



Addressing Dilemmas of Social Justice Mathematics Instruction through Collaboration of Students, Educators, and Researchers

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Introduction

Social justice mathematics educators explicitly aim to develop students' sociopolitical consciousness in addition to teaching mathematics content (Gutiérrez 2013; Gutstein 2006). Sociopolitical consciousness refers to Paulo Freire's (1970) concept of *conscientização*, or learning to perceive social, political, and economic contradictions (35). In this paper, I provide a definition of Social Justice Mathematics. I explore three dilemmas that arise with SJM instruction and suggest ways in which collaboration among students, educators, and researchers may address these dilemmas.

What is Social Justice Mathematics?

Social Justice Mathematics, SJM, relies on a definition of social justice that focuses both on redistributing resources and recognizing marginalized groups as equals. Basok, Ilcan, and Noonan (2006) define social justice as "equitable distribution of fundamental resources and respect for human dignity and diversity, such that no minority group's life interests and struggles are undermined and that forms of political interaction enable all groups to voice their concerns for change" (267). Critical theorist Nancy Fraser's (1996) *bivalent* approach to justice is a useful framework that aligns with Basok et al.'s definition of social justice. This bivalent approach to justice emphasizes that both *redistributive justice*, or equitable distribution of fundamental resources, and *recognition justice*, or respect for human dignity and diversity with all groups having a voice, are necessary to achieve social justice.

Social justice mathematics has various definitions in the research literature (Bartell 2013; Gonzalez 2009). SJM may also be referred to as critical mathematics or teaching math for social justice. For the purpose of this paper I define SJM with three components.

1) Students and teachers use mathematics to empower those who are marginalized by the dominant paradigm.

By “dominant paradigm” I refer to systems and structures that contribute to a host of inequities, both within and outside of formal education. Within education, inequities in student achievement, course rigor, teacher quality, and disciplinary practices continue to adversely affect poor people and people of color (Anyon 1980; Haycock 2015; Flores 2007; Peske and Haycock 2006; The Education Trust 2014). In addition, poor people and people of color face a variety of civil rights injustices outside of education, such as, but not limited to: racial profiling, police terrorism, and inaccessibility of hospitals, super markets, and green recreational spaces (Harris 1999; Scott 2013; Swaine, Laughland, and Lartey, June 1, 2015; Walker, Keane, and Burke, 2010).

In his (1970) book *Pedagogy of the Oppressed*, educator and philosopher Paulo Freire contends that the current banking model of education, where knowledge is considered “a gift bestowed by those who consider themselves to be knowledgeable upon those whom they consider to know nothing,” (72) serves the oppressor who intends to prepare students to accept their situation as the oppressed. Freire stresses the importance of learning to “read the world” to gain *conscientização*, or sociopolitical consciousness, in order to “write the world,” or change the world. “Reading the world” encompasses the traditional educational goal of literacy along with the social justice goal of gaining *conscientização* (Freire and Macedo 1987).

Critical math education scholar Rico Gutstein builds on Freire’s concept of *conscientização*, or developing sociopolitical consciousness, in order to read and write the world with mathematics. Gutstein’s (2006) book is titled with these terms – *Reading and Writing the World with Mathematics: Toward a Pedagogy for Social Justice*. Gutstein defines reading the world with mathematics as using “mathematics to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences” (26). He defines writing the world with mathematics as “changing the world” (27). Reading and writing the world with mathematics refers to goals within formal education – to learn mathematics, as well as goals outside formal education – to use mathematics to change the world.

Like critical pedagogy (Duncan-Andrade and Morrell 2008) and social justice pedagogy (Ayers, Hunt, and Quinn 1998; Gutstein 2006), SJM goes beyond incorporating instructional strategies into one’s practice, such as culturally relevant pedagogy (Ladson-Billings 1995) or culturally responsive pedagogy (Gay 2010). It differs from culturally relevant and culturally responsive pedagogy because of its explicit focus on addressing hegemonic practices that marginalize a specific group of people (Gutiérrez 2002; Gutstein 2006; Leonard et al. 2010).¹

For example, in a seventh-grade math project conducted by Gutstein (2007), “Will development bury the barrio?” students used mathematics to analyze a developer’s claims that a new housing complex would create jobs for the community and offer “affordable housing.” Mathematics allowed them to investigate how affordable the homes would be for their families and whether the potential new jobs would outweigh family displacement. Students then took action through participation in rallies and city hall hearings to oppose the proposed development. As illustrated by this example, students can be empowered within formal education by learning traditional mathematics (e.g. statistics, percent increases), and empowered outside formal education by applying their mathematics to advocate for social change (e.g. participating in actions at city hall).

