investigated their conceptualization and operationalization of teacher activism finding three commitments. First, they maintained a vision of a socially just world and worked toward this vision considering the inequities they witnessed around them. Second, they used culturally relevant and responsive pedagogical practices and created democratic classrooms to connect with students. Third, they worked outside the classroom engaging in various initiatives and actions, such as advocating for ethnic studies or alternatives to standardized tests.

Theoretical Framework

To explore how STEM teacher activists become committed to organizing and how they conceptualize STA, I employ the following frameworks.

Teacher Activism

I refer to Picower's (2012) definition of teacher activism, which is defined as teachers working toward social justice both inside and outside the classroom. Inside the classroom, teachers may use Social Justice Pedagogy in addition to building trusting relationships with students. Social Justice Pedagogy (SJP) aims to increase students' academic proficiency while developing students' sociopolitical consciousness, or *conscientização*

(Freire, 1970), to critically analyze and change the world (Apple, Au & Gandlin, 2009; Ayers, 2009). In mathematics for instance, Social Justice Mathematics refers to using mathematics to read, write, and change the world (Gutstein, 2006), with the dual goals of learning *critical mathematics*, where mathematics is built around students' cultural identities and addresses social and political issues in society, and *dominant mathematics*, or that which is valued in high stakes testing and maintains the status quo (Gutiérrez, 2002). With SJP the classroom community becomes a co-constructed space where the teacher builds relationships with students to work collaboratively to investigate mathematical correctness, elegance, or efficiency (Gutstein, 2006; Kokka, 2015).

Outside the classroom, organizing work may take place at local or national levels, such as mobilizing against state standardized tests, unfair teacher evaluation systems, stopping military recruitment in schools, advocating for more resources, and/or participating in nationwide efforts such as rallies and marches in Washington D.C. (Picower, 2012). Many grassroots teacher activists are involved in organizations such as the New York Collective of Radical Educators, Teachers 4 Social Justice, or People's Education Movement, founded by teacher activists in Title I public schools. These organizations often engage in political education, where members read and discuss articles by authors such as Paulo Freire, Grace Lee Boggs, Frantz Fanon, or bell hooks. Such organizations often support teachers' curriculum development, forming study groups to create lessons and activities that use SJP. Members also take part in actions such as the Black Lives Matter Week of Action in Schools or the womxn's march (e.g. People's Education Movement Bay Area, n.d.).

Critical Race Feminism and Intersectionality

Critical Race Feminism (CRF) centers the experiences of womxn of color revealing the oppressive nature of their intersectional identities (Berry, 2010; Wing, 1997). CRF stems from Critical Race Theory, applying a feminist lens to clarify that the experiences of womxn of color are different from men of color. CRF builds on the following four tenets of Critical Race Theory (CRT): (1) Racism is endemic, "normal, and ordinary" in American society; (2) Storytelling and narrative techniques are employed to center the experiences of people of color and construct alternate realities than those of white supremacy; (3) Interests of people of color are advanced only as long as they also serve the interests of whites, or what Derrick Bell termed "interest convergence"; (4) Additional theoretical and interdisciplinary approaches (e.g. liberalism) are used alongside Critical Race Theory to create innovative approaches to engage in praxis to take action (Wing & Willis, 2009, p. 3).

Just as CRF goes beyond CRT to consider gender identity, CRF goes beyond feminism to consider race. CRF is useful for education research because the experiences of girls and womxn of color are different than males of color and different from white girls and womxn (Evans-Winters & Esposito, 2010). In addition, CRF is appropriate for research within the American educational system which centers and operates under white supremacy and patriarchy. CRF is an especially useful lens to this study because of its emphasis on praxis, where theory is applied to practice or action.

Intersectionality (Crenshaw, 1989) examines how the combination of various identity constructs, such as race, sex, class, ability status, language, sexual orientation, and/or gender identity influence experiences of oppression (Delgado & Stancic, 2017, p. 49). In STEM education research, mathematics education researchers have begun to explicitly consider how power and oppression interact with intersectional identities such as race, gender identity, and sexual orientation (e.g. Leyva, 2017). Esmonde, Brodie, Dookie, and Takeuchi (2009), for instance, investigate students' socially-constructed identities of gender identity, race, and sexual orientation describing the mathematics classroom as an intersectionally gendered and racialized space. The present study uses intersectionality to consider how participants' identities and their experiences shaped by such identities may influence their motivation to engage in STA.

Tribal Critical Race Theory (TribalCrit)

Tribal Critical Race Theory (TribalCrit) builds on Critical Race Theory to center colonization as endemic to society while still considering the role of racism. Brayboy (2005) identifies nine tenets of TribalCrit in education, and this study utilizes TribalCrit's definitions of culture, knowledge, and power through an Indigenous lens. Culture, knowledge, and power are dialogic and interact with each other, where roots to the land and community are important to all three concepts. TribalCrit emphasizes that culture is rooted to the land. Knowledge consists of cultural knowledge, knowledge of survival, and academic knowledge. According to Brayboy (2005), "Power through an Indigenous lens is an expression of sovereignty—defined as self-determination, self-government, self-identification, and self-education. In this way, sovereignty is community based" (p. 435). Like Critical Race Feminism, TribalCrit also refers to praxis and action, emphasizing the connection between theory and practice to work toward social change.

