Critical Pedagogy and Teaching Mathematics for Social Justice

by
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Abstract

In this article, the authors explore critical pedagogy within the context of mathematics classrooms. The exploration demonstrates the evolving pedagogical practices of mathematics teachers when teaching mathematics is explicitly connected to issues of social justice. To frame the exploration, the authors provide brief overviews of the theoretical tenets of critical pedagogy and of teaching mathematics for social justice. Through using narrative and textual data, the authors illustrate how a graduate-level, critical theory and teaching mathematics for social justice course assisted, in part, in providing not only a new language but also a legitimization in teachers becoming critical mathematics pedagogues.

Keywords: critical pedagogy; mathematics education; social justice mathematics; teacher education; teacher practices

In the United States, *critical pedagogy* is marking its 40th anniversary; it was in 1970 when two English-language translated essays by Paulo Freire (1970a, 1970b), "the inaugural philosopher of critical pedagogy" (McLaren, 1999, p. 49), were published. These publications coincided with the release of the first English translation of Freire's seminal book, *Pedagogy of the Oppressed* (Freire, 1970/2000). Richard Shaull (1970/2000), a liberation theologian, in the foreword to the English translation, wrote, "I consider the publication of *Pedagogy of the Oppressed* in an English edition to be something of an event" (p. 29). These Eng-

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lish translations, coupled with an invitation to be a visiting professor at Harvard in the early 1970s, have led many scholars to suggest that Freire has been the most influential education philosopher on the development and practice of critical pedagogy (Darder, Baltodano, & Torres, 2003). But what is critical pedagogy and how might it relate to mathematics teaching and learning? How might mathematics teachers learn to adopt the philosophical and theoretical tenets of critical pedagogy within the context of their own pedagogical philosophies and practices? And just what might a mathematics lesson "look like" framed within critical pedagogy?

To shed some light on these questions, we begin this article with a brief review of critical pedagogy, connecting critical pedagogy specifically to teaching mathematics for social justice. Next, we provide details of a graduate-level, mathematics education course that explored the philosophical and theoretical tenets of critical pedagogy and, in turn, critical mathematics teaching and learning. We then illustrate what mathematics lessons positioned within critical pedagogy might look like by using two autoethnographic narratives written by Carla Bidwell and Ginny Powell (students who completed the course) that describe the planning and implementing of a social justice mathematics lesson in their respective classrooms. Drawing upon the narratives and extracted written comments from Carla's and Ginny's assignments completed during the course, we conclude the article with a collective reflection on what it is like to attempt a new, different kind of mathematics teaching—teaching mathematics for social justice.

A Brief Review of Critical Pedagogy

Although it has been noted that the first textbook use of the term *critical pedagogy* was in Henry Giroux's book *Theory and Resistance in Education* published in 1983, and that the tenets of critical pedagogy emerged from a historical and continuing legacy of scholars who have labored to advance democratic ideals within education (Darder, Torres, & Baltodano, 2003), we have chosen Freire as our starting point because, individually and collectively, we have been significantly influenced by Freire's prolific scholarship (see, e.g., 1970/2000, 1985, 1994, 1997b, 1998a, 1998b). Freire's literacy scholarship (but not limited to literacy) advocates a critical reading of the word and world "through which men and women take themselves in hand and become agents of curiosity, become investigators, become subjects in an ongoing process of quest for the revelation of the 'why' of things and facts" (1994, p. 105); it advocates a dialectical reading of the word and world, so as to write the word to *rewrite* the world. We believe that it is Freire's scholarship and his popularization of the concept *conscientização*—"learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality" (1970/2000, p. 35)—that provides the foundation for critical pedagogy.

In general, critical pedagogy supports pedagogical theories and practices that encourage both teachers and students to develop an understanding of the interconnecting relationship among ideology, power, and culture, rejecting any claim to universal foundations for truth and culture, as well as any claim to objectivity (Leistyna & Woodrum, 1996). Rooted in a democratic project, critical pedagogy motivates new theories and languages of critique and resistance, critically examining and transforming the traditional academic boundaries and social and pedagogical practices that maintain the de facto social code in the United States (Leistyna & Woodrum, 1996). In short, critical pedagogy motivates both critique and agency—for teachers and students alike—"through a language of skepticism and possibility and a culture of openness, debate, and engagement" (Giroux, 2007, p. 2).

