



Bank Street

Occasional Paper Series

Occasional
Paper
Series

Volume 2019
Number 41 *Critical Mathematical Inquiry*

Article 1


March 2019

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Recommended Citation

Greenstein, S., & Russo, M. (2019). Teaching for Social Justice through Critical Mathematical Inquiry. *Occasional Paper Series, 2019* (41). Retrieved from <https://educate.bankstreet.edu/occasional-paper-series/vol2019/iss41/1>

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Teaching for Social Justice through Critical Mathematical Inquiry

Steven Greenstein and Mark Russo

Mathematics education, like all disciplines of learning, sits within larger fields of social, cultural, and political beliefs and practices. As we think about the range of these beliefs and practices, we can imagine a linear spectrum of teaching, including mathematics teaching, with each point on the spectrum representing a set of often unacknowledged assumptions about the nature of teachers, students, knowledge, and authority.

At one end of this spectrum, imagine traditional, lecture-based teaching. Teachers are positioned as the knowledgeable ones, and students are positioned as compliant recipients of that knowledge. Teachers act with authority, and students are acted upon. This is where many of us spent most of our time when we were students in school.

Moving toward the other end of the spectrum, teaching becomes more oriented to inquiry. Pedagogy is informed by the tenets of a constructivist theory of learning, which assumes that we are not blank slates. Nor is knowledge passively received. Instead, learning is understood as a constructive process. As we wander the world and engage with it, we construct new knowledge as we make sense of and organize our experiences.

This model of knowing and learning calls for a pedagogy that immerses learners in experiences that support them to figure out—by thinking and reasoning, and reflecting upon their own thinking and reasoning—how to make sense of these experiences. It is an inquiry pedagogy, which recognizes existing knowledge as the basis for new learning and which is oriented to learners as knowers. Knowledge, then—cultural, conceptual, experiential, and linguistic knowledge—is regarded as a resource for learning. This is the interval of the pedagogical spectrum in which we, the readers of the *Occasional Paper Series*, begin to do our work.

Now, even further along the spectrum is where we situate *radical* teaching. We use “radical” as Jean Anyon did (2014), to refer to teaching that addresses the root causes of injustice. *Critical education*, as Ole Skovsmose (1994) describes it, is the purview of radical teaching. He writes, “If education, as both a practice and a research, should be critical it must discuss basic conditions for obtaining knowledge, it must be aware of social problems, inequalities, suppression etc., and it must try to make education an active progressive social force” (pp. 38-39). This is the interval of the spectrum where lowercase-critical thinking (e.g., making sound judgments) joins uppercase-*Critical* thinking (e.g., analyzing forms of authority and injustice) as teaching and learning center on issues of equity, diversity, democracy, and social justice.

The teacher, then, is one who understands the political nature of schooling (Gutiérrez, 2013) in terms of how power, access, oppression, and inequality cooperate (Picower, 2012). The teacher’s role is to support and advocate for students’ inquiries into the “inequities in the social order” (Cochran-Smith et al., 2009, p. 352), with an eye toward “transform[ing] society into a place where social justice can exist” (Westheimer

& Suurtamm, 2008). Teaching is not only about leveraging students' knowledge as a resource for learning, it is about positioning them as agentive intellectuals (Freire & Freire, 1994) who are oriented through a humanizing inquiry (Freire, 1970/2000) to posing and pursuing questions that have them "critically analyze and challenge oppressive relationships to create more just and inclusive alternatives" (Picower, 2012, p. 1). These are the purposes of critical education. Approaches to *teaching mathematics for social justice* are models of critical education, and *critical mathematical inquiry* is one of them.

Introducing Issue 41

Welcome to Issue 41 of Bank Street's *Occasional Paper Series*. The issue features a collection of papers by authors with a shared affinity for the work of critical mathematical inquiry (CMI). In what follows, we present our framing of mathematics education as a participatory venue for CMI and situate it in the context of another, perhaps more familiar approach to teaching mathematics for social justice (TMfSJ).

We'd like to briefly introduce ourselves and our positions in relation to this work. I (Steven Greenstein) was once a high school mathematics teacher and am now a professor at Montclair State University in northern New Jersey. I (Mark Russo) was also a high school mathematics teacher and now serve as a mathematics supervisor in the Pascack Valley Regional High School District, also in northern New Jersey. Our shared passion for critical mathematical inquiry has developed over the course of our professional careers, most notably in response to students' experiences in schools that attribute their (lack of) performance to deficit explanations or that alienate them by positioning them as compliant objects of instruction centered in curricula they did not choose. We've found the promise of CMI in our responses to these phenomena, including the co-construction of interest-driven, problem-posing, and culturally relevant mathematics curricula. These activities have served to broaden what it means to do mathematics and changed the nature of student agency, engagement, and participation. We invite you to explore this shared passion for CMI through the contributions to this volume. At the end of this introduction, we also offer readers links to curricular resources that we have found useful in our own preparation to teach mathematics for social justice.