TribalCrit is appropriate for this study because it centers on conceptions of culture, knowledge, and power through a lens that acknowledges

the endemic nature of colonization and racism. TribalCrit, alongside Critical Race Feminism and Intersectionality, allow analysis of how gender identity, race, culture, colonization, and other identity constructs and experiences relate to participants' individual experiences and conceptualizations of STA.

Methods

To investigate the two research questions of what sparked STEM teacher activists' organizing work and how they conceptualize STA, I focused on a purposive sample of the founding members of a STEM educator activist organization, founded in 2016. I interviewed each participant remotely on the phone using an in-depth semi-structured interview protocol, recording the audio, and then transcribing the interviews with a professional transcription service. Interviews lasted 60–90 minutes. Transcripts were sent to participants for member checking along with a follow-up interview to ensure accuracy of transcripts and allow participants an opportunity to share any additional thoughts. Data was analyzed through qualitative thematic analysis (Boyatzis, 1998) with an inductive, grounded theory approach (Glaser & Strauss, 1967) with the assistance of Atlas.ti. Interview transcripts were coded and recoded to generate themes of participants' reasons for engaging in STA and their conceptualization of STA. Codes were reduced and refined to establish themes of participants' conceptualization of STA. Twenty-seven codes were grouped into five themes: Ancestral Knowledge/Humanizing Pedagogy, Community, Equity, Personal Experience, and Understanding Oppression. In addition, monthly meeting notes were collected and analyzed to clarify participants' conceptualization of STA. The primary source of meeting note data were the notes from a presentation the group gave at the Creating Balance in an Unjust World Conference on STEM Education and Social Justice. This presentation required the group to crystallize their principles and activities to present them to an audience, adding clarity to their conceptualization of STA.

Participants

Participants were founding members of a grassroots social justice STEM organization, founded in the Bay Area, California in 2016. Participants all identified as STEM teacher activists. Participants had considerable teaching experience, and those who held roles outside the classroom were teachers in Title I schools in New Jersey, Philadelphia, and the Bay Area prior to moving into other roles such as coaching or providing professional development. Victor was the only participant

whose experience did not include teaching at the K-12 level; his 14 years of mathematics teaching were in community colleges and a state university. See Table 1 for further participant information.

Positionality

I am deeply embedded as an indigenous insider to this research. Banks (1989) describes an indigenous insider as a researcher who "endorses the unique values, perspectives, behaviors, beliefs, and knowledge of his/ or her primordial community and culture," and is perceived as a "legitimate a member of the community who has a perspective and knowledge that will promote the well-being of the community, enhance its power, and enable it to maintain cultural integrity and survive" (p. 8). I am a womxn of color and one of the founding members of this organization who co-planned and attended meetings.[7] I endorse and enact the values, beliefs, and knowledge of the organization, and I am seen as a legitimate member of the community who has garnered the trust of study participants. My personal experiences with STA span 10 years as a high school mathematics teacher activist in New York City, where I co-founded the Creating Balance in an Unjust World Conference on STEM Education and Social Justice[8] in 2007 and continue to organize biennial national conferences. I am also a member of the People's Education Movement Bay Area and have continued my involvement in STA for over 15 years. In addition, I was the mathematics teacher participant in Catone's (2017) study of teacher activists,[10] one of few studies of contemporary grassroots teacher activists that includes a STEM teacher.

Table 1
Participant Information

Pseudonym	*Race / Ethnicity*	*Subject*	*Role*	*Years Teaching*	*Age*	*State Where Raised*
Carissa	Taiwanese American	Math	Teacher & Coach	11	38	Colorado
John	White	Math	Teacher & Coach	8	31	Pennsylvania
Rose	Latina*	Engineering	Teacher & Coach	9	42	California
Victor	Vietnamese American	Math	Community College Professor	14	37	California

* Rose describes her mixed heritage in the interview. This is discussed in the findings

Reliability and Validity

To consider my potential bias and attend to concerns of reliability, I wrote reflexive memos about my reactions, wonderings, and early thoughts of patterns I noticed in the data to be mindful of potential bias I may bring to the analysis (Paulus, Lester, & Dempster, 2013). Documentation of codes and analytic memos using Atlas.ti indicated steps taken in analysis to allow for potential replication of the study by another party.