Critical pedagogy, however, is not a one-size-fits-all pedagogy but rather a humanizing pedagogy that values students' (and teachers') background knowledge, culture, and lived experiences (Bartolomé, 1996), moving students (and teachers) into their own ever-expanding interpretations of their lived worlds (Greene, 1996). Critical pedagogy supports a problem-posing pedagogy in which *Subjects* who know and act—in contrast to *objects*, which are known and acted upon—"develop their power to perceive critically *the way they exist* in the world *with which* and *in which* they find themselves" (Freire, 1970/2000, p. 83). A problem-posing pedagogy is dialogical, reconfiguring the traditional teacher–student roles of pedagogy: "the teacher is no longer merely the-one-who-teaches, but one who is [herself and] himself taught in dialogue with the students, who in turn while being taught also teach" (p. 80). The dialogical educator creates pedagogical spaces for epistemological curiosity where students (and teachers) become apprentices in the rigors of exploration (Freire & Macedo, 1996). These epistemologically curious spaces refuse singular explanations that attempt to provide a locus of certainty and certification around the social constructs of race, gender, ethnicity, class, sexual orientation, and so forth (Lewis & Simon, 1996). Through epistemological curiosity, teachers and students develop a *critical ontology* that assists them in understanding how and why their political opinions, religious beliefs, racial positions, gender roles, sexual orientations, and so forth have been shaped by the power relations and ideology of dominant groups (Kincheloe, 2003). Above all, critical pedagogy links the classroom experience to the wider sociopolitical community, recognizing schools as public spheres where teachers and students engage in a process of deliberation and discussion aimed at recapturing the idea of critical democracy and community (Giroux & McLaren, 1996).

The past three decades has witnessed a growing body of scholarship that provides a variety of perspectives from critical pedagogues who challenge the de facto social code of U.S. education (see, e.g., the following edited volumes: Darder, Baltodano, & Torres, 2003; Freire, 1997a; Kincheloe & Steinberg, 1996; Leistyna, Woodrum, & Sherblom, 1996; McLaren & Giarelli, 1995; McLaren & Kincheloe, 2007; Sleeter & McLaren, 1995; Shor, 1987). Much less scholarship,

however, is available that positions the discipline of mathematics within critical pedagogy, but it too is growing (see, e.g., Bartell, 2011; Frankenstein, 1987, 1990; Gonzales, 2009; Gutstein, 2003, 2006; Gutstein & Peterson, 2005a; Skovsmose, 1994, 2005; Wager & Stinson, in press). In the most general sense, critical pedagogy enacted in the mathematics classroom adopts the pedagogical theories and practices of critical pedagogy, while explicitly using mathematics as an analytical tool for examining and challenging social injustices. Or said more directly, critical mathematics pedagogy is most often framed as teaching mathematics for social justice (TMfSJ[1]).

Teaching Mathematics for Social Justice

The meanings behind *teaching for social justice* are complex, multi-layered, and often contradictory (North, 2006). North, in delving into the substantive meaning(s) of social justice, emphasizes the multifaceted and relational aspects of different conceptualization about social justice but resists presenting a delimiting, unifying theory with the hope of provoking more questions and stimulating new discussions about the many meanings of teaching for social justice. Bartell (2011), borrowing from the work of Apple, designates the concept as a "sliding signifier," which suggests that defining what social justice teaching "actually means is struggled over, in the same way that concepts such as democracy are subject to different senses by different groups with sometimes radically different ideological and educational agendas" (M. Apple, as quoted in Bartell, 2011, p. 2). Nonetheless, the concept teaching for social justice is increasingly being emphasized in teacher education programs as part of teachers' overall "diversity" or "multicultural" initial preparation or professional development (McDonald, 2007). Coupled with this increased emphases has been literature (as previously noted) that has explored (some of) the multifaceted and relational meanings of TMfSJ.

Gutstein (2006) identifies TMfSJ as having two dialectically related sets of pedagogical goals: one set focuses on social justice and the other set focuses on mathematics. Building from Freire's literacy scholarship, Gutstein's *social justice pedagogical goals* are reading the world with mathematics, writing the world with mathematics, and developing positive cultural and social identities. Reading the world with mathematics means to use mathematics to understand relations of power, resource inequities, and disparate opportunities and explicit discrimination among different social groups based on race, class, gender, language, and other differences (Gutstein, 2003). Writing the world with mathematics means to use mathematics to rewrite the world—to change the world (Gutstein, 2006). Developing positive cultural and social identities means to ground mathematics instruction in the students' languages, cultures, and communities, while providing

1 To our knowledge, Tonya Gau Bartell was the first to conceive of an acronym for teaching mathematics for social justice – TMfSJ (see Gau, 2005); here, we have slightly modified her acronym with a lower case f, TMfSJ.

them with the mathematical knowledge needed to survive and thrive in the dominant culture (Gutstein).