An eighth-grade SJM project developed by teacher Jana Dean involves investigating minimum wage to learn linear functions (Gutstein and Peterson 2013). Students model earnings where y represents wages and x represents hours. Students model the earnings of different professions where the hourly wage is represented by the slope, and expenses (e.g. cost of a required uniform that the employee must purchase) are represented by the y -intercept as a negative number. The professions that students investigate are service sector positions that many members of Jana Dean’s students’ community hold, such as a retail clerk, security guard, and home nursing aide. By investigating the different hourly wages and comparing living expenses to the minimum wage, students learn that the minimum wage is not sufficient to be a living wage, or the hourly rate necessary to raise a family when working forty hours per week. Students can then use mathematics to build arguments to advocate for a living wage in their own community. This is especially powerful for students with families who struggle to make ends meet because of the wages they earn in comparison to the cost of living.

SJM’s use of mathematics to empower those who are marginalized by the dominant paradigm can be engaged in by both “historically marginalized” students and “mainstream” students. I use the term students of “historically marginalized,” or “nondominant,” backgrounds to refer to students who are adversely affected by the dominant paradigm – both within education (e.g. inequitable access to quality teachers, resources, cognitively demanding instruction, and fair disciplinary practices) and outside of education (e.g. racial profiling, subprime mortgage lending practices, police terrorism, and inaccessibility of hospitals, super markets, and green recreational spaces). Historically marginalized, or nondominant, students are often African American, Latina, Native American, Southeast Asian American, and poor students (Gutiérrez 2002, 2012; Stinson 2008; U.S. Census 2004). I use the word “mainstream” to refer to students who have been offered greater opportunities, within and outside of formal education, often affluent and/or white students. This paper focuses primarily on considerations to empower historically marginalized students.

2) Rigorous mathematics is actively offered to all students.

SJM involves increasing the rigor of mathematics for students, focusing on marginalized students who have been historically denied such opportunities. All students should be offered opportunities to engage in challenging and rigorous mathematics and enroll in advanced math courses (Moses and Cobb, 2001).

I include the word *actively* because SJM is about more than “access.” For instance, a school cannot expect to achieve equity and success by suddenly offering all high school seniors the opportunity to enroll in Advanced Placement Calculus if the students’ kindergarten through high school mathematics instruction did not prepared them for such a course. This is especially true for historically marginalized students who often attend under-resourced districts, with minimal curricular resources, and with teachers without certification or a major or minor in math or a math related field (Darling-Hammond and Skyes 2003; Peske and Haycock 2006). In addition, many students have been sorted into learning tracks that limit their opportunities to learn advanced mathematics (Oakes 1990). Rather, schools must prepare students throughout their K-12 educational careers for mathematical rigor. Even high schools, which cannot influence students’ K-8 math experiences, can work to offer students rigorous mathematics by creating double-blocked math classes, providing math electives, and facilitating after-school math programs to “catch students up.”

Increasing mathematical rigor for students may also require school- and/or district-wide structural changes to course placement and course completion policies. San Francisco Unified School District has detracked its math courses and revamped the middle and high school math course sequencing to offer multiple pathways to advanced courses (San Francisco Unified School District Math Department 2015; The Education Trust West 2015). Detracking has been found to improve student achievement, both for students assigned to the lower track and the higher track courses (Boaler and Staples 2008; Boaler, William, and Brown 2000; Burris, Heubert, and Levin 2006; Oakes 1990). This offers more equitable opportunities for students to enroll in advanced math courses, rather than the tracked course sequence that prevents students’ ability to take advanced level mathematics.

To actively offer rigorous mathematics to students also means that pedagogical practices may need to be changed to include those that are more equitable. For example, Complex Instruction, a form of groupwork for academically heterogeneous groups, has been found to decrease the achievement gap, increase relational equity (the ways in which students treat each other and their ideas with respect), and improve achievement for all students (Boaler 2008; Boaler and Staples 2008). Teachers may need training and support to engage in equitable pedagogical practices that may be new to them. Supporting teachers’ development may include building time into the school day for teachers to collaborate, providing necessary funds for teachers to participate in ongoing training, and offering leadership opportunities for teachers. In some schools, dedicated and qualified math teachers may need to be recruited and retained. Most

importantly, actively offering rigorous mathematics to students involves teachers’ belief that all students can achieve, a political stance of SJM educators.