To attend to validity concerns, I listened to the audio recording of interviews several times to make corrections and attend to accuracy of transcripts, which also helped me stay closer to the data. I engaged in member checking with participants to ensure that the data accurately reflected participants' experiences and viewpoints. Participants were given interview transcripts to review, and then engaged in brief (~30 minute) follow-up phone calls with me to check for accuracy and to investigate if they had any additional insights they wished to share. These follow-up discussions were valuable to validate data because participants affirmed that the interview transcript reflected their thoughts, and participants offered consistent sentiments to the original interviews, indicating stability of their views. None of the participants expressed sentiments divergent from the transcript data, and only minor edits to the transcripts were suggested where the professional transcriptionist made errors. Meeting note data, such as the presentation notes for the Creating Balance Conference, offered another set of data for triangulation of multiple data sources.

I also applied Milner's (2007) four components of the Framework of Researcher Racial and Cultural Positionality. This framework was particularly useful for this study because of my positionality as a member of the organization with experience engaging in STA. Milner's (2007) framework calls on the researcher to engage in (1) reflection of self, (2) reflection of self in relation to others, (3) dialogue with participants to collaboratively reflect on findings, and (4) consideration of the influence of systemic factors (e.g. racism, classism, patriarchy) to the findings. Reflexive memo writing helped address the first two components, and the third component was addressed through member checks as well as by sharing earlier versions of this manuscript with participants to ensure it accurately reflects their viewpoints. The fourth principle was addressed through the theoretical frameworks chosen for this study, which explicitly attend to marginalization related to structural factors (e.g. racism, colonialism, patriarchy, and oppression based on other intersectional identity characteristics) to foreground systemic factors in analysis.

Results

Not only is there less research in STEM teacher activism (STA) there are few organizations that focus on STEM education and social justice. The participants in this study founded their own organization specifically to address the need for STEM educators to find and work with like-minded colleagues to organize around social justice work. This study focuses on these four participants to explore what experiences sparked their engagement in STEM teacher organizing and how they conceptualize STA to learn more about teacher activism in STEM fields.

Personal Experiences with Marginalization Sparked Activism

Findings indicate that because participants have experienced marginalization due to structural racism, colonialism, patriarchy, and/or classism, they engage in STA for their own healing and empowerment and to work toward a larger goal of liberation. All four participants shared individual experiences related to their intersectional identities that sparked their organizing work. Most of these were experiences of marginalization except for John, a white cisgender heterosexual man who witnessed the marginalization of others.

Rose, 42, who recently moved to a coaching role within the district, was an elementary and engineering teacher in Title I urban public charter schools for nine years. She described her feelings of marginalization from an early age. When asked how she became involved in activism she described a Latinx student club she founded in high school and why she founded the organization. "I'm kind of an 'other' within the Latino context, or within the Chicana context. I'm not Mexicana, and I'd always been aware of that since I was little." She explained the influence of colonialism in Nicaragua and how she was raised with her father's war stories about her parents' experiences living under the dictatorship in Nicaragua. Her parents fought for Samoza against the Sandinistas and were therefore exiled to the United States after Samoza was overthrown. She explained how these experiences led to development of her "political consciousness."

Likewise, Victor, 37, who is Vietnamese American and has been teaching mathematics for 14 years, 11 at the community college level and three years for undergraduates at a state university, described his entrance to social justice work through a belated recognition of the oppression he experienced growing up in a low-income community with predominantly residents of color. When asked about his social justice work in the classroom, he first explained his own "transformation"

when a friend pushed his thinking and opened his eyes to the classism and racism he was experiencing in his own life. He explained, "Before I was brainwashed by the dominant culture, the dominant narrative. I was brainwashed on what students should and shouldn't do, should and shouldn't be." He described how he and his friend "would have disagreements on the economic system." When he attended the National Conference on Race and Ethnicity (NCORE) he explained, "some of their arguments on classism really, really hit home for me. There have been times where people have been overtly racist to me and I'm like, okay yes, I see that. I've experienced it." He described his retroactive reflections of experiencing marginalization due to his intersectional identities related to race and class. He explicitly discussed the intersection of these identities in his reflections of becoming engaged in social justice organizing.

> Little did I know I had also been experiencing classism as someone low-income, and then I just never reflected on that. After coming out of NCORE 2013 it really, really, really hit home. Then I really started seeing the connection between the two, between racism and classism. So that was one of the major catalysts [of engaging in social justice work].

He also contrasted his experiences living in a community with predominantly residents of color to a white community, when his parents moved him during high school because he began associating with gangs and his "grades were slipping." This experience also made him realize his ethnic and racial identity as a person of color. Victor's personal experiences of being marginalized and "brainwashed by the dominant culture" fuel his commitment to social justice work.

John, 31, is a white teacher who began teaching at an Afrocentric freedom school in Philadelphia with 99% black students where he was one of two white teachers in the school. When asked how he became engaged in social justice work he immediately described his experience of incarceration as a teenager. His negative experiences in school led him to stop attending school at age 14, and by age 15 he had dropped out. He got into a fight and ended up incarcerated in the Juvenile Detention Center. He witnessed white youth enter and then quickly get transferred to a "nicer placement, a less restrictive setting," but because he was "not on good terms" with his parents they did not advocate for him to be transferred. Witnessing patterns in the Juvenile Detention Center he began to question, "Why am I the only white person here most of the time?" He described his youth incarceration experience as the most pivotal to his political identity stating, "I think that this is at the core of at least my political identity if not just at the core of my identity altogether."