Gutstein's (2006) *mathematics pedagogical goals* are reading the mathematical word, succeeding academically in the traditional sense, and changing students' (and teachers') orientation to mathematics. Reading the mathematical word means developing mathematical power, defined as deducing mathematical generalizations, constructing creative solution methods to nonroutine problems, and perceiving mathematics as a tool for sociopolitical critique (Gutstein, 2003, 2006). Succeeding academically in the traditional sense means to have students achieve on standardized tests, graduate from high school, succeed in college, have access to advanced mathematics courses, and pursue mathematics-related careers (if they so choose). And changing students' (and teachers') orientation to mathematics means to understand mathematics not as a series of disconnected, rote rules to memorize and regurgitate, but as a powerful and relevant analytical tool for understanding complicated, real-world phenomena (Gutstein).

Similarly, Gonzales (2009) composes a definition of TMfSJ comprised of four components. The first component is access to high quality mathematics instruction for all students, noting access to algebra as a civil right (cf. Moses & Cobb, 2001). Building on the scholarship of culturally relevant pedagogy (e.g., Ladson-Billings, 1995; Leonard, 2008), Gonzales's second component is a (re) centering of the mathematics curriculum around the experiences of students, specifically students from historically marginalized groups. Perceiving mathematics as a tool for sociopolitical critique is her third component (e.g., Skovsmose, 1994). Gonzales's fourth and final component is the use of mathematics to radically reorganize or reconfigure society so that it might be more ethical and just. Here, Gonzales, similar to Gutstein (2006), draws on the scholarship of Freire, claiming that when mathematics is understood as a tool to further social change and the emancipation of oppressed communities, it is being viewed as an extension of Freire's (e.g., 1970/2000) pedagogy of liberation.

A Course on Critical Mathematics Pedagogy

One of the often-argued critiques to TMfSJ is how do teachers learn to teach mathematics in socially just ways. That is, how do mathematics teachers acquire a deep understanding of social justice issues and the pedagogical skills to engage students in what are often controversial issues while attending to the mathematics to be learned (Bartell & Carpenter, 2008)? Within the mathematics education literature there are few accounts of how teacher education programs and/or professional development opportunities might engage preservice and inservice teachers in the pedagogical skills of TMfSJ (see Bartell, 2011, Gonzalez, 2009, and Wager & Stinson, in press, for exceptions). In an attempt to address this often argued critique, I (the first author) designed a graduate-level, mathematics education course

that had the intended goal of assisting in the development of critical mathematics pedagogues who teach mathematics for social justice.

The course was a graduate-level seminar, with three reading-intensive components. First, it provided students with a brief overview of critical theory, familiarizing students with the scholarship of Marx and Engels and to scholarly critiques of their theory (see, e.g., Campbell, 1981; Crotty, 1998; Marx & Engels, 1848/1978; Tucker, 1978). Second, it introduced students to not only the scholarship of Paulo Freire but also to other notable contemporary critical pedagogues through using the edited volume *Breaking Free: The Transformative Power of Critical Pedagogy* (Leistyna, Woodrum, & Sherblom, 1996)—a collection of reprinted 1980s and 1990s *Harvard Educational Review* articles. Third, the overviews of critical theory and critical pedagogy provided the students with a foundation to begin an initial critical analysis of the scholarship of critical mathematics pedagogues (see, e.g., Gutstein, 2006; Gutstein & Peterson, 2005; Skovsmose, 2005).

The specific learning objectives of the course were for students to develop an introductory familiarity with the philosophical underpinnings of critical pedagogy and to explore and (re)position the philosophical and structural foundations of mathematics teaching and learning within critical pedagogy (i.e., TMfSJ). A daily written assignment for the course was to maintain a reading journal that included written summaries of each assigned reading, student-selected significant quotations from each reading, and comments regarding the student's struggles with each reading and how it might (or might not) assist in her or his teaching. The final for the course was a reflective, academic essay in which each student was to discuss her or his understandings of critical pedagogy within mathematics teaching and learning and her or his struggles with and remaining (or new) questions about positioning mathematics teaching and learning within critical pedagogy. Throughout the course, I aimed to construct a Freirian problem-posing pedagogical space in which "people teach each other" (Freire, 1970/2000, p. 80); often reminding students: "Those engaged in critical pedagogy don't need to agree with one another, rather, they need to passionately engage in the radical fire of discursive disagreement" (Steinberg, 2007, p. x).