3) The classroom community is a co-constructed space.

If SJM educators aim to disrupt the dominant paradigm, they must begin with sharing their power and authority with their students (Freire 1970; Gutstein, 2006). This represents both a pedagogical strategy and political stance. I draw on critical mathematics education scholar Rochelle Gutiérrez’s articulation of this political stance in her (2013) article, *The Sociopolitical Turn in Mathematics Education*. This sociopolitical turn involves changing theoretical perspectives to challenge prevailing notions of identity and power. That is, mathematics as a subject itself has been conceptualized as a rational universal arbiter of truth; therefore, individuals who are successful in this paradigm are conferred status. Instead, a sociopolitical turn recognizes that identity is an ongoing instantiation of cultural production and that power is not a possession, but rather, is negotiated through social discourses.

To create a space where students develop their own ways of knowing and understanding mathematics, classroom norms should foster collective inquiry rather than conceptualizing the teacher (or a textbook) as the authority figure of “correctness” or mathematical sophistication. SJM teachers must develop *sociomathematical norms*, or classroom social norms specific to mathematics, around what counts (and who decides – students and teachers should collectively decide) as mathematically elegant, mathematically efficient, mathematically sophisticated (Yackel and Cobb 1996, 461). This type of approach to teaching mathematics – through collective discovery, discussion rather than teacher dissemination of knowledge, and open-ended problem solving – is also characteristic of the larger “reform” and equity efforts in mathematics (Gutiérrez 2002; Mathematics Learning Study Committee 2002). SJM goes beyond these efforts to include critical investigation of the world and of power structures. It is important to note that students should be allowed to develop their own conclusions and opinions, not coaxed toward a particular political stance or viewpoint through SJM.

Dilemmas of Social Justice Mathematics Instruction

Several dilemmas arise when bringing SJM instruction to the classroom. I describe three dilemmas and consider how they may be addressed through collaboration of students, educators, and researchers. While offering suggestions around how collaboration may address dilemmas of SJM instruction, this paper largely raises more questions than it offers solutions. I hope these questions may spark new ideas, deeper questions, and motivate us to continue to engage in this work.

1) What constitutes student success?

The first dilemma of SJM instruction is that teachers must navigate multiple goals. They aim to empower their students to critically analyze the world with mathematical tools while simultaneously meeting formal educational goals, such as passing state standardized exams, earning good grades, and

pursuing STEM field majors and careers. This tension is best captured by the question, "What constitutes student success?"

If a student uses mathematics to save his or her home from being demolished through advocacy work with city officials, but the student does not pass the required math exit exam, would this student be considered successful through the lens of SJM? Conversely, if a student passes the required math exit exam but does not understand how mathematics may be used for social change, would this student be considered successful?

Rochelle Gutiérrez (2002) argues that both goals are important and complementary to each other. She refers to the "mathematics that supports the status quo," tested in high stakes exams, and privileges perspectives of an elite group as *dominant mathematics*, whereas *critical mathematics* explicitly challenges dominant mathematics, exploring issues of power and highlighting contributions and perspectives of marginalized groups (150-151). "The learning of dominant mathematics may serve as an entrance for students to critically analyze the world (using mathematics), and being able to critically analyze the world with mathematics may be an entrance for students to engage in dominant mathematics" (152).

Similarly, Gutstein (2006) also describes two complementary goals of SJM— with *mathematics pedagogical goals*, or succeeding academically in the traditional sense, and *social justice pedagogical goals*, or developing positive cultural and social identities (23). "An emancipatory education does not neglect disciplinary knowledge. In fact, learning specific subjects such as mathematics helps one better understand the sociopolitical context of one's life" (40-41). Yet he makes clear that he disagrees with the "position that urges increased access to mathematics opportunities, but that simultaneously leaves unchallenged the very structures that created the injustices" (30).