John eventually took the GED to earn his high school equivalency and attended college where his professors also influenced his awareness

of injustice, where he learned about "other '-isms'" and "the ways in which schools can marginalize kids, not just based on race or whether they grew up in a city or not, but also by sexual identity and gender, and ability / disability status, and those kinds of things." Like Victor, he emphasized that once you begin learning about systems of oppression, "It's like a rabbit hole. Once you start becoming aware of the systems that lead to these kinds of things, then that just raises more questions, and I read more things and talk to more people."

Carissa, 38, also described personal experiences sparking her social justice work. Carissa is a Taiwanese American woman who taught mathematics for 11 years in Title I public schools before working as an instructional coach, which has been her professional role for the past six years. She explained that she grew up "in this very in-between world" where she lived in a poor working-class neighborhood, but she and her brother attended school in a community that was in "a university town, super well-off, very white." She explained, "On a daily basis we were seeing our privilege by attending wealthier schools than our neighbors, and then on the other hand, we felt how much we didn't fit in in this K-12 setting." She reflected on her experience of living in these two spaces. "I think that existence also really primed me for my politicization when I got to college." In college she learned about Asian American history and the civil rights movement and became involved in "anti-racism organizing on campus."

Participants shared stories of firsthand experiences that ignited their engagement with social justice organizing, explicitly discussing their intersectional identities. Race and class were mentioned most, likely because all four participants were cisgender, not queer,[10] and able bodied.

Strong Understanding of Systemic Oppression

In addition to personal experiences sparking their organizing work, participants expressed a strong understanding of systemic oppression that both fueled their commitment to engage in social justice work and also influenced their conceptualization of STA.

Rose described "how dysfunctional we are in systems and institutions in the U.S. and, especially, how the educational system serves as a re-traumatizing experience." She explained the dangers of the school to prison pipeline and the "education industrial complex." She explained that oftentimes as educators, "we don't get at core issues like poverty and imperialism and capitalism. And, so in those respects, we still fall short in our analysis." She analyzed the intersection of capitalism and technology, where we have a "history of amazing scientists and technologists and engineers' ideas being co-opted by the U.S. government and

by corporations." She became an engineering and technology teacher to position herself in the "center of these conversations" to empower her students to question capitalism especially regarding the current boom of technology, which is of great relevance to Rose and her students being close to the Silicon Valley.

Victor also discussed systems of oppression at length. When describing his own "transformation" he explained, "I was learning how the system is very—the newest word for me is colonized—how the existing education system is colonized, how it perpetuates social inequalities and that it's so disconnected from the people they serve." Not only is he highly conscious of systemic oppression such as colonization, which TribalCrit stresses is endemic to our society, he constantly checks his own privilege.

> The system, the people with privilege just keep it all to themselves. I was just like, okay, am I contributing to that? And I was. In many ways I still am, so just checking myself and checking my positionality and this is definitely an ongoing effort, because of what we're surrounding by, these unhealthy bootstraps arguments everywhere, it permeates this culture. So that I'm always working on.

He described his desire to constantly question his power in his own classroom. He aims to disrupt dominant classroom structures by offering students agency, by "giving them power to run the class and have decision making over classroom environments and policies."

Like Victor, John constantly checks his privilege. He chose to begin his teaching career at an Afrocentric school in Philadelphia because he specifically wanted to learn from black womxn who ran the school. He expressed his interest in working with the members of this STA organization. "I really wanted to be in an organization that was led by womxn of color, for my own grounding." He explicitly stated that this is especially important for himself as a white man. "I guess that's a danger for anyone, but I think it's particularly dangerous for white men, because there's so many institutional factors that reiterate that or can reinforce that, if you let them."

Carissa also checks herself, reflecting on her own internalized racism. "How have I internalized these racist ideas in the ways that I behave, in the ways that I conduct my classroom and interact with my colleagues, with my students?" She explained her own susceptibility given the power of racism and white supremacy, "Even though I think that I have pretty good power analysis of what happens, that doesn't mean that I haven't been affected and taken on that toxicity." Likewise, Rose reflected on her own role in "being complicit in imperialism and capitalism," and her desire to continue her own learning for herself and for students. All four participants questioned their complicity in perpetuating systems of oppression without being prompted, as I did not ask any interview nor probing questions specifically about this.

Not only do participants have a deep understanding of power and oppression, they constantly question their own participation in such systems. They work to check their own privilege, their internalization of "toxicity" such as racism and patriarchy, and strive to continually develop their consciousness through reading, research, and discussion.