Mathematics for Social Justice in the Classroom

In this section, we attempt to shed light on the learning outcomes of the course by describing in part the evolving pedagogical philosophies and practices of two mathematics teachers, Carla and Ginny (co-authors of this article). Carla and Ginny were students in the course and are part-time doctoral students and full-time mathematics teachers, Carla at an urban/suburban high school, Ginny at an urban community college. The discussion that follows does not intend to report the "findings" of an empirical study that documents mathematics "teacher change," a complex endeavor (see, e.g., Sztajn, 2003). Instead, we aim to illus-

trate that teaching is a continual journey; in that, "effective" mathematics teachers do not master teaching, but rather find themselves in a continuous state of growth and change (Mewborn, 2003). Or, said in another way, effective teachers find themselves in a continuous state of *becoming*. Becoming a teacher is a process that is never finalized or fixed, but rather a fluid process of continuous critical examination of self and students in which old ways of thinking and acting are disrupted and transformed into new ways of thinking and acting (Gomez, Black, & Allen, 2007).[2]

The discussion begins by providing two autoethnographic narratives (Ellis & Bochner, 2000). Each narrative begins with a description of Carla and Ginny, respectively, and the context in which she teaches mathematics. It then provides details of how she planned and implemented a specific TMfSJ lesson, concluding with a brief reflection on the lesson taught. The narratives are followed with a collective reflection on the course and critical mathematics pedagogy in general that connects the narratives to extracted written comments by Carla and Ginny from course assignments, interwoven with comments by critical pedagogy scholars. The purpose of the collective reflection is to illustrate that becoming a critical mathematics pedagogue is indeed a journey.

Carla's High School Story

As a White woman in my mid 30s, I am not sure why I am drawn to a diverse population of students as opposed to the all-White setting in which I grew up. During my primary and secondary education in southwest Virginia, I had limited exposure to racial and/or ethnic diversity; likewise, during my undergraduate and graduate education in Tennessee. As a mathematics teacher, I began my career with a traditional mindset that often placed school mathematics as being somewhat discounted from students' lived experiences. Through my past 5-year experience in teaching mathematics at a racially diverse urban/suburban high school, however, I have come to realize that connecting mathematics to students' lived experiences is of significant importance if I expect my students to strengthen their mathematics understandings.

Planning

The students who participated in the TMfSJ lesson described were International Baccalaureate (IB) Algebra II students who attended a diverse urban/suburban high school in metro Atlanta. This particular group of students, however, was fairly homogenous racially due to the "tracking" of students into the academic-

2 Walshaw (2010), in providing a postmodern perspective on the concept of becoming, writes: "Becoming a teacher is not so much an issue of a personal journey as a barely visible set of highly coercive practices. Teaching 'know-how,' then, is linked to networks of power, targeting thinking, speech, and actions, with a view toward producing particular constructions of identity" (p. 126).

ally prestigious IB program. Although there were a few African American and Latino/a students, most of the students were White. The last unit of study for fall semester was a statistics unit; therefore, the mathematics goals for the TMfSJ lesson were for students to gain more experience at representing datasets graphically and to be able to use technology to do so. Finding a dataset around social justice issues to achieve these goals would not be a problem. Narrowing down the abundance of options would take some time however.

After searching extensively on the Internet, I decided on the topic of racial profiling—a topic in which I felt the majority White students had little exposure but one that could possibly have an effect on their lives. Although no dataset on racial profiling was available in my students' own communities, an Internet search in neighboring states uncovered an extensive document from Tennessee where data had been collected from 44 law enforcement agencies on the racial composition of persons pulled over for traffic violations, subdivided into six state regions.[3] Although it would have been ideal for the students to examine this type of data within their own community, I felt that using data from a different state would neither alter the mathematics being taught nor lessen the awareness that I hoped they would gain from the lesson. Once my topic was chosen, I developed a project comprised of two parts: Part I focused on calculating and organizing statistics; Part II focused on a written analysis of the students' perceptions of racial profiling.