Gutiérrez and Gutstein's approaches align with Fraser's bivalent approach to justice, where a redistributive approach to justice, or being successful through performance with dominant mathematics, and a recognition approach, or dismantling the dominant paradigm to gain equitable recognition of historically marginalized groups, are simultaneously pursued. While many teachers who use SJM firmly believe in the importance of both goals, the day-to-day reality of classroom work forces teachers to make tough decisions – when pressed for time, when an exit exam approaches, and/or when submitting lesson plans to administrators.

Critical math education professor Susan Gregson (2013) highlights these challenges through her case study of one eighth-grade math teacher who used SJM in her classroom in a school with primarily nondominant students, Mrs. Myles. Mrs. Myles engages students in a math project about the criminalization of youth to investigate trends in the demographics of police stops, through students' data collection and analysis. She worries about whether or not the project is "mathy enough" (186). Mrs. Myles tries to design the project so that the mathematics required to analyze the data is also the mathematics tested on the standardized exam.

She also worries about "crunch time;" (190) of having enough instructional days to engage in the criminalization project and also prepare students for the exam. Ultimately, she was not able to complete the criminalization project, because it required a significant amount of instructional time that she felt she needed to address more math topics to prepare students for the standardized exam. She instead discussed issues of the criminalization project in her advisory class, a non-math class similar to homeroom.

The relationship between dominant mathematics goals (or, as Gutstein refers to them, as the mathematics pedagogical goals) and critical mathematics goals (or social justice pedagogical goals) may not be as complementary as theorized. In actual teachers' classrooms, the constraints of time and pressures of testing often force teachers to prioritize one goal over the other. In Mrs. Myles's case, the "crunch time" pressure to prepare students for the standardized exam trumped her goal of fully engaging students in the criminalization project.

In addition to the tension between dominant and critical mathematics goals, students of historically marginalized backgrounds must also manage their cultural identities and their identities as mathematicians (Martin 2006, 2007). How can nondominant students maintain positive racial identities while achieving within traditional formal mathematics education, or achieving with their knowledge of dominant mathematics (e.g., gaining high test scores, earning good grades, pursuing STEM careers)?

Critical race scholar William Tate (1995) poses the question, "Is it possible to develop high-level mathematical competence for African American students within a Eurocentric paradigm?" Tate suggests exploring mathematics possibilities within the Africentric paradigm and within the practices of culturally relevant pedagogy, rather than attempting to fit within the Eurocentric paradigm, which I argue corresponds to the "dominant paradigm" previously defined, or dominant mathematics as defined by Gutiérrez.

This question has been asked repeatedly. Gloria Ladson-Billings (1994) reiterates W.E.B. Dubois's question from 1935, "Does the Negro need separate schools?" in her book *The Dreamkeepers: Successful Teachers of African American Children*. A similar question was posed by critical language and literacy scholar Kris Gutiérrez at an Equity in Math Education conference, "Do I get to become a better me or do I have to become you?" Rochelle Gutiérrez (2002) refers to Kris Gutiérrez's question when posing her own, "Can we call it equity if students are expected to give up their cultural identities to participate in society?"

A bivalent approach to justice is a helpful framework to analyze Tate's, Dubois's, Gutiérrez's, and Gutiérrez's questions, where consideration of both redistribution and recognition approaches to justice are necessary. If a historically marginalized student is successful as measured by distributive means, by achieving in the dominant paradigm (e.g., by achieving high test scores or by acquiring lucrative post college employment earnings in a STEM career), can he or she achieve this success while maintaining a positive racial identity? To achieve justice, a student should be able

to achieve success while maintaining and celebrating his or her racial identity. Redistribution approaches cannot be considered without addressing recognition conceptions of justice, such as students' of nondominant backgrounds retaining their identities while achieving traditional academic success in mathematics.

University researchers, teachers, administrators, and youth may work together to discuss these dilemmas. How do educators manage dominant mathematics goals with critical mathematics goals? How can students of historically marginalized backgrounds be successful in the current education system while still maintaining positive identities? These conversations should be non-hierarchical, where adults learn from youth, youth learn from adults and each other, and all parties learn from each other's vastly different perspectives. Youth in particular, and especially youth of historically marginalized backgrounds, may be empowered by opportunities to share their perspectives with researchers, teachers, and administrators about their experiences in formal mathematics classrooms.

2) What is the curriculum for SJM instruction?