STA as a Tool for Healing and Liberation

This deep awareness of systems of power and oppression coupled with their individual experiences of marginalization fuel their commitment to activism where STA becomes a tool for healing and empowerment for themselves and their students. Their understanding of the structural and intersectional nature of oppression serves as a protective measure to buffer participants from internalizing racism, patriarchy, and classism, where participants do not blame themselves for their own oppression, which can happen to members of minoritized communities (Ginwright, 2016, p. 8). The STA organization becomes a space where participants work collaboratively to decolonize STEM education and work toward creating humanizing ways of teaching STEM subjects.

Participants conceptualize STA as engaging in healthy, humanizing practices that honor and incorporate ancestral knowledge while working in community with one another. This conception of STEM education as humanizing and collaborative counters the current enactment of STEM education in many classrooms, where many schools still utilize a "banking model" of learning where students are merely receptacles of information from a source of authority, such as a textbook or teacher (Friere, 1970), rather than co-constructing knowledge with an intellectual community (Senk & Thompson, 2003).

Community Health. Victor spoke at length of the importance of "healthy practices" and "healthy classrooms." When asked what some of the benefits of engaging in STA are, he responded, "the highs for sure are the really healthy practices in healthy classrooms, which then leads to more student engagement, more student desire to learn, more student connection to the content." When asked to elaborate on what he meant by "healthy" he explained,

> I'm going to tie this back to radical STEM and one of the founding pillars is to use humanizing, liberatory practices. What I mean by healthy is I mean these are spaces where there's healthy communication, healthy interactions, between students and each other—students and faculty. One of those is that if something's going on with a student, then that's addressed. If the student has needs that are nonacademic, that's addressed. And usually a lot of low-income students have needs that are nonacademic.

Victor mentioned students' nonacademic needs, such as counseling

services to maintain their health and well-being, or even facilitating access to basic necessities such as food security and a safe consistent place to live with access to transportation to and from school and work. He also offered a contrasting example of an unhealthy classroom where students are excluded from learning experiences through "exclusionary acts, being kicked out of class."

He described how he stays healthy amongst such narratives by staying connected to the community he identifies with, "low-income working-class families, who've been intentionally held out and pushed out and don't have access." These community connections help him to "able to serve them [the community] as opposed to answer to the industry." Victor views his STA work as a healthy practice, where STA becomes a means of engaging in his own healing.

Likewise, Carissa discussed the importance of being able to "read and write the world, using math to transform that world… where you can truly exist as a whole human with everything you are and everyone that you bring with you." Like Victor's comments she stressed the importance of "connecting our humanity to these technical fields which so often are abstracted from that … and making sure that our students also get access to those connections and are able to grow them in their own ways." She connected this to the work of the STA organization which supports her own healing and connection to humanity. She named two principles of the organization that emphasize STEM learning as "humanist" and "environmentalist." "STEM is not just about getting a good job in the tech industry or being able to be a doctor or a lawyer, but that really it is in service to, in service of our communities." These sentiments are like Victor's comments about schooling being in service of and for communities rather than what he referred to as "the industry." John also described the importance of building a "network of people" with other STEM educators interested in social justice work to "learn from each other and support each other." By attending to community health, participants engage in their own healing and care for others through their activism within the STA organization.

Community Ancestral Knowledge. Like Victor, Carissa, and John's commitment to work in community with others, Rose also spoke of her desire to work "with teachers in community to build community around social justice and STEM ... to get reconnected." She linked this to ancestral knowledge, imperialism, and ethnic studies. In addition, she discussed her own ancestral background as integral to her desire to learn more about her own cultural background, which she described as "part colonizer and part colonized, a survivor of colonization." She explained, "I'm not pure indigena. I have Spanish and Arabic blood in my lineage. I have Chinese blood in my more recent lineage. I say that

to be aware of my people before me in history." She reflected on her own K-12 educational experiences and the lack of connection to learning about her ancestors, nor any connection of her science education to her Nicaraguan ancestors. She wishes she knew more about her "ancestors from the region where [she's] from prior to colonization." She wants to help students learn about the mathematical and science knowledge of their ancestors, and one way she strives to do this is through intersecting ethnic studies and STEM subjects. Rose explained,

> The ways we've stripped science and math out of the curriculum for such a long time is just another way of disconnecting our youth from their scientific and mathematical ancestral knowledge. And then disconnecting us from the land and from our own agency - on how to be on the Earth, and how to live without corporations producing for us. It's just another cog in that mechanism of dependence created by imperialism. So I want to be teaching in classrooms where that knowledge was going to be uncovered, even for myself.

She continued and explained her goals for engaging in STA and for teaching STEM through a critical and liberatory lens.

> I'm trying to play catch up, but my goal would be for kids to have an experience where they're learning technical, scientific, mathematical knowledge and be able to apply those in real-world situations. But also be better grounded in understanding where that knowledge comes from and how, historically, a lot of that knowledge has been co-opted and at this point, we just assume that it comes from the government.