Implementing

The project was completed over the course of two 90-minute, block classes, with a few hours outside of class required to complete the project. As an introduction to the topic, I had the students read an article on racial profiling by the American Civil Liberties Union (ACLU) prior to day one of the project. The title of the article itself, *Racial Profiling: Definition* (ACLU, 2005), elicited some responses from the students. Although the majority of students made no comments when handed the article, a small number of students immediately questioned the relevance of the topic in a mathematics class. For instance, some students asked, "What does this have to do with math?" Surprisingly, one of the few African American students in the class was resistant to the topic altogether, suggesting, "Why don't you just give us data instead of having us read some stupid article?" Instead of responding to each negative comment, I simply explained to the class that their assignment was to read the article by the next class period and be prepared to discuss it then.

I began the following class with a brief discussion of the article, seeking their reactions to what they had read. In general, the students were reluctant to speak, but a few students did comment on some of the examples of racial profiling given in the article. During the two class periods, students were assigned a different

3 See http://www.comptroller1.state.tn.us/Repository/RE/vehiclestops2007.pdf.

subdivided region of Tennessee and worked in groups of four students to calculate statistics (by hand and using a *TI-84* graphing calculator). For each of the regions, groups were instructed to calculate the mean, mode, standard deviation, and 5-number summary for the percentage of traffic stops for each racial group (Asian, African American, Hispanic, and White). Students created box plots for each racial group in their region, and made a double-bar graph comparing the mean scores of the recent Census data to the mean scores of the percentage of vehicle stops for each racial subgroup.

The second part of the project gave the students an opportunity to share what they had learned about racial profiling and to voice their own opinions on the subject by providing written responses to four questions. Along with answering questions pertaining directly to the statistics that they calculated for their region, students also had to find examples of racial discrimination in their communities, state their opinion on whether or not they felt racial profiling occurs in Georgia, and express whether or not they felt that data should be collected on traffic stops in Georgia.

The students gave thoughtful responses, especially to questions one and four. In question one, where students were asked to find someone who could tell a story either about racial profiling or discrimination, some students gave very personal accounts. A Latina student vividly described a trip that she took with her father to Mexico in which she and her father were pulled over by Texas state policemen three different times. She expressed anger over one policeman's insinuation that the man she was with was not really her father because she spoke better English than him. Another girl explained the anguish experienced by her Pakistani neighbors following the months after 9-11. The discrimination they experienced forced the family back to Pakistan.

In response to question four, where students were asked whether they believe that racial profiling occurs in Georgia and whether or not they feel that Georgia should collect data on the race of persons involved in traffic stops, the students had mixed reactions. The majority of students felt that racial profiling occurs everywhere because, as one student stated, "humans are everywhere." Only about half the students, however, felt that Georgia should follow suit with Tennessee. Some students supported data collection of race in traffic stops because "it will show Georgia residents if the state is racially profiling people." Others felt that there was no evidence of a problem and to collect data would create a problem. One African American female student in particular stated: "I don't think other states should [collect data on race during traffic stops] for the simple fact it draws extra attention to it. By drawing attention to it, more issues arise."

Reflecting

The most rewarding part of this project for me was observing how my students' attitudes about the project changed over the course of just 3 days. Although very

little conversation ensued initially from reading the ACLU article, the students had much more to say on the day the project was due. As students entered the classroom, I could hear conversations all over the room about the project. One African American male student asked me if he could share his story on racial profiling with the class. This very shy, reserved young man who rarely spoke in class told his classmates about taxi drivers who refuse to pick up African American males in a certain part of the city. This story spawned a class discussion with numerous other stories. Some of the few non-White students in the class shared stories of being searched at airports. A White male student even shared with us that his wealthy grandmother refuses to allow non-White tenants into her apartment complex.

During the discussion, we also had a conversation about Rubin Carter (an African American boxer convicted of three murders and released from prison 20 years later). Some students had seen *The Hurricane* (Jewison et al., 1999), a movie in which Denzel Washington portrays Carter as innocent, and all of the students had heard Bob Dylan's (1975) song *Hurricane*, as I had played it in class during group work. I cautioned students that although Hollywood had a tendency to exonerate Carter of the crime, some people have devoted much of their lives to proving his guilt. This conversation acted as a perfect ending to our discussion on racial profiling—highlighting the complexities of the issue. The classroom discussion alone convinced me that the project was a success even before I read any of their written reports. I could have taught the same mathematical skills traditionally with no difference in learning outcomes, but instead, I gave them an opportunity to raise their own awareness and form their own opinions on racial profiling.