Introducing Critical Mathematical Inquiry

We frame critical mathematical inquiry in the following way:

- **Critical:** an interrogation of systems of power, privilege, and oppression that strives to remedy political, educational, economic, and social inequities and injustices.
- **Mathematical:** powerful forms of thinking and reasoning that include pattern-seeking, conjecturing, connecting, experimenting, generalizing, visualizing, representing, and proving.
- **Inquiry:** an approach to knowing and understanding mathematics that draws on and builds upon learners' current knowledge by exploring the mathematical world, asking questions, solving problems, testing theories, validating ideas, and explaining relationships.

Like many others who engage in the work of teaching for social justice, we trace the roots of the journey

we're on to Paulo Freire's *Pedagogy of the Oppressed* (Freire, 1970/2000). Freire's analyses of issues of power and oppression, agency and alienation, and the inequitable distribution of resources and opportunities are profound. His foundational text offers threads of a theory of critical pedagogy and a language one can use to articulate the purposes of public education in the context of the myriad inequities and injustices faced by students, their families, and their communities. One such thread is Freire's conception of literacy (Freire, Freire, & Macedo, 1998), which is social and expressive as opposed to hyper-individualistic and mechanical:

To acquire literacy is more than to psychologically and mechanically dominate reading and writing techniques. It is to dominate these techniques in terms of consciousness.... Acquiring literacy does not involve memorizing sentences, words, or syllables—lifeless objects unconnected to an existential universe—but rather an attitude of creation and re-creation, a self-transformation producing a stance of intervention in one's context. (p. 86)

A second thread is Freire's concept of praxis, which refers to the “the action and reflection of men and women upon their world in order to transform it” (1970/2000, p. 79). Henry Giroux (1981, as cited in Frankenstein, 1983) defines the concept as:

a critical mode of reasoning and behavior...[that] functions so as to help people analyze the world in which they live, to become aware of the constraints that prevent them from changing that world, and, finally, to help them collectively struggle to transform that world (pp. 114, 116).

The concept of praxis reminds us that confronting an injustice requires more than coming to understand it; it requires action to remedy it. In the same way, teaching math for social justice cannot be only about consciousness-raising curricular experiences, it must also involve a planned and executed course of action.

Teaching Mathematics for Social Justice

Just as many social justice educators have traced the intellectual roots of their work to Freire, many of us who teach mathematics for social justice trace the foundations of that work to Rico Gutstein's *Reading and Writing the World with Mathematics* (2006). In this section, we build up a model of teaching mathematics for social justice from Freire to Gutstein. In the section that follows, we lay out the distinctions we've made between Gutstein's framing of teaching mathematics for social justice (TMfSJ) and our framing of critical mathematical inquiry (CMI).

Freire's conception of literacy is embedded in his notions of reading the world and writing the world (Freire & Macedo, 1987). Reading refers to deepening one's “understanding [of] the sociopolitical, cultural-historical conditions of one's life, community, society, and world” (Gutstein, 2006, p. 24). “Freire's theory,” writes Marilyn Frankenstein (1983), “compels mathematics teachers to probe... the connections between our specific curriculum and the development of critical consciousness” (p. 324). Mathematical illiteracy was a concern for Frankenstein, who warned us that “a mathematically illiterate populace can be convinced, for example, that social welfare programs are responsible for their declining standard of living, because they will not research the numbers to uncover that ‘welfare’ to the rich dwarfs any meager

subsidies given to the poor” (p. 327). She proposed that a critical mathematics education could challenge students to question the ideologies below the surface of such contradictions (p. 329). This is the work of preparing for engagement in social movements, or writing the world.

Writing, then, is an instance of Freirean literacy, which is about transforming the world by means of “conscious, practical work” (Freire & Macedo, 1987, p. 35). Together, reading (reflection) and writing (action) constitute the dual processes of praxis. Gutstein’s model of teaching mathematics for social justice (TMfSJ) relies on these dual processes and entails both mathematics and social justice pedagogical goals (see Figure 1).