She contrasted traditional conceptions of knowledge that come from textbooks and standards with ancestral knowledge connected to the land stressing that "First Nations pedagogy clarifies that knowledge is a living process, not a commodity to possess." She highlighted the healing power of STA by expressing her desire to engage in personal reflections "starting with the self" and continuing to learn about her ancestral history as well as indigenous ways of being on the Earth.

She explained her desire to "teach STEM so that students can get reconnected to the Earth, so that they respect the Earth. And not teaching them to exploit the Earth and each other." She also clarified the critical nature of ethnic studies stating, "Ethnic studies is really specific about developing student agency for action through critical pedagogy for liberation versus something like cultural responsiveness where you create a safe cultural space to cultivate students' cultural confidence." She continued her explanation clarifying that culturally responsive pedagogy is "a good place to start" to then engage with ethnic studies where students are supported to "take action toward social justice."

Carissa also spoke about connections to ancestral histories where STEM education is a "community-based practice." She stressed that STEM

education should "not be isolated from the histories of people that have practiced it, that have benefited from STEM or that have been oppressed by it either." She continued explaining "that our practice as educators is informed by the struggles of resistance and the experiences of oppression that we've all had in our history." Participants' commitments to working with communities and connecting to ancestral knowledge undergird the mission and vision of their work in the organization. STA serves as a means for participants to heal from their own experiences of marginalization while working to create humanizing learning spaces in STEM to work in community for liberation.

Actualization of STA

Participants' commitment to engage in healthy humanizing practices, connecting to ancestral knowledge, in community with others shapes the goals of the organization. They also recognize the importance of doing this work specifically for STEM education because of the status granted through achievement in these subjects. John discussed the unfair status that mathematics achievement is given where "mathematics is put on a pedestal," and, "It gets all this special status." He shared that one of his goals is to "dispel the notion that it takes a special type of person to be able to do mathematics, and really help everybody to see that it's not an arcane subject." He continued, "It [mathematics] really is based in the ways in which they already think and talk and live, and I want to help them to make those connections and be empowered in those ways."

Carissa described her social justice goals in her role as an instructional coach as well as the STA organization's principles and goals. Through her position as a mathematics instructional coach, she initiated a Social Justice Mathematics inquiry group where teachers, administrators, coaches, and other professional development providers participate in monthly meetings at the county department of education and engage in action projects at their school sites. When asked about her Social Justice Mathematics goals she responded, "In my current sphere of influence, it would mean that teachers and administrators, all the different levels, are thinking about how to make sure that every student leaves with a high-quality math education." She continued specifying that every student should develop "the ability to analyze, quantitatively, what's happening in their world, but also an ability to take those skills and apply them to different contexts." She emphasized that she means every single student, referring to her four years of experience teaching special education, and her commitment to improving education for all students. She described the district policies that would need to be in place to support this work, and she clarified that, "Ultimately, if Social Justice Math was successful, there wouldn't be a term 'Social Justice

Math' because it would just be math education, and we would be making sure that every student got what they needed."

Participants described their goals for STA as achieving high-quality STEM education for all students which is humanizing, connected to ancestral knowledge, and where students are empowered to investigate their world in community with others. The organization explicitly focuses on three principles. Carissa described them in her interview. "One is that it's led by womxn of color, and that is to address the traditional way that STEM fields have been dominated by white men, in particular." She explained, "This idea that comes from Critical Race Theory and ethnic studies where those folks who haven't had access, who've been subjugated or oppressed, have a much more nuanced and refined analysis of what is actually going on in the field." The second principle, "is that it is humanist and environmentalist… that really the goal is community empowerment and liberation." The third principle, "is that it's grounded in ethnic studies… making sure that our students also get access to those connections [to ancestral knowledge] and are able to grow them in their own ways as they develop their own practices in these fields." These goals connect to principles of Critical Race Feminism, which center the experiences of womxn of color, and to the principles of TribalCrit, that center ancestral knowledge connected to the land and to communities.

The organization strives to meet these goals in monthly meetings which consist primarily of three activities. The group clarified the principles, aims, and activities of the organization to present a workshop at the Creating Balance in an Unjust World Conference on STEM Education and Social Justice. First, the group consistently engages in political education to continue learning. To do this, texts are used to further members' political education utilizing Gallery Walks and other structured reading discussion protocols (e.g. like those from the National School Reform Faculty, n.d.). These texts focus on the intersection of STEM education, social justice, and humanizing, liberatory pedagogies. (See a sampling of articles in Table 2.)

Second, the group uses Critical Friends Protocols (National School Reform Faculty, n.d.) to collaboratively develop and refine lesson plans to teach STEM in a humanizing and liberatory way. For instance, one lesson refined in a meeting used Social Justice Mathematics to explore data related to a local social issue. A teacher at a private school, created a mathematics activity where students collaboratively graphed trends in the rising cost of housing in comparison to the mean salaries over time. The teacher aimed to humanize community members experiencing homelessness, where some students held prejudices. The Critical Friends Protocol allowed the teacher to gain feedback at the meeting

to refine and improve the lesson, attending to social justice goals such as humanizing STEM instruction.