Ginny's College Story

Despite the fact that I grew up in an urban environment, as a White woman in my mid 30s, I never attended a school that had more than a handful of non-White students. Even my undergraduate education at an urban university was lacking in racial and/or ethnic diversity. Nevertheless, currently I teach mathematics at a community college in metro Atlanta in which the student body is almost entirely African American and non-traditional (i.e., most of my students work full-time and have families in addition to being college students). I began my teaching career as a very traditional teacher: lecture and drill, lots of homework, frequent quizzes, strict attendance policy; things I carried from my own schooling. Traditional teaching lasted through my brief stint as a high school teacher and into my college teaching career. I thought, as the teacher, I knew best, and it was up to the students to take responsibility for their own learning. Through my 10 years of teaching, however, it has become apparent to me that a different approach is needed.

Planning

In planning my TMfSJ lesson, I first wanted to determine a topic that I felt might have personal relevance to my students. I decided to use Minimum Wage data to explore mathematical functions as a means to develop models that might predict possible future wages. I had used the dataset before and knew it was an easily available dataset of manageable size.[4] When I had used it before, however, I had not allowed time to discuss the implications. This iteration, I was determined to take the time to get at the meaning of the material, instead of just using it as an available dataset. It is also real-world data that I believed would interest my students, as many had worked, or were working, minimum wage jobs. This lesson occurred during the lead-up to the mid-term elections, and the Democrats were using raising the minimum wage as a plank of their campaigns, so it was also timely.

Implementing

I presented the data to the students in my College Algebra class and we explored it orally as a class. I chose to leave out details that would have made the task more realistic, like putting all amounts in current dollars, for simplicity, and also so the students might be exposed to just what sort of actual wages their grandparents might have made. Upon seeing the data, many students called out that they were making minimum wage, and that it was inadequate. Most students had a hard time grasping the idea of 25 cents an hour back in 1938, and also of how low wages had been within their own lifetimes. Most had not realized that the minimum wage had been the same for nearly 10 years. I tried to harness the outrage in the room into a curiosity about how the data could help convince someone in Congress that the minimum wage needed to be raised. The objective of the lesson was for the students to make an argument for what they thought the minimum wage should be, using mathematics to back it up.

The class at that time had studied linear and quadratic functions extensively, and piece-wise functions, and had some experience using their graphing calculators to find the "best fit" line or parabola to model a dataset. Their assignment was to, in groups of two to four students, choose a subset of the data and model it with the function of their choice, and then use the group's model to predict or make an argument for what the minimum wage should be in the future. The group members were expected to defend both their choice of data and their model and prediction.

I left the instructions deliberately somewhat vague, to avoid the gut reaction against "word problems" and instead framed it as an exploration. They were given a week to work on the problem out of class, with the understanding that they would be presenting their findings to the class. During that week, many students

4 See http://www.dol.gov/whd/minwage/chart.htm.

came to my office hours to discuss the project; it seemed to me that they were more interested than they had been in previous projects, and willing to work harder. But when the due date arrived, few groups were ready to present. So I went around to many individuals and groups to see what they had attempted. Most were on the right track—had chosen a subset of the data and done some correct calculations—but seemed lost at not knowing if they had the "right" answer. I went over what was expected again, once more explaining that all of their approaches to this multi-year dataset were valuable, and gave them two more days to work on it.

When the new presentation date came, all groups were ready with the mathematical part of the assignment. I had hoped to get some of their thoughts on paper, but they were resistant; we had a lengthy oral class discussion instead. Each group put their equation on the board, and graphed their model on the calculator software displayed on the projection screen, superimposed over a plot of the data. I had each group discuss how they had chosen the data and what process they had used to get the model. There was quite a range of choices made by the students. Some used only two points; some used the entire dataset. Some chose the regions of greatest increase, and some the regions of smallest increase. Some chose data for historical reasons—the Reagan years, their own lifetime, the 70s. Mathematically, choices varied, too. Some performed calculations by hand, some used the calculator functions. Although we had not yet studied them extensively, some groups experimented with cubic and exponential function models. The various models led to quite different predictions.

