

PUBLIC STORIES OF MATHEMATICS EDUCATORS

Critical Transformation of Mathematics Educators

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What can be done to enhance pre-service educators' knowledge of social justice and its role in the elementary mathematics classroom? I (Maggie) pondered this question as a graduate student and mathematics educator. Following the advice of Cochran-Smith (1991) who advocated for connecting reform-minded teachers and pre-service teachers, I approached my colleague Dr. Jennifer (Jenn) Kosiak, an associate professor of mathematics education, about assisting in my research. Although Jenn had little background knowledge in social justice, her strong passion to continually learn and grow made her an ideal traveling companion as we set off on a journey to enhance pre-service mathematics teachers' awareness of social justice issues and their relevance in the mathematics classroom.

This public story focuses not only on the pre-service educators we worked with but also, and more so, on our own professional and personal growth through the journey. We found that we could not speak of the transformation that we witnessed in these future teachers without addressing our personal transformations. Throughout this story, I will share our journey from my perspective. As part of the research involved written reflections from Jenn, I will incorporate her voice throughout the article in *Arial font* to address her growth in her own words.

Before embarking on this journey, I read literature about how to best implement a social justice curriculum. I found that, in education, social justice themes are enacted to enhance students' learning and their life chances by challenging the inequities of school and society (Michelli & Keiser, 2005). Yet, social justice education cannot be implemented without the dedication of critically aware teacher educators who have examined their own identity and privilege so

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that they are able to guide pre-service teachers in the process of developing critical consciousness. Quin (2009) explicitly states the goal of social justice educators is “to empower [both] educators and learners to act in anti-oppressive ways for social justice” (p. 110, emphasis in original).

To implement such pedagogy, social justice educators must create what Freire (1970) calls horizontal relationships, relationships where teacher and learner work together toward a common goal. This is the type of relationship that developed between Jenn and me. No longer were Jenn and I limited to our respective roles of professor and graduate student; rather, we were both mathematics educators with the desire to create a dynamic classroom where pre-service educators could learn about social justice through critical dialogue.

Analyzing Identity

Through my initial readings in critical pedagogy, I learned that our first step as educators was to reflect upon our own identities and privileges. As two White females from small towns with little diversity of race, ethnicity, or language, we had a lot of examining to do. Reflecting upon our own personal and educational upbringing, we asked the following questions:

- As a teacher, what is my role in the classroom?
- As a White person, what innate biases do I hold regarding student learning?
- As a female, what privileges may be affecting my teaching practices?
- As a White female, how do the tasks that I select for my students either include or exclude students in my classroom?
- Overall, how do these lenses affect my view of social justice in a mathematics classroom?

Many of my biases come from my upbringing and education. Most of my peers were from two-parent, middle-class homes. Having experienced little diversity, I believed that all students had the ambition to go to college, to become educated, and to find a fulfilling career. It was not until I started working in public schools while in college that I came to understand that many students, whether urban, rural, or suburban, come from backgrounds much different from mine. Desiring to engage students through relevancy in learning, I began to search for resources, conferences, and like-minded colleagues who could help me to examine my privilege in order to become a critical educator who can embrace all students. Although I summarize my desire to change in a few sentences, this transformative process occurred over multiple years (and continues). In the midst of learning more about critical pedagogy, I approached Jenn about my research idea.

When Maggie first approached me about incorporating social justice into my elementary mathematics methods course, I was apprehensive because I thought that social justice merely meant making my classroom equitable to diverse student populations. With the National Council of Teachers of Mathematics (NCTM, 2000) Equity Principle in mind, my beliefs about social justice suggested that I should create a classroom environment that was both challenging and supportive of student learning regardless of their background. "I already do this, right?" I thought to myself. However, listening to Maggie's discussion about social justice and critical pedagogy caused me to reformulate my understanding of social justice as a mechanism to investigate injustice in the world and create change. Immediately, I thought of issues such as distribution of world wealth and poverty rates and how I could use statistics and number facts to model math concepts to my pre-service students. I believed that purposefully modeling pedagogical practices would help these future teachers understand the role that social justice could play in the classroom, especially the mathematics classroom.

Defining Social Justice Mathematics

Much of the planning for this project occurred over the summer preceding the mathematics methods course. When the first class assembled, I had some jitters. Were the students willing and ready to embark on this journey with Jenn and me? Would they believe in the value of transforming the mathematics classroom into a place where all students can feel empowered to enact social change? We were about to find out.

We administered a pre-survey to all of the pre-service educators in three sections of a mathematics methods course in order to ascertain their beliefs and abilities regarding social justice and mathematics. Like Jenn, the students began the semester with little knowledge of what social justice meant, specifically what it meant in the mathematics classroom. Similarly, these students were also influenced by the NCTM Equity Principle, which was introduced the week before, as much of their pre-survey definitions focused on supporting all students in the classroom. This finding made me realize that these students needed a firmer grounding in general social justice literature before I could move them toward integrating social justice and mathematics. However, given the limitations of a one-semester course, Jenn and I decided to focus on the concept of social justice within the mathematics classroom, all the while maintaining that the principles of social justice can be utilized in every classroom regardless of content.