Third, the group uses Racial Identity Caucusing (Racial Equity Tools, n.d.) to engage with reflective discussion questions such as the following, which they used during their workshop at the Creating Balance Conference:

> 1. How does your internalized superiority/oppression play out in the social justice STEMM[11] work that you do?
>
> 2. How are you addressing your internalized superiority/oppression on a personal and/or systemic level to be a better STEMM teacher?

These caucus groups offer "a space for [racial] groups to process how oppression is playing out in [our] analysis and work" as stated as the "purpose" for racial identity caucusing for the Creating Balance workshop. Because the caucus groups are specifically delineated by race, typically two groups are formed which they refer to as "norm dominant" and "oppressed," creating a group of white educators and a group of educators of color. After discussion in the two identity groups, attendees reconvene to report back and engage in further dialogue. This process can also work with different intersectional identities considering gender identity, language backgrounds, or ability status to name a few.

These three activities, (1) reading texts with protocols, (2) social justice STEM lesson design, and (3) racial identity caucusing, intend to align with the three principles of the organization which are (1) womxn of color lead the organization, (2) STEM is approached through human-

Table 2
Sample of Articles

Article Title	*Author(s), Year*
Political *Conocimiento* for Teaching Mathematics: Why Teachers Need it and How to Develop It	Gutiérrez, 2017a
What's Radical Love Got to Do with It? Navigating Identity, Pedagogy, and Positionality in Pre-Service Education	Douglas & Nganga, 2015
Pedagogies of Liberation in a Thermodynamics Engineering Class	Riley, 2003
Making Through the Lens of Culture and Power: Toward Transformative Visions for Educational Equity	Vossoughi, Hooper, & Escudé, 2016
Black Women's and Girls' Persistence in the P–20 Mathematics Pipeline: Two Decades of Children, Youth, and Adult Education Research	Joseph, Hailu, & Boston, 2017

ist and environmentalist pedagogy, and (3) STEM is taught through an ethnic studies lens connecting to ancestral knowledge. In addition to the three principles of the organization, the following essential question guides their work: How do we explicitly teach STEMM through a critical and liberatory lens?

Participants are also acutely aware of dangers of dominant groups claiming to decolonize STEM. Rose explained how this manifests in engineering and making, "The maker movement claims to use pedagogical approaches like 'shared knowledge,' 'redirecting authority,' 'figuring it out,' and 'project based or collaborative learning.'" She continued,

> My critique is that in doing so the Maker Edu movement perpetuates white, colonizer cycles of discrediting indigenous pedagogy while taking that knowledge and practice and re-branding as its own. This means that we are still not decolonizing ourselves to understand origins of practices. It means that we are still accepting that these ideas are new to the Maker Edu movement of today completely ignoring or are complicit in the erasure of the fact that indigenous peoples passed down knowledge in these ways already.

To address such tensions and work toward the three goals of the organization, monthly meetings are held with invitations to interested STEM teachers.

Meetings rotate between various K-16 school sites to encourage participation from teachers of schools of diverse locations. Meetings start with introductions, where members also state their preferred pronoun, an overview of three principles, and posing of the essential question. Meetings then engage in one of the three activities. Reading a text and then discussing and engaging with it through a Gallery Walk or other text protocol tend to be the most common. After the discussion of the text, breakout groups work on various "action items," such as writing letters of support for scholars under attack[12] or preparing to co-host the welcome event for the Creating Balance Conference. Meetings typically end with announcements of social justice related events and actions that members may be interested in supporting, such as a Black Lives Matter in Schools event, the womxn's march, or events held by other social justice organizations.

This organization's principles, activities, and backgrounds of founding members provide an example of how four teacher activists conceptualize STA. Their commitment to humanizing STEM education offers insights about how STEM teacher activism may function as a vehicle for healing and empowerment for teachers of STEM subjects.

Discussion and Implications

Carissa, John, Rose, and Victor's personal experiences and their

strong understanding of the structural nature of power and oppression deeply motivate their engagement in STA. They described experiences of marginalization related to the intersections of oppressive structures such a racism, classism, and colonialism like Collay (2002) and Catone's (2017) teacher activist participants. As previously mentioned participants in the present study did not speak of marginalization due to gender identity, sexual orientation, or ability status given that they are all cisgender, not queer, and able-bodied.

Participants' conceptualization of teacher activism differs from the teacher activists of Picower's (2012) study because of their STEM content areas. They rejected the notion that mathematics or science should be "on a pedestal" explicitly calling out the influence of capitalism and "the industry," especially for STEM fields where math and science achievement are often sought after simply to secure "a good job in the tech industry." These findings are significant given the current promotion of STEM education in the service of securing employment in the tech industry. Participants highlighted the need for the fields of education and technology to pause and consider humanizing, naturalist, environmentalist ways of knowing to benefit our well-being and the environment.