The class discussions first centered on how the different groups had chosen data points. The center mass of points, from 1974 to 1981, was popular. One student said they just "looked like a parabola" to her. Others said they liked the upward trend of that time period. At least one student volunteered that the steepness of the rise was due to inflation, and "we should be happy it's not like that now." The first two points, and the last two points, seemed to have been chosen for ease of calculation and extremity. The majority of groups used the entire dataset and found the best fitting quadratic, most likely because similar problems had recently been done in class. Some students remarked on the large gaps through the years, and many were knowledgeable about who had been president or how the country had been going economically at the time. While I had hoped to use different group results to cobble together a piece-wise function to cover the entire time period, and discuss the possible historical and political justification for raising, or not raising, the minimum wage in various years, students seemed more interested in discussing the future.

Once the models had all been shown on the calculator screen, and the equations and predictions written on the board, we discussed which model we liked best. Some liked the models that gave the highest minimum wage prediction, regardless of fit, but when pressed to give better reasons, the majority decided that the visually best fitting model, the quadratic found from using all the data points, was the easiest to support, and gave a reasonable possibility for how much

the minimum wage might be raised. We talked about which political party might choose which model to back up their own policy. It was discussed that Congress might have been using something like the linear model found from all the data points, as it gave a close estimate of the actual current minimum wage.

Reflecting

I struggled with this project concerning how much time to devote to it in class. Previous attempts at using socially relevant topics in my classes had seemed to lack enough discussion time to give real meaning to the data and to give closure. This time I was sure to schedule enough time for a final discussion, but students may have gotten more out of it if I had given them more background in a pre-project discussion. In particular, they needed to know more U.S. political history, so next time I will provide that to them as part of the assignment. Additionally, with the easy access of several datasets via the Internet, in the future I might plan the same mathematical objective, but allow groups to select their own socially relevant topic to explore. I also need to think about ways in which such projects might be extended into action, such as assisting students in disseminating their newly acquired knowledge by writing letters to their state and national congressional representatives or to the local newspapers. Nevertheless, overall, I felt good about the project, especially in how it forced at least some of the students to stretch their idea of mathematics problems as having only one correct method and answer. I hope that it also impressed upon them the power of mathematics in important decisions at even the highest reaches of government.

Reflecting on the Course and Critical Pedagogy

Throughout the aforementioned narratives and written assignments from the critical pedagogy and TMfSJ course, Carla and Ginny articulate what it is like to attempt a new, different kind of mathematics teaching, one based in critical pedagogy. But TMfSJ is a journey, not a destination. Carla, in describing her journey, wrote, "I am trying to make the move toward a more democratic classroom where my students' voices are heard, their cultures have value, and everyone in the class is both a teacher and learner." Ginny articulated her journey as developing a new way of life rather than a mere method of teaching: "[TMfSJ] is about questioning everything, from the foundations of mathematics itself to every practice and belief. It is a way of life rather than methods of teaching. … I now find myself second-guessing everything I do, everything I plan, even my word choice in real time as I stand before a class."

As Carla and Ginny spoke about their journeys, each also noted that she had begun her teaching career with a more or less "traditional" belief structure about mathematics teaching and learning. Over the years, however, as mathematics teachers with several years of teaching experience, both have begun to recognize that traditional practices are not working for every student—or for most students.

Individually and collectively, they believe that their participation in the critical pedagogy and TMfSJ course provided them with a new language that assisted them in communicating and acting on what they were in some ways already thinking. Carla wrote, "I realize now that 5 years ago I was already thinking like a critical pedagogue, I just didn't have a clue what that was." Ginny echoed and extended Carla's remark, writing: "I began to grow on my own toward a more student-centered, equitable style, though I did not have the words for it or the feeling that what I was doing was being done elsewhere or would be respected by others."

In effect, this new language brought empowerment and confirmation to what Carla and Ginny were, through their years of teaching experience, beginning to understand: "Unless educational methods are situated in the students' cultural experiences, students will continue to show difficulty in mastering content area that is not only alien to their reality, but is often antagonistic toward their culture and lived experiences" (Bartolomé, 1996, p. 249). Or, said in another way, "the only education that can have meaning is education that is personal and therefore political" (Lewis & Simon, 1996, p. 261). In many ways, the narratives demonstrate the benefits of experiential learning, as advocated by Dewey (1938/1997). In each of the lessons, knowledge of subject matter—in this case, mathematics—was used to examine or make better sense of the sociopolitical lived worlds of the students (and teachers). And even though the majority White students in Carla's IB class had not experienced racial profiling directly, they were still somewhat aware that others had such experiences given a post 9-11 world.

