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Striving Toward Transformational Resistance: Youth Participatory Action Research in the Mathematics Classroom

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In this article, the author contributes to the growing body of scholarship on critical mathematics pedagogy. In particular, the author advances this scholarship by outlining how critical pedagogy in the mathematics classroom can support students to engage in transformational resistance. Using a critical practitioner research approach, the author retells (some of) her experiences as a high school mathematics teacher of ninth-grade Latin@ students in an Algebra I classroom. Beginning the course with activities to build a beloved community *and connecting mathematics with social justice issues, the author strived to facilitate a learning space that supported transformational resistance. Through a culminating youth participatory action research project, students developed a critique of societal oppression, a motivation for social justice, and critical mathematical literacy.*

KEYWORDS: critical pedagogy, teaching mathematics for social justice, transformational resistance, youth participatory action research

The sun beamed through our East Los Angeles classroom windows as my 23 Algebra I students excitedly entered data from a school-wide student survey on school food (in)justice issues which they had designed and conducted the weeks prior. Students were still learning how to use data software on the classroom laptops, when one student noticed that a column for data entry was missing. I showed her how to insert a new column. She titled it, paused, and then said, "This column is a variable, right? Yeah, yeah, *that's a variable*." Her tone was as if something spinning around in her mind for a while, or perhaps since she first took Algebra I the year prior as an eighth grader (and "failed"), just settled into place. This moment encouraged me to conclude class that day with a discussion of the meaning of a variable, something that the students, instead of only saying "a letter that represents a number," now attached real-world significance to as they were defining, measuring, representing, and making claims about variables related to a social justice issue in their lives. As a teacher, I sought to develop a critical pedagogy to support students to understand and transform the world (Freire, 1970/2007). Witnessing students'

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excitement as they came to understand the meaning of a foundational component of mathematical knowledge in the context of conducting their own research and activism related to school food (in)justice, affirmed for me the promise of teaching mathematics for social justice (see, e.g., Gutstein, 2003) and integrating mathematical investigation in youth participatory action research (Terry, 2011; Yang, 2009).

My aim with this article is to contribute to the growing body of scholarship on critical mathematics pedagogy (see, e.g., Bacon, 2012; Bartell, 2013; Brantlinger, 2013; González, 2009; Gregson, 2013; Gutstein, 2003, 2006; Gutstein & Peterson, 2013; Terry, 2011; Wager & Stinson, 2012; Yang, 2009). In particular, I advance this body of work by outlining how critical pedagogy in the mathematics classroom can support students to engage in transformational resistance (cf., Solórzano & Delgado Bernal, 2001). Using a critical practitioner research approach, I retell (some of) my experiences as a high school mathematics teacher of ninth-grade Latin@ students' in our Algebra I classroom in East Los Angeles. Beginning the course with activities to build a *beloved community* (King, 2010) and facilitating lessons throughout the course that connected mathematics with social justice issues (Gutstein & Peterson, 2013), I strived to foster the classroom as a space where developing transformational resistance was possible. Through a culminating course youth participatory action research (YPAR) project, students conducted a quantitative study on school food (in)justice. Students developed a critique of societal oppression, a motivation for social justice (Solórzano & Delgado Bernal, 2001), and critical mathematical literacy (Gutstein, 2006). I argue that YPAR involving quantitative investigation can support students to develop positive mathematical and researcher identities and contribute to change for social justice.

Conceptual Framework

Teaching Mathematics for Social Justice

Striving to teach mathematics for social justice involves engaging students in critical quantitative thinking around issues of social (in)justice that are relevant to their lives and daily experiences (see, e.g., Frankenstein, 1983; Gutstein, 2006; Skovsmose, 1994). Freire (1970/2007) argues, "the great humanistic and historical task of the oppressed" is "to liberate themselves and their oppressors as well" (p. 44). Students of color and economically marginalized students bring valuable life expertise from their own experiences and backgrounds into the classroom, and can develop critical literacies to examine the unjust world around them so that they may both understand it and change it. Freire posits that a problem-posing pedagogy in which students pose problems and develop solutions as they co-create knowledge is necessary for the liberation of all peoples. Both teachers and students engage in cy-

cles of praxis, or the continuous process of "reflection and action upon the world in order to transform it" (Freire, 1970/2007, p. 51).

Powell (2012) outlines the historical development of critical perspectives on mathematics education. Teaching mathematics for social justice, also referred to as critical mathematics or criticalmathematics education in different regions and time periods—and also deeply intertwined with ethnomathematics—has origins from long ago, as national and global struggles for social justice and struggles for mathematics education have always been intertwined. Conferences convened by organizations such as the African Mathematical Union and talks such as D'Ambrosio's 1986 plenary address introducing ethnomathematics were turning points in the mathematics education field. A number of conferences beginning in the late 1980s called for a sociopolitical look at mathematics and the teaching of mathematics, including the Mathematics and Society Special Programme of the International Congress on Mathematical Education in 1998, the Political Dimensions of Mathematics Education: Action and Critique conference in 1990, and the Critical Mathematics Education: Toward a Plan for Cultural Power and Social Change conference in 1990, which gave rise to the Criticalmathematics Educators Group (CmEG).

In a 1990 CmEG newsletter, Frankenstein, Volmink, and Powell offer a definition of a criticalmathematics educator, offering insight into how those who strive to be a criticalmathematics educator may think about commitments as a mathematician, as a teacher, and as a concerned active citizen. Criticalmathematics educators, as re-printed by Powell (2012)—

> view the discipline as one way of understanding and learning about the world … as knowledge constructed by humans … as one vehicle to eradicate the alienating, Eurocentric model of knowledge … listen well (as opposed to telling) and recognize and respect the intellectual activity of students … and have a relatively coherent set of commitments and assumptions from which they teach, including an awareness of the effects of, and interconnections among racism, sexism, ageism, heterosexism, monopoly capitalism, imperialism, and other alienating totalitarian institutional structures and attitudes. (pp. 26–27)

Drawing on Frankenstein's (1983) argument about the importance of mathematical literacy for gaining power in society over economic, political, and social structures and Tate's (1995) argument for culturally relevant pedagogy in mathematics, which includes the study of issues relevant to students' lives, as well as other mathematics education scholars committed to education and change, Gutstein (2006) argues that social justice mathematics prepares students "to investigate and critique injustice, and to challenge in words and actions, oppressive structures and acts" (p. 4). Merging mathematics and social issues is not primarily for the purpose of understanding mathematical concepts but for using mathematics to create a more just world (Frankenstein, 2010).