To push back against capitalist motives for STEM achievement, participants work to use healthy, humanizing pedagogical practices connected to ancestral knowledge and ethnic studies within STEM education. They operationalize this goal by developing social justice STEM lesson plans and engaging in political education. Participants engage with academic texts about STEM and liberatory humanizing practices that serve as touchpoints for participants to ground their actions in theory. Traditional professional development typically involves practices such as incorporating instructional technology, learning reflective strategies, or increasing pedagogical content knowledge (Avalos, 2011). Findings of the present study offer new suggestions for STEM teachers' professional development where engagement with theoretical and critical texts may support teachers' analysis of their practice.

STA may also promote teacher retention, especially for STEM teachers of color, by connecting teachers' work to a larger purpose of providing humanizing learning experiences for students. Research has found that retention of STEM teachers of color is influenced by their need for competence, autonomy, and relatedness (Kokka, 2016), and STA may be one means of improving their feelings of competence and relatedness by working toward larger social justice goals. Retention of STEM teachers working to create humanizing experiences for students in STEM subjects may also help "historically dispossessed students to radically heal (Ginwright, 2010) from their suffering" (Camangian, 2015, p. 426).

Humanizing STEM experiences may improve students' relationship with STEM subjects and invite them to use mathematics, science, and engineering in humanizing and environmentalist ways. Students graduating from humanizing STEM classes may pursue STEM careers to change the world and protect the earth rather than working primarily in pursuit of a capitalist goal of monetary gain.

STA may also promote teacher leadership through facilitation of learning experiences with colleagues (e.g. text-based discussions) and planning actions and/or events. Opportunities for collaboration with students, teachers, administrators, and families through STA may offer new ways of breaking down hierarchies and barriers amongst school community members of various roles. Collective organizing to bring humanizing, collaborative practices to STEM education may benefit the entire school community and serve as a means for healing and empowerment.

Conclusion

Activists and organizers across the globe and nation have consistently resisted, demanded, and successfully fought for change. STEM teacher activists Carissa, John, Rose, and Victor offer insights about how STEM educators become involved in teacher activism and how they conceptualize STA. Participants' work with STA involves collective organizing with local STEM educators to explore humanizing liberatory STEM pedagogy connected to ancestral knowledge. They work toward this goal through reading and analyzing critical texts, developing curricular resources, and engaging in actions. Such STA activities may serve as a response to the call to humanize STEM education (e.g. Aguirre et al., 2017; Gutiérrez, 2017b). In mathematics education, for instance, Gutiérrez (2017b) recommends creating decolonized reading lists, rethinking professional development, fostering networks amongst educators, and developing a set of principles to rehumanize mathematics education (p. 19-20). STA as enacted by participants in the present study serve as one example of actualization of this work. Future studies continuing this line of research, along with study of how STA may influence novice teachers and STEM educators unfamiliar with social justice concepts, may help the field better understand teachers' engagement with STA and how it may influence their work with students. Collaborative grassroots STA, with students, teachers, families, and administrators may have the power to humanize STEM education to achieve the goal of community empowerment and liberation.

Notes

[1] Teacher activism and educator activism are used interchangeably in this article.

[2] STEM refers to Science, Technology, Engineering, and Mathematics. Some variations of this include STEAM (Science, Technology, Engineering, Arts, and Mathematics) or STEMM (Science, Technology, Engineering, and Mathematics, and Making).

[3] Collay (2010) does not provide information about the 20 participants, but the vignettes share stories of three participants all of whom are elementary teachers. Presumably the 20 participants were also elementary teachers.

[4] STA refers to STEM Teacher Activism or STEM Educator Activism. When referring to individual teacher activists, I have written out STEM teacher activists.

[5] I use the spelling "womxn" to center the experiences of womxn, rather than considering womxn a subset of men. Womxn is an inclusive term that considers intersectional identities, e.g. womxn of color, trans womxn, LGTBQIA womxn, and anyone who identifies as a womxn.

[6] The Jena Six incident at a high school in Jena, Louisiana involved nooses being hung from a tree in the high school courtyard, altercations between black and white students, and the conviction of six black students for the beating a white student in 2007. (One pled guilty and the other five pled no contest.) Several protests erupted to question the fairness of the convictions and harshness of penalty against black youth and lenient treatment of white youth.

[7] I attended meetings in 2016 and part of 2017.

[8] The conference focused on mathematics and social justice until 2018.

[9] Catone (2017) uses all of our real names in his work.

[10] I use "not queer" to make queer the normative.

[11] The group uses the acronym STEMM (Science, Technology, Engineering, Mathematics, and Making).

[12] Rochelle Gutiérrez, Laurie Rubel, and others were attacked by the media and received numerous threats via email, voicemail, and through social media. https://mathedcollective.wordpress.com/

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