When introducing social justice mathematics to the pre-service teachers, I was apprehensive about how they would perceive this different course expecta-

tion. I tried to find concrete examples of what social justice pedagogy would look like in the elementary mathematics classroom. I believe these examples were critical based upon the students' initial difficulty in defining social justice education both inside and outside of mathematics. Overall, I was relieved that no one questioned why I was including social justice in the mathematics classroom. In fact, many of the students expressed their satisfaction with the practicality of including social justice in a content area given that no other content methods course addressed this mode of teaching.

To engage the pre-service educators in creating a more formal definition of social justice mathematics, Jenn and I asked them to critically reflect upon the article "A Social Justice Data Fair: Questioning the World Through Math" by Alexander and Munk (2010). This article showcases how a Canadian elementary school introduced social justice through an activity called *The Welfare Diet*. As part of their reflections, we asked these students to develop a working definition of social justice as well as an idea of how they might use this kind of activity with their future students.

I was happy that these pre-service teachers took the definition of social justice beyond equity to include connecting mathematics to real-world problems as well as to the students' lives and communities. Many of my students found that the article helped them to see a new approach to teaching mathematics. Additionally, this article allowed the pre-service teachers to see that mathematics is not a singular course; it can be effectively integrated across the curriculum into areas such as social studies and language arts. Their course reflections continually shaped my own vision of social justice in the mathematics classroom. Perhaps, not having a preset notion of what social justice is and is not allowed all of us to explore, investigate, and conjecture about social justice through the lens of mathematics.

With our building concept of social justice mathematics, I introduced critical mathematics pedagogues such as Gutstein (2006) and Gutiérrez (2007). Using my research to spur a more formalized definition, we decided that teaching mathematics for social justice hinges on a teaching and learning environment where

- students are introduced to the various issues of equity, diversity, and social injustices;
- students increase and strengthen their mathematical content knowledge; and
- students learn to use mathematics to identify and examine social issues with the intent to enact change.

Modeling Social Justice Mathematics

The Association of Teacher Educators (2003) states: “In order for teacher educators to impact the profession, they must successfully model appropriate behaviors in order for those behaviors to be observed, adjusted, replicated, internalized, and applied appropriately to learners of all levels and styles” (p. 1). With this charge in mind, our first task was to slowly but intentionally model social justice pedagogy in the math classroom. Embracing our love of children’s literature, Jenn and I chose to read the book *If the World Were a Village* (Smith & Armstrong, 2006) that scales the world population to a village of 100. This book provides the reader with demographics and statistics such as “20 villagers earn less than one dollar a day” or “60 are always hungry.” As I listened to Jenn read this book aloud to the pre-service teachers and heard all of the descriptions of the world’s population in terms of percents and fractions out of 100, I wondered if they, too, were reacting to the reality behind those numbers.

After reading *If the World Were a Village*, we asked students to pick a page from the book related to language, ethnicity, age, or wealth and to make mathematical models to represent the data presented. I wondered if these pre-service teachers would concentrate solely on the numbers and ignore the real-world inequities that were so vividly portrayed. Jenn and I were delighted when they discussed not only the mathematics but also the inequities across the world’s population. For example, they were surprised that roughly one-third of the population is illiterate and almost 40% of the population does not have access to running water.

This activity led to a richer discussion of how percents and fractions can be used in the mathematics classroom to illustrate larger social issues. We discussed ways in which they could extend such an activity into their future classrooms, including creating a real-life version of the book entitled *If Wisconsin Schools Were a Village*. This project would entail investigating the make-up of the classroom and comparing that to statistics in Wisconsin including the number of minority students, ELL students, and students with special needs.

Experiencing Social Justice Mathematics

In addition to modeling social justice mathematics, we wanted to develop a purposeful learning experience where these pre-service teachers could apply their definitions of social justice to a mathematical concept. This desire led to the implementation of *The Accessible Playground Project*, adapted from a social justice lesson plan developed by the Centre for Urban Schooling.

I walked into the classroom one day and declared, “All children have the right to relax and play!” After some initial wonderment about my strong declaration, Jenn and I outlined *The Accessible Playground Project*. Groups of students

were given the task to research both playground equipment and accessibility requirements. They then completed a scale 2D blueprint and a 3D model using mathematical concepts such as geometric shapes and solids, area and perimeter, scale and proportional reasoning. Additionally, they calculated an estimated cost for the playground. These pre-service teachers summarized their findings and outlined the criteria they established in a formal report. At the end of this 3-week activity, the groups presented their models in the classroom linking their presentation to not only why their model was safe and accessible but also to the UNICEF (1990) Convention on the Rights of a Child, Article 31, which prompted the activity.

Through this activity, groups of pre-service teachers determined what accessibility meant not only in a playground situation but also their own classroom. Our conversations began with the appropriate angle of an accessible slide and the cost function to model this task, but quickly shifted. We found ourselves discussing accessibility is a classroom-based issue focused on things like location of white boards, heights of desks and lab stations as well as instructional materials that would meet the needs of all students regardless of ability.