Stinson and Wager (2012) define teaching mathematics *for* social justice as "the underlying belief that mathematics can and should be taught in a way that supports students in using mathematics to challenge injustices of the status quo as they learn to read and *re*write their world" (p. 6). They also define teaching *with* social justice as implementing equitable pedagogical practices, and teaching mathematics *about* social justice as teaching lessons with critical (and often controversial) social issue contexts. Examples of social issue contexts that connect with mathematics detailed in *Rethinking Mathematics: Teaching Social Justice by the Numbers* (Gutstein & Peterson, 2013) include: racial profiling, how the unemployment rate is determined, global poverty, school evaluation, and media and body image. Scholars argue that students may benefit from teaching mathematics *about*, *with*, and *for* social justice in the following ways:

- Developing a positive mathematics identity – students overcome fears in mathematics by building a positive mathematical disposition rooted in their culture and community (Gutiérrez, 2012). Gutiérrez contends:

> Black and Latino/a adolescents, like all young people, reap the benefits of programs that attend to their academic and their social/emotional needs. Learners show more confidence and are better able to find an answer—and they can reflect on how reasonable that answer may be when they have opportunities to…use mathematics to analyze social injustices. (p. 35)

- Reading and writing the world with mathematics – students consume and produce texts from a critical standpoint, making sense of data and the social context behind numbers, and developing social agency (Gutstein, 2006; Yang, 2009). Gutstein describes students' critical questioning as he quotes one student, Marisol, reflecting on a racial profiling unit: "I think I am better able to understand the world now using math…as soon as I finished the reading I already knew there was a problem there" (p. 67). Yang describes how students produced their own version of a school accountability report card with measures that the students themselves felt best evaluated their school.

- Building mathematical power – students understand mathematical concepts, engage in complex mathematical tasks, and communicate ideas in ways that allow students to access spaces in which "dominant mathematics" is used, such as high school and university courses as well as in science, technology, engineering, and mathematics professions (Gutiérrez, 2012; Gutstein, 2006).

While critical mathematics education scholars emphasize the possibilities and promise of teaching and investigating connections between mathematics and social change, there are also "limitations of the knowledge we gain from mathematical analyses of our world" (Frankenstein, 1994, p. 56). Brelias (2015) found that as high school students who were engaged in social justice mathematics lessons reflected back on mathematics as a tool for social inquiry, while they argued for its transformative power, they also argued mathematics can be "reductive and impersonal," "irrelevant for moral arguments," "inaccessible to the general public," and can provide "inadequate explanations for problems" (p. 7). The students demonstrate a "reflective knowing," as Skovsmose (1994) describes, evaluating the use of mathematics.

Scholars have laid the groundwork in theorizing teaching mathematics for social justice and translating critical theory to practice mathematics in schools, but this body of work must be further informed by more accounts of the affordances and challenges of integrating critical social justice issues in the mathematics classroom (Gutstein, 2006). Duncan-Andrade and Morrell (2008) note:

> Very little empirical work has been done that theorizes the possible translation of principles of critical pedagogy into practices, and even less work has been done that evaluates the outcomes of these practices in pushing forward the development of grounded theories of practice. (p. 105)

Youth Participatory Action Research and Transformational Resistance

As with critical pedagogy, conceptualizations of participatory action research (PAR) are influenced by critical theory developed in the Frankfurt School. McTaggart (1991), drawing on Carr and Kemmis (1986/2004), asserts that PAR is "motivated by a quest to improve and understand the world by changing it and learning how to improve it from the effects of the changes made"; it "treats people as autonomous, responsible agents who participate actively in making their own histories and conditions of life" (p. 181). Freire (1973) writes, "critical understanding leads to critical action" (p. 44). PAR can be understood as a cyclical process: those in oppressed conditions are engaged in research to understand a critical issue that they themselves identify as key to their freedom; they develop a plan for social action to challenge the inequity presented in that issue; and finally, they implement a plan for social change that they themselves developed. PAR methodology recognizes people as experts of their own knowledge and lived experiences. Those experiencing oppression, therefore, must be leaders of the research-action to understand and challenge it.

Educators throughout the nation are bringing PAR into schools or doing PAR with youth outside of schools, adding a "Y" in front, to explore how this action-research can be done specifically with youth (Cammarota & Fine, 2008). YPAR

engages youth as researchers on societal or school (in)justice and supports youth to take action connected to their findings. YPAR is a problem-posing approach to education that challenges inequity by viewing youth as experts of their lived experiences and places power in their hands. Cammarota and Fine (2008) argue, "YPAR teaches young people that conditions of injustice are produced, not natural; are designed to privilege and oppress; but are ultimately challengeable and thus changeable" (p. 2). They define YPAR as a process in which "young people resist the normalization of systemic oppression by undertaking their own engaged praxis—critical and collective inquiry, reflection and action focused on 'reading' and speaking back to the reality of the world, their world" (p. 2). Duncan-Andrade and Morrell (2008) put forth the argument that students in urban schools are the ones best equipped to be agents of change for equity and justice in urban education:

> As educators and as advocates for educational justice, we must understand that youth are much-needed collaborators with valuable experiences and energy to add to our movements. We firmly believe that youth participatory action research can ultimately develop the academic capabilities of students and, equally important, that youth-initiated research can help adult researchers and advocates to better confront the seemingly intractable problems of urban education. (p. 106)

In this way, YPAR challenges the notion of research as an objective endeavor and challenges traditional conceptions of who can become a researcher. Additionally, YPAR offers opportunities for young people to think about and partake in the ways in which research can be connected to resistance against oppression.

YPAR fosters students to resist injustice in a transformative way (Cammarota & Fine, 2008). Transformational resistance, as defined by Solórzano and Delgado Bernal (2001), encompasses a motivation for social justice and a critique of societal oppression. Solórzano and Delgado Bernal provide the 1968 East Los Angeles student walkouts and the 1993 University of California, Los Angeles student strike for Chicana/o Studies as examples of transformational resistance, as secondary students and college students alike in each of these historic periods held critiques of oppressive societal conditions and were motivated to make change for greater social justice. Cammarota and Fine call for further documentation of how young people engage in transformational resistance—in and out of classrooms and related to various social injustices—and how educational processes can foster resistance.

Supporting students to bring a social justice motivation to their mathematical coursework and to critique societal oppression through mathematics is undertheorized and further examples of such praxis are needed. Terry (2011) and Yang (2009) each present theoretical arguments and empirical evidence to assert that young people can foster critical mathematical literacy and move that literacy to action as they engage in YPAR. Terry (2011) argues that YPAR in mathematics can support students to engage in mathematical counterstory-telling, as he shares the

ways in which Black male youth identified and contradicted a dominant narrative and framed access to freedom, in the context of an after-school program in South Los Angeles. Constructing mathematical counterstories can support students to self-identify as doers of mathematics and ultimately involve "more transformative forms of resistance" (p. 43).

Yang (2009) addresses the quantitative aspect of a multiyear YPAR study in which he and collaborators supported 30 high school youth to create their own School Accountability Report Card. Instead of accepting measures the state selected for school accountability, the youth decided what should be measured, including attributes like culturally relevant teaching. They conducted survey and interview research to discover if the school was meeting students' needs and then reported that work to the student body and school leaders. Students "critically consumed" and "critically produced" texts, thus engaging in the process of reading and writing the world with mathematics. However, "math education has not realized its full potential in developing youth researchers capable of producing critical texts at the level of public intellectuals" (p. 102).