Second, is the dilemma of the actual SJM curriculum, or the projects and activities to be developed for one's students. SJM involves interrogation of problems relevant to students' lives. For example, students may wish to map and examine the availability of grocery versus liquor stores in their community, providing opportunities to teach statistics, geometry, and ratio and proportion.

Students themselves should choose the social issue they wish to investigate and use mathematics to analyze and take action to solve such problems. This empowers students and fosters a co-constructed classroom space, rather than the teacher choosing and designing a mathematics project around a social issue he or she finds relevant. Students may need coaching to feel comfortable sharing ideas if this is their first experience with a co-constructed classroom. Teachers may benefit from coaching and support to create productive frameworks and guidelines for new ways of working and relating in the classroom (Boaler 2006; Gregson 2013; Gutstein 2006).

However, a great amount of time, content expertise, and creativity are needed to design a SJM lesson or project based on students' interest. Mrs. Myles, the eighth-grade math teacher from Gregson's (2013) study clearly captures this dilemma, "I can't run eighth grade math as [students] choose the topics and I figure out how to do all the math we need for the standardized test...I don't have sufficient background for that and that would take so much time I just don't know how I would ever do it" (8).

Teachers may also need knowledge of other pedagogical techniques (e.g. Project Based Learning, Complex Instruction) to aid their SJM instruction. Some books and programs provide good starting points for SJM lessons and projects (e.g. Rethinking Mathematics, Creating Balance in an Unjust World, The Algebra Project, Young People's Project, RadicalMath.org, Mathematics in Context, Mathematics Modeling Our World), but the topics, issues, and contexts of exploration must still

be initiated by students themselves. Students' interests are sensitive to place and time; the social issue relevant to one group of students may or may not be relevant to another group of students. This of course is further complicated by district and state mandates, especially with the introduction of Common Core State Standards and their associated standardized tests (e.g. Smarter Balanced, PARCC).

In addition, the mathematics required to pursue students' nominated investigations may or may not align with the mathematics of their grade level. For example, to map and examine the availability of grocery versus liquor stores in the community, a teacher can teach statistics, geometry, and ratio and proportion. However, for a high school upper grade class the mathematics may not be rigorous enough, or as Mrs. Myles called it "mathy enough" (Gregson 2013, 186). On the other hand, if students are interested in exploring subprime mortgage lending and foreclosure rates, they may need to understand discrete dynamical systems, as Gutstein's students learned in a twelfth grade math course (Gutstein 2010). In this case the math may be too difficult depending on the grade level of students.

Opportunities for collaboration to develop SJM lessons and projects are helpful, with teams of teachers themselves and/or with outside guests from local universities. Professors and students in graduate schools of education can assist in SJM teachers' development of such projects. This is not to suggest that teachers need help, rather the input of others who may have more time may help SJM project development. Of course, student input comes first and foremost as their ideas for investigations of social issues relevant to their lives build the foundation of the SJM lessons and projects.

3) How can teachers possess sociopolitical consciousness?

When developing SJM lessons and projects, teachers (and professors and graduate students if they collaborate with teachers) must have an awareness of students' lives. However, professors, doctoral students, and SJM teachers themselves may or may not live in students' neighborhoods and may or may not possess the sociopolitical consciousness needed to create meaningful SJM projects.

Critical mathematics scholar Danny Martin raises questions of teacher consciousness in his (2007) article *Beyond Missionaries or Cannibals: Who should teach mathematics to African American children?* This question is relevant for nondominant students of many backgrounds, particularly because most nondominant students are taught by mainstream teachers. In 2008, the U.S. population of children of color was 44% and is projected to be 62% by 2050 (U.S. Census Bureau 2008). The American teaching force is 84% white, according to 2007-2008 National Center for Education Statistics data, with a pipeline of bachelor's degree teacher candidates, 82% of which are white, who will enter the field, according to 2009-2010 data (AACTE 2013).

Martin (2007) argues that teachers' racial competence and their commitment to anti-oppressive, anti-racist teaching are just as important as their mathematics content knowledge. He stresses that teachers of African American students should develop a deep understanding of the social realities

experienced by his or her students (10). In this paper, I broaden the discussion to include students of historically marginalized backgrounds.