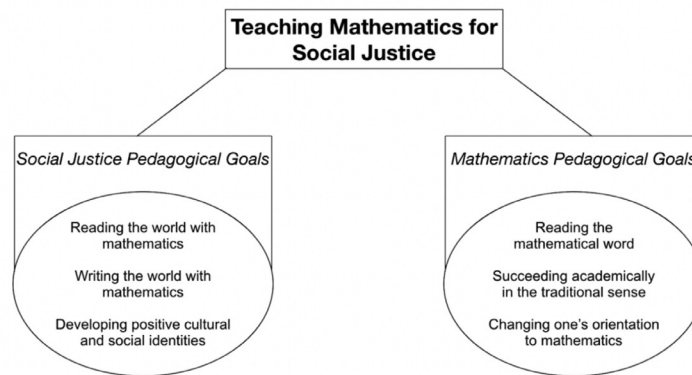


Figure 1. Eric Gutstein’s model of teaching mathematics for social justice (recreated from Gutstein, 2006, p. 23)

Gutstein’s (2006) mathematics pedagogical goals are reading the mathematical word, succeeding academically in the traditional sense, and changing one’s orientation to mathematics. Reading the mathematical *word* (as opposed to reading the world with mathematics, which we explain below) means developing mathematical power, which has been defined either in reference to the National Council of Teachers of Mathematics’ (NCTM’s) (2000) *Principles and Standards* (e.g., students’ capacities to engage in complex mathematical tasks, demonstrate flexibility in problem-solving, communicate ideas and results effectively) or to the National Research Council’s (2001) five strands of mathematical proficiency: conceptual understanding, procedural fluency, strategic competence, productive disposition, and adaptive reasoning.

“Succeeding academically in the traditional sense,” for Gutstein, “means that students achieve on standardized tests, graduate from high school, succeed in college, have access to advanced mathematics courses, and pursue (if they so choose) mathematics-related careers” (p. 30). This particular form of success is important to Gutstein, because students have historically been marginalized and excluded. This includes even those who *have* developed the requisite mathematical power but do not perform well on tests.

While we’re on board with Gutstein in terms of the importance of ensuring that students remain centered and included, we propose a broadened framing. Mindful of the range of ways that people move through the world after—and even without—high school, we want students to accomplish whatever mathematical tasks with which they engage.

Finally, changing students' orientation to mathematics means changing their understanding of the nature of mathematics as a collection of disconnected procedures to be memorized and regurgitated, to seeing it as a powerful tool for analyzing and understanding complex, real-world phenomena.

Gutstein's model has social justice pedagogical goals, as well, and this is where it derives its particular power. These include reading the world with mathematics, writing the world with mathematics, and developing positive cultural and social identities. Reading the world with mathematics is about using mathematics to "understand relations of power, inequitable distributions of resources, and disparate opportunities between different social groups, and to understand explicit discrimination based on race, class, gender, language, and other differences" (Gutstein, 2003, p. 45).

Writing the world with mathematics means using mathematics to change the world—and, in doing so, developing a sense of social agency and seeing oneself as capable of making change (Gutstein, 2003). As an example, Gutstein offers William Tate's (1995) work with students who wrote the world by presenting data-based arguments to their city council to confront the problem of a disproportionate number of liquor stores in their neighborhood.

Other examples of mathematics for social justice curriculum include "Home Buying While Black or Brown," "Sweatshop Accounting," and "The Geometry of Inequality," all of which appear in the edited volume, *Rethinking Mathematics*, by Rico Gutstein and Bob Peterson (2013). Links to additional resources appear at the end of this introduction.

Developing positive cultural and social identities, Gutstein's third social justice pedagogical goal, means grounding mathematics instruction in students' languages, cultures, and communities, while providing them with the mathematical knowledge they need to survive and thrive in the dominant culture (Gutstein, 2006). For this goal, Gutstein draws on Gloria Ladson-Billings' conception of culturally relevant pedagogy (1995), in particular, her notion of "cultural competence," which ensures that students are able to "maintain their cultural integrity while succeeding academically" (p. 476). Others also draw on the concept of funds of knowledge (Moll, Amanti, Neff, & Gonzalez, 1992) to enhance students' cultural and social identities.

Why CMI?

Gutstein's model of teaching mathematics for social justice (TMfSJ) is a powerful form of critical education. Indeed, it's so profound that just about any mathematics educator who regards the purpose of education as a tool for humanization and liberation draws on Gutstein to some extent. Then why the need for critical mathematical inquiry? We framed CMI as we did for several reasons. First, we wanted to emphasize that TMfSJ isn't only about curriculum. We offer you some curricular resources, but they don't fully constitute the essence of the work. Indeed, we regard curriculum as the experience (Dewey, 1938; Pinar, 2012) these resources can be used to generate—the *processes* of praxis and self-reflection. Furthermore, these resources are lessons grounded in an injustice identified by their authors, not by the students who will be using them. Written curriculum is a great starting point, but students' problem-posing is what's fundamental to Freire's liberatory, humanistic concept of education (1970/2000). It's also

fundamental to Gutstein’s model, and we want to emphasize it: TMfSJ is about supporting students as they pose and pursue their own inquiries. Moreover, we propose that *these inquiries need not be grounded in some injustice outside the classroom and in one’s community*. This is where our framing of CMI diverges a bit from the ways that teaching mathematics for social justice is commonly understood.