The study presented here further explores the possibility of quantitative action-research projects, examining the implementation of YPAR within the context of an Algebra I classroom. Overall, I sought to provide students with the opportunity to engage in YPAR in our mathematics course, after we had laid a foundation for transformational resistance by building community and completing units connected to social (in)justice issues. I wondered: How can teaching students to be critical quantitative scholar-activists be included as a meaningful part of teaching a mathematics course?

Methods

The voices of teachers in national conversation and research are essential for advancing change for educational equity and justice (Cochran-Smith & Lytle, 1999; Oakes & Rogers, 2006). Practitioner research is a "promising way to conceptualize the critical role of teachers' knowledge and actions in student learning, school change, and educational reform" (Cochran-Smith & Lytle, 2009, p. 5). Critical, qualitative methodologies (Kincheloe & McLaren, 2002; Steinberg & Cannella, 2012) shaped the design of this practitioner research investigation. In particular, this study is informed by practitioner research that emphasizes "equity, engagement, and agency," as Cochran-Smith and Lytle (2009) identify as a more recent turn in practitioner research, pointing to books on YPAR and critical pedagogy such as Duncan-Andrade and Morrell's *The Art of Critical Pedagogy* (2008) and Cammarota and Fine's *Revolutionizing Education: Youth Participatory Action Research in Motion* (2008). They argue that such critical practitioner research has potential to question the goals of schooling, raise questions about power and whose voices are

heard, bring meaning to equity in local contexts, and link teacher and student inquiry as interconnected.

Research Questions

The research questions that guided this investigation were:

1. How can a mathematics classroom develop as a beloved community lay a foundation for transformational resistance?

2. How can YPAR in a mathematics classroom support students to engage in transformational resistance as they build critical mathematical literacy?

These questions serve as the focus of this article because integrating YPAR in the teaching of mathematics for social justice within mathematics courses is understudied. Teachers' stories that shed light on possibility and challenges of teaching mathematics for social justice are necessary to advance understandings of how social justice may come to fruition in a multitude of ways in the mathematics classroom (Bullock, 2014). I do not assert that the questions I pose can be fully addressed within this practitioner research examination, but I hope that striving to share an in-depth, critical practitioner research study can join in dialogue with other accounts of mathematics teaching (such as Bacon, 2012; Brantlinger, 2013; Gutstein, 2003; Terry, 2011; Yang, 2009) and offer implications for future work.

Teacher and Researcher Positionality

Like all educational research, mathematics education research is political and non-neutral (D'Ambrosio et al., 2013; Gutstein, 2003). My experiences reflect the political nature of mathematics education research in my choice to be a part of social justice mathematics communities of educators, my belief that educational research can and should contribute to a more socially just world, and my choice to follow in the footsteps of scholars who examine their own positionality as researchers.

I entered teaching with an understanding that being a continual learner is an essential aspect of critical pedagogy and teaching mathematics for social justice. I believe it important for teachers—and for myself as a White female teacher and a teacher of STEM (science, technology, engineering, and mathematics)—to constantly work to become more aware and knowledgeable about the historical and present day intersections of oppression based on race, ethnicity, class, gender, sexual orientation, religion, age, special need, legal status, language, and so on. As a mathematics teacher, I strive to understand the ways in which STEM education perpetuates yet can intervene to challenge oppression. I also believe it important to

build with other educators, both new and veteran, to learn from and alongside each other. As a White woman, I came into this research with the same consciousness that I attempted to bring into my classroom teaching: an understanding that White women are the most represented demographic group in the teaching profession. Voices from this group, therefore, are often centered and privileged in (and out of) schools. Moreover, the teaching profession is looked down on as "women's work"; a devaluating I often felt as a teacher and experienced the seeds of growing up as a young woman. Interrogating my own positionality and pedagogy is a complex, life-long process that can never be completed.

Amidon's (2013) argument on teaching mathematics with *agape* (a Koine Greek word, often translated to "unconditional love"), pushes me to think about the following questions, which I adapted from his work: What *can* I do from a position of power and privilege to interrupt oppression and be a part of supporting students to have the opportunity and expectation of success in mathematics and life? How can I learn from and alongside teachers from similar and different backgrounds who are working to support students to succeed in mathematics (according to traditional and critical ways of thinking about success)? In my teaching of mathematics to Latin@ students in an economically marginalized community, I sought to interrupt power, privilege, and oppression (Amidon, 2013); develop a "critical care praxis," challenging a colorblind approach of caring for students (Rolón-Dow, 2005); and express to students a political and radicalized love (Darder, 2002). Below I detail the ways in which I attempted to bring these ideas to life in my pedagogy, while acknowledging my continuous need for critical self-reflection.

Classroom and Study Context

The public school in which I taught was one fought for and created by community teachers and organizations in East Los Angeles, including the organization InnerCity Struggle (see http://innercitystruggle.org). It was one of the first public high schools built in the larger community in 80 years, after community organizing pushed for new schools due to over-crowding. This activism was by no means new in East Los Angeles. Home of the 1968 East Los Angeles School Walkouts (Solórzano & Delgado Bernal, 2001), the community's historical and present-day struggles for educational justice laid a significant and meaningful historical and cultural foundation for the new school. I had hoped to teach in a public school at a time when few jobs were available in public schools, so I felt fortunate for the opportunity to teach in this school, fought for by Latin@ students, families, and community organizations. I believed that our mathematics classroom community could attempt to learn from and draw on the historical legacy of social justice efforts by and for the community.

The Algebra I class I chose to study for this investigation consisted of students who took and had previously "failed" (or were failed by) the course the prior

year as eighth graders in middle school, and mostly students who were not tracked into algebra in eighth grade at all—the highest track in the feeder middle schools being geometry for eighth graders. Because of this "low" placement, the students in this class were positioned as the least knowledgeable/capable students in the school. The textbooks in the feeder middle schools as well as the textbooks at the high school where I taught, like many traditional texts from large textbook publishing companies, marched through mathematics procedures and included a long list of problems for which students were expected to apply procedures, with a couple "critical thinking" word problems at the end of each section. The textbooks did not arrange the mathematics from an integrated mathematics perspective but rather as separated subjects: Algebra I, Geometry, Algebra II, Trigonometry/Pre-Calculus, and Calculus. The books did not include relevant, real-world, current or historicized issues. The content area covered in the Algebra I textbook, the same as the content covered on the high-stakes state exams, amounted to: properties of real numbers; solving, graphing, and writing linear equations and linear inequalities; systems of equations and inequalities; exponents and exponential functions; quadratics; polynomials; and rational equations and functions.