To be clear, teachers of all backgrounds can teach students of all backgrounds. However, if teachers were raised in contexts and communities very different from their students, how shall they gain this deep understanding of the social realities of their students without tokenizing, essentializing, or objectifying them? (Delpit 1988; Hilliard 1991; Tate 1995). Should teachers who share backgrounds with their students, without mathematics content knowledge, be recruited to pursue mathematics teaching? What about those teachers who may share the same racial ethnic background but do not believe that the current power structure should be questioned? I believe that all of the above are important issues to address. Teachers of all backgrounds should strive to develop a deep awareness of their students' lives, in addition to the contributions that each student brings to the classroom (Turner et al. 2012).

Students of all backgrounds and socioeconomic levels bring a wide variety of experiences and contributions to the classroom. Strong relationships with students and their families can help teachers design relevant SJM activities and establish a co-constructed classroom space. Teacher-student relationships may also help SJM educators recognize the strengths and contributions of each student. By contributions, I am not referring to celebration of students' cultures with a tokenized "food and festivals" or "heroes and holidays" approach (Ladson-Billings 1994; Meyer and Rhoades 2006). Rather, I refer to students' contributions that lead to success in both dominant and critical mathematics (e.g., their ability to persevere, to think critically, to think outside the box, and growth of collaboration and/or presentation skills, commitment to learning at lunch and after school, and commitment to their classmates and to their communities) while also being sensitive to students' backgrounds.

Students may be able to help teachers gain sociopolitical consciousness. This is an effective way to cultivate a co-constructed classroom space because students take the lead as experts. For instance, the Chicago Grassroots Curriculum Taskforce offers a community tour project where students design and host a community tour, highlighting sites of cultural importance and strengths of the community (Chicago Grassroots Curriculum 2015). The community tour is intended for students to guide their teachers, many of whom do not live in and did not grow up in students' communities. Teachers may gain sociopolitical consciousness by learning from students on the community tours. Teachers may also improve their sociopolitical consciousness by learning from students' parents and other community members.

I have used the community tour in my own work as a university researcher. My colleagues and I have been working with a group of five math teachers to co-design a sixth-grade project-based learning math curriculum. One of our units is a community tour unit inspired by the Chicago Grassroots Curriculum Taskforce. Students choose a location of their choice to lead a tour and learn about ratio and proportion through calculating time to travel the tour after finding their

own walking rate. They also apply ratio and proportion to their creation of scaled maps, while strengthening their geometry skills. This is an example of a long-term university-school partnership (the partnership is three years), where researchers work to create and cultivate a co-constructed, nonhierarchical space with teachers. Researchers visit teachers' classrooms on a regular basis, teachers confer with their students to gain their input on the projects, and teachers meet regularly with university team members to develop the curriculum collaboratively. Interviews indicate that teacher partners "feel needed by the university partners," that their opinions and classroom experience are valued, that they are "on the same level," and that there is "an equal platform." (Kokka, Malamut, and Mok 2015). While this project does not focus on SJM instruction, it offers one example of collaborative possibilities with universities and K-12 schools to address the second dilemma of creating SJM lessons and projects.

Not only does a community tour project offer a way for teachers to gain sociopolitical consciousness, but it establishes a co-constructed classroom space where students take leadership roles as experts about their own communities. Likewise, university researchers must gain sociopolitical consciousness by listening to teachers and students. This is only one idea for improving teachers' sociopolitical consciousness. Researchers, teachers, administrators, youth, and their families can think creatively to create collaborative spaces to tackle dilemmas of SJM instruction together. This not only helps resolve dilemmas of SJM instruction, but strengthens the collaborative and co-constructed philosophy underlying SJM to empower students to achieve with dominant and critical mathematics.

Conclusion

All students should be able to achieve mathematics success and empowerment while improving their sociopolitical consciousness and cultivating positive racial identities. I have outlined three goals of SJM: student empowerment, engagement in rigorous mathematics, and learning in co-constructed classrooms. These goals bump up against the three dilemmas of SJM: tensions of SJM goals for student success, SJM project and curriculum development, and teachers' sociopolitical consciousness. These dilemmas may be addressed through collaboration of students, educators, and researchers to empower students to succeed in both dominant and critical mathematics.



Endnote

¹ Teachers can also share the mathematics contributions of diverse groups of people, often referred to as ethnomathematics (d'Ambrosio, 1985, 2001). Discussion of ethnomathematics is beyond the scope of this paper, but is necessary to mention this field of study as it is relevant to SJM.

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