In TMfSJ, the mathematics used to identify and ultimately challenge injustice is applied mathematics, that is, the application of mathematics, such as statistics, to solving practical problems. In contrast, the mathematics of CMI can be pure, that is, the study of mathematics for its own sake, independent of application—as long as *the pedagogy is critical*. Critical mathematical inquiry can take place in the context of pure mathematics, because there are injustices that occur not just outside the classroom, but also inside the classroom, such as when students experience the mathematics curriculum as alienating or disenfranchising. A critical pedagogy is a powerful force with which to confront these inside-the-classroom injustices, which is why we framed the critical in CMI above to explicitly include efforts to remedy educational inequities and injustices.

Anita Wager (as cited in Wager & Stinson, 2012) describes moving beyond teaching mathematics *about* and *for* social justice to teaching mathematics with social justice. These pedagogical practices support a co-created classroom and a classroom culture that provides opportunities for equal participation and status. For example, we’ve found opportunities to enact a critical pedagogy when we’ve asked students to prove mathematical theorems such as *The product of three consecutive integers is divisible by 6*. The problem isn’t related to an injustice and it’s not real-world, but they understand what the theorem *means* and that allows them to engage, sometimes enthusiastically.

Similarly, we note that CMI generates a space for student-directed inquiry. At times, students are interested in pursuing problems unrelated to injustice. In keeping with the commitments of teaching for social justice, honoring students’ interests can be understood as a form of critical mathematics pedagogy. Furthermore, the moves and judgments we make as students pursue their inquiry, even within the space of a micro-moment of teaching—what Deborah Ball (2018) referred to as “discretionary spaces” in an AERA Presidential Address—have the potential to invite equitable and legitimate participation. They cultivate students’ sense of connectedness (Maloney & Matthews, forthcoming) and well-being (Kokka, 2018), develop their identities as doers of mathematics, and provide them with opportunities they can leverage to act with agency. Ultimately, these moves and judgments help us broaden what it means to know and do mathematics so that new students emerge as able. These are the features of a critical pedagogy conducive to teaching mathematics for social justice.

One final point about TMfSJ in regards to pure mathematics problems: Dennis Almeida (2016) makes the argument that mathematical-proving activity is democratic in nature, because proofs of theorems must be convincing to the entire classroom community. Indeed, in a mathematics pedagogy that emphasizes student argumentation over getting right answers, arguments are presented, students participate in a discussion about the proof, they critically examine it, challenges are made to its validity, strengths and weaknesses are identified, and ultimately the proof is improved. If the primary purpose of teaching mathematics is less about the content (e.g., you’ll never encounter a quadratic in the real world that can

be factored) and more about providing a context for powerful forms of logical thinking and reasoning, then we can imagine that critical interrogations like these prepare students to make informed judgments and decisions about consequential issues outside of school.

The Contributions to this Issue

Our goal for this issue is to provide a venue for teachers and teacher educators to share their images of learning as participation in critical mathematical inquiry (CMI). We pursue this goal so that we may collectively identify, explore, and generate new pathways for praxis at the intersection of mathematical inquiry and education for democracy and social justice, with a particular emphasis on what “doing mathematics” looks like when math is pursued for critical consciousness. In the Call for Papers, we framed CMI according to its three features, but we did not suggest its meaning. Instead, we aimed to generate a space in which contributors to the issue could do that with us. They have. And this is how they did it.

Two contributions to the issue leverage **theoretical and historical perspectives** to generate broadened conceptions of curricular experiences associated with CMI within the field of mathematics education. Fahmil Shah uses an analysis by Harouni (2005, 2015) to track how school mathematics has historically been dominated by a commercial-administrative agenda. He proposes that a socio-analytical approach to standards, curricula, and standardized assessments can transform school mathematics into a tool for social justice.

Mary Raygoza utilizes Westheimer and Kahne’s (2004) framework of personally responsible, participatory, and social justice oriented citizens to argue for the intersectionality of mathematics and civics education. For Raygoza, CMI invites students to understand, reveal, and inform action on issues of social inequality and requires math teachers to reimagine their classrooms as interdisciplinary spaces ripe for developing students’ quantitative civic literacy.