I believed this class was a good fit to practice YPAR because I hoped to provide the space for students to get excited about mathematics, which, for most students, had already become a despised school subject. For most students, this course was the first time they had access to Algebra I, which tends to be a gate-keeping course. While I hoped to integrate YPAR into multiple class periods in the same school, I recognized as I began to plan the introduction of the unit that I did not feel prepared to facilitate multiple different action-research projects at once, so I chose one class period of Algebra I.

Data Collection and Analysis

Data sources included:

- My teaching journals, in which I reflected on my pedagogical choices and took note of student leadership, participation, presentations, and specific contributions students made in the class (I put student statements I remembered verbatim in quotation marks);
- Pre- and post-questionnaire (see Figure 1) with students on their beliefs about what it means to do research;
- Math autobiographies students wrote at the beginning of the course as well as an end-of-course reflection on mathematics; and
- Student artifacts, including a final paper the class collectively wrote on their YPAR study and a video based on their quantitative data analysis and a collection of photos of the school food.

To analyze the data, I developed (and triangulated) a coding schema across the data sources. I took note of reoccurring themes as I taught throughout the school year, using the constant comparative method for data analysis (Bogdan & Biklen, 1982). In this article, I discuss my pedagogical decisions and reflections on those decisions, incorporating some of the ways in which students engaged in the course and in the culminating YPAR project.

Name: _____ **Date:** _____ **Period:** _____

Research Questionnaire – Explain all your answers

1. What is research? Give your own definition!
2. Give an example of research.
3. What are the different steps of research? (Make a guess if you're not sure! Come up with at least four steps.)
4. *Who* does research in our society?
5. What skills do you think a researcher needs? Do *you* have any of those skills?
6. Do you think research is important for society? Why or why not?

Figure 1. Pre- and post-questionnaire about research.

Developing Foundations for Transformational Resistance

Beginning the Algebra I Course

Joining other mathematics educators across the nation, I attempted to create a social justice mathematics class to provide the space for students to feel empowered to read and write the world with mathematics (Freire, 1970/2007; Gutstein, 2006). From the first day of school, I sought to lay the foundations to critique societal oppression and explore possibilities for social justice within my classroom. The social issue-related units and ultimately the YPAR project I facilitated in the classroom did not occur in a vacuum, but rather surfaced out of practices I had used and activities students had engaged in at the beginning of the school year.

Just prior to asking students to share more detailed information about themselves to me in a student information sheet (see Appendix A), I briefly introduced myself and my history, opening up to students as a person. First, I told them about my name, Mary Candace. Mary is my grandmother's name and Candace was her

sister's, or my great aunt's name. I go by "Ms. Candace" with students because of the kind of person my great aunt was. She suffered a heart condition and passed at a young age. Throughout her life, she devoted herself to the happiness of others and to supporting people with what they needed. For example, she always remembered everyone's birthdays and made elaborate cakes. After being diagnosed with her heart condition, she started a chapter of an organization in Buffalo, New York called *Mended Hearts* (see http://mendedhearts.org), which brought together patients who had previously undergone heart surgery and patients who were about to go through it. The goal was to have conversations that may ease fear before experiencing the surgery. I told students that I hoped to bring my great aunt's spirit with me to guide me in my teaching, and that I will always remember and celebrate each of their birthdays in honor of her.

I told students a story of taking Algebra I at a Title I middle school in eighth grade and getting As, but when my parents transferred me to a high school out of our neighborhood, I got an 11% on the "how much of Algebra do you remember?" test on the first day of school. I remained in Geometry and did well, ultimately making it to Calculus, but doubted myself and had always felt inferior to the other students at school because of that initial test. I told another story of intending to major in statistics in college but barely passing the first upper-division course because I was intimidated by what I perceived as the cut-throat, competitive nature of the class. I also felt I was at a disadvantage because I was one of only a few women enrolled in the course. I shared with the students that my experiences do not mean that I understand their experiences—acknowledging that the students have a wide variety of experiences with mathematics. I also recognized that although I, as a White person from a middle class background, have benefited from many privileges, I could, to certain extents, relate to feeling disempowered in mathematics as well as empowered. I asserted that to push back on disempowerment in mathematics, we must co-create a space in which we collaborate to build a beloved community.

In "Letter from a Birmingham Jail," Dr. Martin Luther King, Jr. (1963) wrote: "Injustice anywhere is a threat to justice everywhere. We are caught in an inescapable network of mutuality, tied in a single garment of destiny. Whatever affects one directly, affects all indirectly" (p. 2). I first learned of Dr. King's concept of the beloved community as applied to the classroom when I was an undergraduate at the University of California, Berkeley and took a course entitled "June Jordan's Poetry for the People" in which we read and wrote poetry on systemic oppression, resistance, humanization, and liberation. I understood building a beloved community in the classroom to mean developing a space in which both the students and the teacher see the humanity in one another as they work toward a more socially just world. I told my students that each of them is each other's greatest asset for learning, for making it to graduation and beyond, and for changing the world—that they are connected to and dependent on each other.

During the first week of class, I facilitated class dialogues in which students declared their rights in the mathematics classroom, the demands they have of themselves and each other, and the demands they have of me as their teacher (see Appendix B). I told students that I am a teacher because I believe they will be the ones to change the world. I also told students that I would try to make the class center around their own self-improvement and building confidence in mathematics as we use mathematics to understand and change the world.

I then provided the syllabus to the class—the title of the course matched what I told students it would be about: "Viewing and Changing the World Through Mathematics." Underneath the title, I placed a picture of a mural in the housing projects of East Los Angeles,[1] as Gutstein (2006) writes about teaching about after he read an article of Marilyn Frankenstein's (1997) that included a photo of the mural. Some of the students in our classroom lived in this housing project, so I felt it was especially relevant. Alongside Che Guevara is the message: "We are not a minority!!" I then facilitated a scaffolded class discussion, where students shared how they, as People of Color, are not minorities—according to the mathematical definition *and* because they are not "less than" other people. I also began with a Math Autobiography writing assignment (cf., Peterson, 2013), asking students to write me a letter telling me their stories (see Appendix C). I structured the assignment with many questions about their past experiences with school in general and mathematics specifically, and why they feel mathematics is important to learn. The most common response to the latter question: "We need math to count change at the grocery store." Their responses motivated me to want to expose the students to how powerful a tool mathematics can be for understanding racial, social, and economic injustice in education, health, incarceration, and so on, and for constructing arguments to fight for justice through mathematics. I explained that certainly mathematics is important and essential for everyday calculations, but that I firmly believe students have the power to use mathematics in ways that connect more deeply to their lives. My role was to provide them the support and context for this learning.

One of the first activities I implemented with students was an "ICEbreaker" similar to one from my teacher education program. Students wrote down on an index card three "variables" about themselves: I = an interest they have, C = a characteristic or personality trait about themselves, and E = a unique event or story from their past. The whole class stood up as I began to read aloud a card. Students remained standing until I read all three statements, and they guessed, from the group who was left standing, the person to whom the card belonged. Students were excited to learn about each other's "variables." This activity built community by getting to know each other.