But it is not enough just to present problems based on something known to the students; a fundamental tenet of critical pedagogy is the need to include students' *and* teachers' voices and lived experiences in the learning process (Leistyna & Woodrum, 1996). The challenge for critical mathematics pedagogues therefore is how critical pedagogy might be employed to appropriate the more radical and useful aspects of contemporary cultural studies in addressing the different social, political, and economic contexts that are producing students and teachers (Giroux, 1996). In other words, the active participation, interest, reflection, and critical understandings of those taught—and those teaching—are necessary (Freire, 1994). Carla and Ginny believe that the most satisfying part of TMfSJ is the conversations with and between their students. These conversations have become not only culturally relevant (Ladson-Billings, 1995) but also personally relevant, even politically provocative at times; thus, achieving an essential aspect of TMfSJ (Gutstein, 2006).

For instance, each of the TMfSJ lessons described contained both a personal and political element for students and teachers. During Carla's lesson on racial profiling, students shared their personal experiences, both orally and in writing, unveiling the social injustices that occur in their communities. For the adults in Ginny's class, most of whom had had some experience working for minimum wage, the lesson was very personal and led into political discussions as state and national elections were approaching. Many students were outraged upon realizing

that the minimum wage had not changed in 10 years. In co-created classrooms like these, where mathematics content and process standards are continually integrated, as suggested by the National Council of Teachers of Mathematics (2000), Carla and Ginny believe, "once a fabric of relevance has been constructed, content learning naturally follows" (Kincheloe & Steinberg, 1996, p. 189). That is to say, when teachers create learning environments where students, even those perceived as "low performing," can demonstrate their possession of knowledge and expertise, they then demonstrate ability and competency (Bartolomé, 1996). In both of the lessons, Carla and Ginny "tapped into" students' knowledge that led them to take personal ownership of the projects—and most importantly, of the mathematics.

In teaching for social justice, Freire (1970/2000) contended that the humanist, revolutionary educator is the students' partner as they engage together in critical thinking and a quest for mutual humanization. Although their students may not have been aware of it, Carla and Ginny were engaged in the process of learning as much as the students during the described lessons. In that, the discussions revealed lived experiences and political opinions that presented both students and teachers with new knowledge. The social justice pedagogical goal during the TMfSJ lessons was the production of students' and teachers' own ideas and values rather than the mere reproduction of those of the dominant groups (Leistyna & Woodrum, 1996), and, most importantly, the use of mathematics as a sociopolitical tool to support these newly produced ideas and values (Skovsmose, 1994).

TMfSJ, however, asks much of teachers—and students—and it is not easy. Crotty (1998) claimed, and Carla's and Ginny's becoming illustrate, that with every action taken the context changes and one must critique her assumptions again and again. But the possible benefits of students and teachers engaging meaningfully with mathematics and transforming into agents of change are worth the work. Carla and Ginny believe that they, as well as their students, must "exercise the kind of courage needed to change the social order where necessary" (Giroux & McLaren, 1996, p. 318). Both Carla and Ginny acknowledge a choice between a pedagogy that accepts the status quo and a pedagogy that seeks to bring about change—they are committed to choosing the latter.

Closing Thoughts

Since completing the course, and teaching the social justice lessons described, Carla and Ginny continue their journey in becoming critical mathematics pedagogues. They actively seek and encourage critical connections with other disciplines. They continue to use the tenets of critical pedagogy in planning curricula, developing classroom environments, and establishing channels of communication with students and colleagues. In general, they have become stronger facilitators of TMfSJ discussions not only with their students but also with their colleagues. On

the other hand, Carla and Ginny also concede that their pedagogical philosophies have changed faster than their pedagogical practices—not an uncommon phenomenon among mathematics teachers (e.g., see Wilson & Goldenberg, 1998). While they both agree that their practices should move away from perceiving students as passive, empty depositories awaiting the teacher's deposits of knowledge, what Freire (1970/2000) strongly objected to as the "'banking' concept of education" (p. 72), they often find themselves mired in traditional practices that in many ways reflect this depository process. But then again, both assert that they will be diligent in developing methods that overcome or undercut these traditional practices as they continue to establish the tenets of critical pedagogy as an integral component of their pedagogical philosophies as well as their pedagogical practices. In other words, Carla and Ginny have an ongoing sense of constant change and improvement, very different from the traditional idea of their being a "best practice" that a teacher should learn and use forever. In short, each has a sense of becoming as they continue to explore pedagogical practices that are both–and rather than either–or, achieving both social justice and mathematics pedagogical goals (Gutstein, 2006) in their respective classrooms.

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