Three contributions to the issue focus on **features of a critical pedagogy** that support environments conducive to student participation in CMI. Debasmita Basu and co-editor Steven Greenstein demonstrate how tasks they refer to as “knowledge-eliciting mathematical activities” can help teachers build relationships with their students and make instruction more effective by drawing out their students’ home, community, cultural, and mathematical knowledge. Basu and Greenstein present two approaches they found to be productive through their work in a mixed-age middle school classroom, one involving modified *Would You Rather?* mathematical tasks and the other using a “contextual scaffold” grounded in a consequential community issue to bridge students’ at-home and in-school knowledge.

Frances Harper emphasizes two particularly effective instructional strategies—complex instruction and project-based mathematics—because “*how* students learn” matters just as much as “*what* they learn.” Harper draws on two food desert projects from a high school geometry class to illustrate how different pedagogical approaches position mathematical authority and ownership among the teacher and students.

Lynette Guzman and Jeffrey Craig explore how incorporating students' funds of knowledge, deconstructing dominant narratives, and engaging in transdisciplinary inquiry can support CMI. They describe an activity centered on *The World as 100 People* infographic, and they consider how digital media and transdisciplinary inquiry can help us reconsider which stories we choose to tell with or without mathematics.

Three contributions to the issue offer **images of CMI as they play out in mathematics classrooms**. An early childhood classroom is represented through Elinor Albin and Gretchen Vice's demonstration of how mathematics can support social-emotional learning with four- and five-year-olds. They describe how number lines and "power-o-meters" are used to help students better understand their own emotions, better empathize with their peers, and think more deeply about the meaning and importance of community.

There are two examples situated in elementary classrooms in this issue. The first, by Cathery Yeh and Brande Otis, uses textbook analysis to argue for leveraging and extending students' community and classical mathematical knowledge. Yeh and Otis describe how the strategy of "say-mean-matter" invites students to first identify the social and political messages conveyed in word problems, and then to reframe these problems into more personally meaningful, relevant, and socially just contexts.

The second piece, by Teddy Chao and Maya Marlowe, draws on principles from the #BlackLivesMatter movement to explore how first and fifth graders wrestled with the concept of fairness through a Peace Park activity. Their work highlights how relationships with parents and members of the community are essential in supporting a comprehensive and sustained study of Black culture and the insidiousness of racism.

Finally, Laurie Rubel and Andrea McCloskey describe some very real **challenges faced by critical mathematics educators** who engage with or advocate for CMI. Interrogating the ways in which the phrase the *soft bigotry of low expectations* and related ideologies have been used in political far right media and mainstream discourse about mathematics education, Rubel and McCloskey juxtapose the work of CMI against the context of powerful, public actors who seek to maintain the status quo by delegitimizing CMI. The authors' call to action both prepares and encourages educators to persist in their engagement with CMI as they critically analyze and challenge oppressive structures and relationships.

CMI is inherently an iterative, reflective process. Just as the authors in this issue describe some of the successes of their work, they also share their failures and ongoing struggles, emphasizing the real work of embedding CMI in an education framework of social justice. While each of these authors provides a unique perspective on CMI, taken together they demonstrate the power of student participation in critical mathematical inquiry as well as the urgency with which such participation must take place. Our hope is that by engaging with these contributions as a whole, powerful themes will resonate with readers who believe in the potential for social change through education, and that these themes will inform the development of critical pedagogies and curricular experiences for use in their own classroom communities and spheres of educational influence.

Curricular Resources

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Additional Resources:

- CEMELA: Center for the Mathematics Education of Latinos/as. Available at <https://math.arizona.edu/~cemela/english/resources/links.php>
- Creating Balance in an Unjust World. Available at <http://creatingbalanceconference.org>
- Free Minds, Free People. Available at <https://fmfp.org>
- Math and Social Justice: A Collaborative MTBoS Site. Available at <https://sites.google.com/site/mathandsocialjustice/home>
- NYCoRE: The New York Collective of Radical Educators. Available at <http://nycore.org>
- TODOS: Mathematics for All. Available at <https://www.todos-math.org>

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Steven Greenstein is an Associate Professor in the Department of Mathematical Sciences at Montclair State University. He enjoys thinking about mathematical things... and how people think about mathematical things. Through his work, he aims to democratize access to authentic mathematical activity that honors the diversity of learners' mathematical thinking, that is both nurturing of and nurtured by intellectual agency, and that is guided by self-directed inquiry, mathematical play, and the having of wonderful ideas.