[1] See http://www.muralconservancy.org/murals/we-are-not-minority.

As a pre-service teacher, I dreamed of creating an Algebra I course that consisted only of social issue-related and other real-world units. As I entered the classroom, I began to more fully understand the pressures on teachers to teach all of the content standards that Bacon (2012) and Gregson (2013) detail in case studies of social justice mathematics teaching. For Algebra I, this includes a long list of many fundamental concepts necessary to accessing the "rest" of mathematics. These pressures come from a multitude of directions and, in my case, included:

- "value-added" measures imposed by the school district that rate teachers based on student test score improvement,
- standardized tests such as the high school exit exam, and
- administrators that put pressure on teachers for students to perform "or else" (see Gutiérrez, 2013 for many other examples).

I realized that, while I would not compromise my plan to teach social-issue related units, I would have to create them in a way that was strategic, so that the activities I designed addressed a variety of content standards in a rigorous enough way to address these demands. I believed that covering content standards and teaching social justice mathematics did not have to be mutually exclusive; however, I had not yet conceived how I could tie much of the mathematical content to real-world contexts.

Across all mathematics lessons, I sought to draw on culturally relevant approaches, which I knew would require me to change the culture of my classroom to be different than how mathematics classes looked like for me as a student. A daily pattern of whole class instruction where students follow along passively, copying problems the teacher solves, and then working on a set of similar problems alone following the lecture does not call on students to communicate almost at all orally or build on each other's ideas (Tate, 1995). In my classroom, I worked toward supporting students to discover concepts in mathematics (as opposed to teaching procedures) and having students work in groups collaboratively to validate and build on the knowledge of one another (including seating the students in small circle groups). This classroom set up assisted me in providing the space to meaningfully connect mathematics and social justice issues whenever possible.

Teaching Mathematics about, with, and for Social Justice

One of the first tasks in Algebra I is to review computation and the order of operations. Students are expected to have mastered fractions prior to taking the course, and this often can be students' least favorite element of a mathematics problem. I thought about how I could re-introduce fractions and start off my class with real-world connections that would show students how important fractions can be. I

designed a lesson using the video *If the World Were 100 People*[2] (see Appendix D), which students and I viewed together. In the video, statistics report that if the world was shrunk down to 100 people, for example, 12 people would have a computer and 21 would live on less than $1.25 per day. Before watching the video, I asked the students to guess what they thought the numbers would be for all of the statistics, and, while watching the video, they then recorded the data. Some students were shocked at the differences between their guesses and the actually reported statistical data.

Following this activity, I asked students to write the data as fractions out of 100 (e.g., 12/100), then reduce the fraction, if possible, write it as a decimal, and write it as a percent. We discussed the importance of being able to do so when making arguments in different contexts; that it can be powerful to express parts of a whole in different ways.[3] For homework that night, I gave students a chart entitled "If East L.A. Were 100 People," with data I had taken from the census (we acknowledged and problematized that it often does not include people who are undocumented), and their task was to find the fraction, decimal, and percent equivalents and then write concluding observation sentences about what they noticed. My goal was for students to gain confidence in mathematics as they read the mathematical world around them. Some students, accustomed to more traditional courses and skeptical of change, wondered out loud, "Why are we talking about community in math class?"

Early in the Algebra I course, it is typical to study inequalities, and I seized the opportunity to plan a unit that connected the way we discuss inequalities in mathematics with inequalities (or inequities) in society (see Appendix E). To get a stronger sense of what issues students were feeling particularly interested in, I presented them with several graphs relating to topics such as race and incarceration, incomes of people with and without disabilities, child poverty before and after economic recessions, and health vs. wealth. In teams, students chose a graph to study as the starting point in their Inequality Project. They answered several questions about the graph (e.g., questions designed to invite a range of participation from all group members, such as what stands out to them the most) and wrote out mathematical statements of inequality, using *less than*, *greater than*, *less than or equal to*, and *greater than or equal to*—using variables and numbers—in ways that were meaningful to them. Following this activity, students did additional background research on that inequality, created a poster, and presented findings to the class, in-

[2] See http://www.miniature-earth.com; the video is based on the book *If the World Were a Village: A Book about the World's People* (Smith, 2011).

[3] This was a brief moment in the lesson that I could have elaborated on more, by, for example, calling on students to identify instances of how parts of a whole have been communicated in the media and speculating together why they were communicated in such a manner.

cluding questions that arose as they explored the topic. One of the students, Roberto, who was having challenges in most classes because of issues outside of school, spoke during this presentation. At the moment that he began to break down the importance of looking at percent difference as opposed to numerical difference in the context of racial underrepresentation and racial overrepresentation in prisons, the principal walked in to our classroom. She asked him a question, then another, and another. This ninth grader, whom she had only seen in her office for misbehavior, confidently addressed all her questions related to this inequality and why it was an important one to understand. Following his presentation, he expressed that he felt validated as an intellectual; that he had something to say about social issues and mathematics.

My last example of a social justice mathematics lesson is on the topic of slope. Often, textbooks and traditional curricular materials introduce slope as being equal to $(y_2 - y_1) / (x_2 - x_1)$. This formula can be challenging for students to understand, especially if not introduced to the conceptual meaning of slope. I do not argue that students should never be introduced to such a formula. But rather, when they are, it should come after interacting with slope in more meaningful and conceptual ways so that students can understand that slope captures how much one variable changes with respect to another. Without mentioning the word "slope" in class, I presented two graphs to students of data with almost linear relationships, the first being a graph of asthma rates over time in a California city and the other family income vs. student SAT math scores. We discussed the first graph together as a class and the students studied the second graph together in groups. I asked students to share everything they noticed about the graphs. Then, I asked students to focus on the *x*-variable (horizontal axis) and then on the *y*-variable (vertical axis), for each identifying how much that variable changes from one point to another point. Next, I asked students to write this ratio out as a sentence (e.g., For every $20,000 more a family makes, the average student's SAT math score is higher by 14 points). After students identified this relationship, I said that we call this relationship "slope." For many students who had already taken Algebra I in eighth grade and "failed" (or were failed) they responded with statements, such as: "Oh! Why didn't they just tell us that before?!" or "That's it!? Man I just couldn't remember those formulas!" After students saw real-world context examples of slope, in subsequent exercises the majority of students excelled at finding and interpreting $\Delta y/\Delta x$ as they discussed the meaning of a graph's slope. I saw ways in which I believed students were striving to "read the world" with mathematics in my classroom. In addition to sharing their (our) learning on social issues, how could I support them to further "write the world" with mathematics?

Developing Transformational Resistance and Critical Mathematical Literacy through Youth Participatory Action Research

Thinking of how to introduce the YPAR unit, I returned to an article I had introduced to students earlier that year: Solórzano and Delgado Bernal's 2001 germinal article on transformational resistance. I had used the article earlier to introduce the Cartesian coordinate plane (see Figure 2). Students are often introduced to the coordinate plane as an abstraction, and plotting points becomes a mechanical procedure without meaning (e.g., 5 over and 2 down). I had remembered that Solórzano and Delgado Bernal's article contained a quadrant showing four types of resistance, each quadrant representing the presence or absence of a variable, x – motivation by social justice, and y – critique of societal oppression. I put blue painters' tape on the floor of the classroom to make a coordinate plane, asking students to move about it representing the presence or absence of two variables (first starting with variables such as their preferences on two different sports rivalries, and then moving to examples of high school student resistance that students could relate to, mapping them out on the coordinate plane according to Solórzano and Delgado Bernal's conceptualization of resistance).

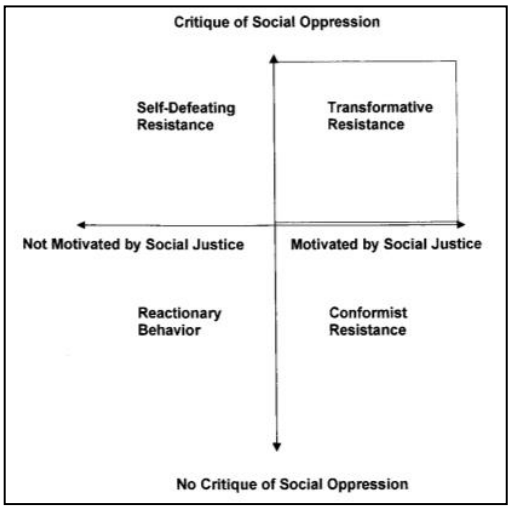

Figure 2. Defining the concept of resistance.

From "Examining Transformational Resistance Through a Critical Race and LatCrit Theory Framework: Chicana and Chicano Students in an Urban Context," by D. Solórzano and D. Delgado Bernal, *Urban Education*, *36*(3), p. 318. Copyright © 2001 by Corwin Press, Inc. Reprinted by permission of SAGE Publications, Inc.

To kick off the YPAR project, I invited Professor Solórzano to come to my classroom and speak to the students about transformational resistance (my contact

with him and his class visit are recounted in Solórzano, 2013). Professor Solórzano shared with the class examples of transformational resistance and specifically spoke about the ethnic studies ban in Arizona and upcoming film *Precious Knowledge* (McGinnis & Palos, 2011). The students were energized following his presentation and excited to engage in action-research themselves.

The students chose to study school food injustice, as health injustice related to race and class. They were passionate about this topic following the inequalities project. Before we dove into designing the study, we watched the film *Unnatural Causes* (Adelman, 2008), which weaves together biology, public health, sociology—and even mathematics, with data and graphs throughout—to understand how wealth disparities lead to poorer health. Students chose to look at school food because: (a) it affects them every day, and the district had recently changed the food in such a that they were unpleased; and (b) after intense class debates about how to make change and what it means to be a leader, students felt that they had a realistic chance of making some concrete changes on this issue.

As we embarked on the study design, students piloted survey questions with peers in other classes before refining a survey protocol, asking their peers to talk through how they understood each question and what should be modified for clarity or added. Additionally, during lunchtime in the first couple weeks of the project, students talked with their peers and took pictures of school food to deepen their understandings of the student body's greatest concerns. They also shared stories in class of their own experiences with school food. While I guided students toward a school-wide survey so that we might analyze large-scale quantitative data, we discussed strengths and weaknesses of quantitative and qualitative research. The informal conversations students led with their peers and the photo element of the investigation gave them a sense of various research methods (e.g. interviews, photo voice) and how the stories behind numbers are necessary to uncover what they want to know. That said, I acknowledge that in the spirit of YPAR it is problematic to point youth in particular directions, but I chose to make the exception of guiding them toward quantitative investigation, while still highlighting the limits of doing so, because of my desire to integrate YPAR in the mathematics class.

The class then designed and implemented a school-wide survey with closed-ended and open-ended questions on the school food as well as demographic information, which they administered to over 400 of their peers. Students analyzed the survey data and created graphs using Microsoft Excel, which they had not used before, and presented their findings to school food officials. In each phase of the action research, different student facilitators led the class (after I had a planning meeting with them on facilitating for that particular class segment).

In summary, the class had five findings: (a) students overwhelmingly gave the school food the lowest rating; (b) the predominant reason students reported eating the school food was because they were hungry and did not have other options; (c)

students had a desire for all components of the school lunch to be tastier, healthier, and in larger portions; (d) students wanted to exercise more choice in their meal options; (e) and all but eight students surveyed said they received "lunch tickets," meaning they qualified for free lunch. One of the biggest shifts with respect to mathematics I observed was students' use of mathematical discourse as they communicated with one another (and me) while entering, analyzing, and displaying their data. For example, students were regularly using the terms such as variables (as described in the anecdote in the introduction of this article), relationship, correlation, *x*-axis, *y*-axis, coordinate, data point, pattern, outliers, respondents, bar graphs, pie graphs, frequency, intervals, best-fit line, mode, mean, range. Prior to the YPAR unit, we covered linear equations beginning with the investigation of slope (as previously discussed). I had hoped that more students would apply the algebraic concepts behind linear equations as they engaged in this research, but few did, due to, I believe, a lack of support on my behalf. I would have liked to have done more, and at the same time I made the choice not to push certain aspects of the mathematics, assessing that students were gaining non-algebraic, statistical skills and ways of thinking and confidence in their participation as students in mathematics class.

Following analysis and writing a summary research report as a class, the students called for a meeting with the cafeteria manager to share their research findings and ask about the school lunch program. They concluded with recommendations to have daily comment cards available for all students so as to quickly give feedback on the food (and for these comments to make their way to those who prepare the food); to "change our menu into food that helps us be healthy—food that does not have an exaggerated amount of grease, fat, sugar, etc. so we can adapt to the habitat [sic] of being able to eat healthy"; to offer larger portions; to include more fruit and vegetable options; to offer water and fewer sugary drinks; to distribute a monthly menu; and to eliminate the lunch tickets given that almost the entire student body qualified for them.

As other practitioner researchers striving to teach mathematics for social justice have observed, I believed that students were demonstrating more positive mathematical identities as they began to engage in the process of reading and writing the world with mathematics, solving rigorous problems, and building mathematical literacy. In their math autobiographies at the end of the year, students' views on the importance of mathematics and why we must learn it shifted from being important in specific situations and because it will be useful in the future to an understanding of mathematics being an important tool for viewing and changing the world around them. Most students wrote that they began to feel this way about mathematics as they came to believe they have the capacity to study and change their school, using mathematics.

Returning to the story at the beginning of this article, students often made meaning with mathematics that they previously had not experienced. As students were creating representations of their data, another student, recognizing how data representations could help tell a powerful story, said: "Once they see our data, they will have to listen." This statement demonstrates her perception of the power of critical mathematical literacy. Reflecting on her statement and similar statements by other students, I am glad that the students held firm beliefs in the power of their work to tell a story and demand attention and action. But I wish I had done more to create space to address the complexity of speaking their truth to systems of power, the struggle of working toward social justice for the long haul, and community organizing tactics for making change. Exploring such topics in the mathematics classroom, highlighting the role of mathematics, statistics, and numeracy in organizing for change, would have been powerful. Students did begin to uncover the challenges behind making change toward greater social justice after meeting with the school's cafeteria manager and learning that decisions about school food were not local school decisions but rather large district-wide ones, and after meeting with the Healthy School Food Coalition[4] and learning of persistent efforts by that organization over time, in solidarity with students, to win actionable issues.

Students also demonstrated a significant shift in their interpretation of the meaning of research. Before they engaged in YPAR, most students defined research as looking up a topic of choice online and did not view research as a process they could conduct by posing original questions and collecting data on a topic about which they were passionate. (Figure 3 provides students' statements after the YPAR project.)

Prior to the YPAR project, I hoped to lay a foundation in the classroom where our work would be motivated by social justice issues and to critique societal oppression. I do not believe working toward these goals in the YPAR project would have been possible had we not taken time to build community and participate in social justice lessons throughout the course. I observed that a motivation for social justice and a critique of societal oppression were built over time, especially when fostered within a subject like mathematics where the connections are not often made. Relating to the other forms of resistance Solórzano and Delgado Bernal (2001) discuss, too often students in mathematics class express "reactionary behavior," acting out against teachers and classmates without a critique of social, historical, or political factors influencing their behavior; or they engage in "self-defeating resistance," understandably questioning the relevance of mathematics to their lives; or in "conformist resistance," doing their work knowing that it will help them access college but not challenging the abstract, procedural, or context-void teachings of mathematics. Critical pedagogy in mathematics can support more students to re-

[4] See http://www.oxy.edu/urban-environmental-policy-institute/programs/food/healthy-school-food-coalition.

sist in mathematics in transformative ways. During the YPAR project, students resisted with both a motivation for social justice—to get tastier and healthier food for all at their school—and with a critique of societal oppression—that people of color and people living in poverty are often denied access to healthy food and many other benefits to overall health, and that school food should not exacerbate that inequity but rather fight against it.

- I have learned about research that when we do research it's not only "copy, paste, and print," we have to read it and understand it and do it. Research is to find the information you want on your own.
- Research is to take time to look for information about something that you're looking to uncover, to find facts and explanations about it. Anyone can do it as long as you know what you're looking for. I learned that creating and giving surveys you can really collect a lot of information and different opinions of many students. You get to learn what they think and feel on what you're asking them.
- There are explanations and steps to do research. Research means to find out something but more detailed, like getting to the bottom of it.
- It is very hard to come up with a simple survey. It takes a lot of patience. First we came into teams to construct each category. Anyone can make a survey, just takes patience and research about the topic of the survey. What I learned is that you could get a lot of info in a couple simple questions, and we worked days on a survey and people finish it in minutes.
- We can use research to find out patterns of info for the surveys.
- To find out all of the information and put the information together and analyze and understand it.

Figure 3. Student statements on the meaning of research after the YPAR project.

After representations from the Healthy School Food Coalition visited our class, students wrote thank you notes to them. One student included the phrase "Victory will be ours!" on the cover of his note. Earlier in the project, this same student had been skeptical, questioning how students could really be school leaders who fight for change. Another student's note read:

> I am so glad and I feel so supported by a group of adults that actually care about what we care about, which is the school food. I feel motivated to want to learn more about this and make a change knowing that no one else would do it, but the ones that care. I feel like we can really make a change as long as we keep on trying. ☺ Thank you so much for hearing us out and listening to our thoughts and opinions. I really hope our work pays off in the end. I hope to stay in touch so that together we can also make a difference once we've done it at our school with the cafeteria manager first!

Discussion

In this article, I aimed to contribute to scholarship that imagines, builds, and investigates spaces where critical mathematical literacy and social action are intertwined from the perspective that the work of engaging in critical praxis is a lifelong process. As Sleeter (2015) and Ladson-Billings (2015) contend, scholar-activism not only conceptualizes possibilities of teaching for social justice within inequitable schooling contexts but also works to alter such contexts. Questions that arose for me in reflecting on this YPAR practitioner research are: How can schools and teacher education be altered to foster social justice mathematics? How can social justice mathematics itself be a part of pushing for change to challenge structural inequities that persist within and outside of mathematics education? What role does or can critical mathematical literacy have in developing "justice-oriented citizens" (Westheimer & Kahne, 2004) who engage in transformational resistance as they envision and lead social movement?

This investigation sheds light on the promise of YPAR in the mathematics classroom to open up spaces for students to develop as subjects of transformation as one avenue of teaching mathematics about, with, and for social justice (cf. Stinson & Wager, 2012). School change efforts and research can further explore the expansion of YPAR as a normalized part of students' learning experience at school and the multiple critical literacies students can build as they engage in research and create change. Westheimer and Kahne (2004) argue that one way schools can teach for democracy is to develop students as community activists who analyze root causes of societal inequities and explore how human rights and social justice can be achieved as a result of collective action. Critical pedagogy can be supplemented with "strategies used by community and education organizers" (Anyon, 2005, p. 179). Critical mathematics teachers and their students who engage in YPAR can be positioned as mentors to pre-service teachers and, in teacher education, teachers can learn how to form educational justice-oriented groups with other teachers, such as critical inquiry groups (Nieto, Gordon, & Yearwood, 2010) and Nepantla circles (Gutiérrez, 2012).

While YPAR in the mathematics classroom has the potential to open up space for students to write the world (the action in action-research can be thought of as writing the world), there are a multitude of ways in which young people can write the world with mathematics that can occur within or outside the context of YPAR (e.g., [re]defining what it means to do mathematics such as bringing in cultural practice to mathematics, creating texts and media, sharing work with family and peers), and YPAR itself does not demand particular actions. Future research can capture a variety of ways in which young people can develop transformative resistance through or drawing on mathematics and continue to question the possibilities for and extent to which YPAR and transformational resistance can be fostered

within the classroom walls—within school, district, and larger social-political constrains that often run counter to the spirit of YPAR. Because I guided students toward quantitative investigation, placed a time limit on the project, and did not cover some of the "dominant mathematics" concepts I was supposed to address according to the content standards (polynomials and rational equations and functions), I need to complicate my own claims about YPAR and transformational resistance in the mathematics classroom. These are all areas I would strive to improve on, think harder about, and talk with others about before future implementations.

As studies by Terry (2011) and Yang (2009) do, future research can also include in-depth examinations of how students demonstrate their learning of mathematics in the context of YPAR and following their engagement with YPAR, as well as the connection between students' mathematics learning and mathematical identities. I do not link students' mathematical identities to their mathematical performance in terms of performance on tests or success with future mathematics access. In one sense, I believe this is a limitation of the study. At the same time, I argue that placing high value on and focusing in on how students perceive mathematics and how students perceive research in the context of participating in YPAR are just as important areas of focus for research as other conceptions of what it means for students to "perform" mathematically in the context of YPAR or social issue-related learning.

Pushing for change in schools and teacher education can foster environments where social justice mathematics can grow and, in turn, YPAR connected to quantitative inquiry can work toward creating change itself. As Stinson (2014) asserts, in times of great societal injustices *and* large-scale organizing against such injustices (e.g., the Black Lives Matter and Occupy Wall Street movements), we can call on mathematics education to contribute in greater ways to understanding and changing our society.

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Appendix A
Student Information Sheet

Student Information Sheet

My full name is: I prefer to be called / nickname:

My birthday is (Month Date, Year):_____Gender pronouns:

Do you need to sit near the front of the room to hear or see better?

My home phone number is:

Family member's name *and* their relationship to you (mom, tío, etc.):

The music I like to listen to is:

The foods I like to eat are:

The language(s) I speak at home is/are:

I am talented at:

I am from:

I am:

I would like to get better at:

I come to school because:

In the future, I would like to:

In the past, I have had good experiences in school when:

I have had bad experiences in school when:

Something that gets on my nerves is:

Something I would like Ms. Candace to know about me is:

I would like to change the world by:

The questions I have about this class are:

Thank you for filling this out! I look forward to getting to know more about you!

Appendix B

Declared Students' Rights

Student Rights in Room 304

Right to education
Right to learn
Right to respect and be respected
Right to say your opinion safely
Right to be accepted
Right to ask questions
Right to disagree
Right to speak out
Right to be heard
Right to inspire
Right to be happy
Right to have equal opportunities
Right to be yourself
Right to feel passionate about your work
Right to be treated equal
Right to express yourself the way you want to
Right to share what you think
Right to be fair
Right to go to the restroom
Right to step up
Right to have fun and be funny without taking away from the education experience
Right to be unique
Right to not be bullied
Right to speak your mind.
Right to fight for what is right.
Right to just have fun
Right for coming to school regardless of race
Right to believe
Right to defend other people
Right to help one another

Demands for the Teacher(s) in Room 304

To listen to us
Believe in our dreams
Be prepared
Make the work fun
Don't be mean
Have a good mood to everyone
Do not give or take excuses
To not be offensive
Don't discriminate
Rewards for working really hard
No racism
Teach us equally
Be trustworthy
No mistreatment
Know everyone
Don't give up on us
Have faith
Don't compare us to another class
Support us
Don't tell us we're worthless
Believe in us
Positive messages
Accept our invitations (to sports games, etc)
Respect our beliefs
Have celebrations
Be understanding if we're having a rough time
Protect us
Help us do our work

Student Demands of Each Other in Room 304

To be treated equally
Respect
Trust
Not to be judged
Not to be bullied
Equality
Not to be brought down or belittled
Fairness
To be quiet (at times) and to collaborate (at times)
To write down the homework
To turn in your homework correctly
To be helpful
To act maturely
Respect when someone else is talking
To stay focused
Complete your assignments
Give opinions
Don't be a distraction to others

OUR RIGHTS AND OUR DEMANDS for learning

Appendix C
Mathematics Autobiography

Use the following guidelines to write a six-paragraph letter to me explaining your her/history and experience with mathematics. This letter is an opportunity for you to explore your identity as a math student (and growing mathematician!). Please neatly write *or* type your final letter. Stick to the letter format as shown below, and indent for every paragraph.

August _____, _____

Dear Ms. Candace:

Paragraph 1: My name is_____. I am ___ years-old, and I am a _____th grader at [our school name]. Add a few more sentences about yourself here!

Paragraph 2: What are your strengths and weaknesses as a student? For example, strengths are things you're good at, part of your personality that you are proud of, things people compliment you on, and so on. Weaknesses are areas where you want to learn more, get stronger, places where you struggle as a student, and so on.

Paragraph 3: What do you think about math? Do you like/love/enjoy math? Why or why not? Explain.

Paragraph 4: What have your math classes been like in the past? How did the last school year of math go for you? Do not only write about your grades but your *experiences* learning and with your teacher.

Paragraph 5: Why do you think math is important for you to learn? Think of all the reasons you can. Do you believe that math can be used to understand and change the world? Why or why not?

Paragraph 6: What are your goals for math class this school year? List all of them and explain why you are reaching for those goals. Explain *who* will help you to reach your goals.

Include anything else at the end of the letter that you would like to include.

Sincerely / Peace / Your student (pick one!),

_____
(Your signature)

Appendix D

Work Sheet – *If The World Were 100 People*

NAME: _____ DATE: _____ PERIOD: _____

If we could turn the population of the earth into a small community of 100 people, keeping the same proportions we have today, the village would look something like this …

# of people who …	Your Guess	The Data	Fraction (out of 100)	Reduce Fraction (If you can)	Decimal	Percent
are Asian		61	61/100	61/100	0.61	61%
are European		12	12/100	3/25	0.12	12%
are North American		8				
are South American/Caribbean		5				
are African		13				
are Oceanian		1				
are women		50				
are men		50				
live in urban areas		47				
are disabled		12				
are Christians		33				
are Muslims		21				
are Hindus		13				
are Buddhists		6				
are Sikhs		1				
are Jews		1				
are non-religious		11				
practice other religions		11				
are Atheists		3				
live without basic sanitation		43				
live without an improved water source		18				
own 75% of the entire world income		20				
are hungry or malnourished		14				
can't read		12				
have a computer		12				
have an internet connection		8				
lives with HIV/AIDS		1				
live on less than $1.25 per day		21				

Appendix E
Inequalities in Society

Names: _____

_____

Inequalities Project

In mathematics, we study inequalities – when values are NOT equal to each other. The word "inequality" also takes on an extremely important meaning in our world.

Inequality =

- lack of equality;
- unequal or uneven;
- when groups of people in a society do not have the same rights or social status;
- when socially-defined categories of people (such as gender, age, 'class,' race, sexual orientation, immigrant status, ability, weight, etc) influence people's opportunities in life and access to social goods such as healthcare, education, employment, home ownership, and political representation and participation.

This inequality project will connect what we are learning about mathematical inequalities (less than, greater than, etc) to the inequalities that exist in our society today.

There are eight different topics you may pick from. Think about what you are passionate about! Please rank your top three choices (1 = want it the most, 2 = second most, 3 = third most), and I will hopefully be able to give you one of those three.

_____Gender and the Media

_____Child Poverty During Economic Recessions

_____Pathway to College

_____Income of People With and Without Disabilities

_____Income and SAT scores

_____Income and Health

_____Race and Incarceration

_____Unemployment in California