Jenn and I facilitated discussion amongst the pre-service teachers about including bilingual signs in schools, conservation of the environment, and recycling both inside and outside of the classroom. The idea of going out to play at recess was linked to childhood obesity and school lunch programs. All of these discussions spurned from the initial concept of playground equity. Additionally, part of our established criteria for a social justice mathematics lesson is to use the mathematics to critically examine an inequity, therefore, we asked the pre-service educators to analyze cost differentials between an accessible and traditional playground. Almost every group found that the cost of accessible playgrounds was fairly equal to the cost of traditional school playgrounds. They also found themselves examining the playgrounds at their clinical field sites to give them an accessibility ranking.

Creating Social Justice Mathematics

Jenn and I used discussion, article reflections, purposeful modeling, and learning experiences to teach our students about social justice pedagogy and its relevance to the mathematics classroom. Finally, we implemented a pedagogical project that allowed the pre-service educators to explore their understandings of social justice. The culminating activity was the creation of a mathematical concept plan that embedded a social justice theme. Initially, students were apprehensive about the type of activity that they would use in order to satisfy this course assignment and Jenn and I did not know what to expect. They continually asked,

“Is this a social justice idea?” To which we replied, “You need to decide that for yourself.”

As the semester progressed, students would reflect on different ways they could include social justice in their concept plans and the idea of linking mathematics through socially relevant activities emerged. Some students discussed how they could link measurement to the inequities of fresh water supply in the United States versus India. Other discussions evolved into how they could use percents and fractions to investigate how school lunch programs are related to childhood obesity. They used numbers and operations to model poverty in the United States and its impact on student achievement. Even at the earliest grade levels, these pre-service teachers were able to not only have students use the mathematics but also engage in the discussion of the social justice themes.

Jenn and I were pleasantly surprised at the depth of mathematical connections to social justice these pre-service teachers created. Mathematical concepts of fractions and percents were tied to child labor; coordinate planes and graphing helped locate the Native American tribes of Wisconsin; data regarding cyber bullying was graphed to find the increasing rate of change. Tasks began with critical questions such as: *How many steps do you take to get a glass of fresh water? Do you think all people on Earth can measure the distance to fresh water in steps?* These pre-service teachers found ways to critically embed social justice into mathematics lessons. Their growth throughout the semester was reflected in their post-survey where all students could define social justice in the mathematics classroom, but more so in their final reflections about the value they found in not just “doing” mathematics but “using” mathematics to explore local, regional, national, and global concerns. Yet, just as important to the research was the unintended outcome of our transformation as critical educators.

Overall, the experience of incorporating social justice into the mathematics class was rewarding as I saw not only growth in my pre-service teachers’ understandings of social justice but also in my own. The main challenge was that I did not fully grasp the concept of social justice in education at the onset of the course. Indeed, I often felt that I learned more about social justice as I processed article reflections with the students and read their concept plans.

I also wonder if my own identity might have influenced how I modeled social justice to my students. As a White female educator teaching mainly White female students, I think it is important for all of us to examine how our beliefs shape our teaching and the types of activities we give to our students. If you asked me a year ago if I would incorporate themes of societal inequalities into my mathematics methods classroom, I would have probably said, “Don’t they get that in Social Studies?” I have always been a believer of purposeful modeling about math concepts including integrat-

ing reading and writing into the mathematics classroom. This project has helped me understand how all curricula can be integrated in a manner that will enhance students' academic and social learning.

Though I had studied social justice practices and had begun my transformation as a critical educator, I had worked with others in their exploration of these difficult concepts. While moving with these pre-service educators towards a deeper mathematics pedagogy guided by social justice principles, I realized just how difficult it is to maintain an atmosphere appropriate for critical pedagogy. I would constantly critique and reflect upon everything that occurred in class from the tasks we chose to the language we used. Sometimes, I could tell the pre-service educators were frustrated with Jenn and me because we never "gave them the answer." The perception of mathematics is that all problems have a direct solution. However, one of the most difficult tasks was attempting to open the pre-service teachers' perception from a purely quantitative view of mathematics to a qualitative, narrative understanding that highlights problem solving and process more than the solution. Indeed, this view of mathematics as a dynamic set of knowledge still plagues me. I fall into the trap of teaching to skill building without providing a critical context for the learning.

Nevertheless, in small and large ways, social justice pedagogy has transformed my teaching. My students engage in an activity that examines the wage gap between White men and White women, Black men, Black women, Latinos, and Latinas. I ask my students not only to engage in the mathematics of finding models of equations and when White men and afore mentioned groups would earn equal pay, but I also encourage them to reflect upon their future career. I recognize that the experience of leading others to an awareness of social justice truly transformed me into an emerging critical educator. I realize I will continue to explore my identity and reflect upon my teaching practices; however, with the lens of social justice, I know that my awareness of social justice will lead to praxis in my teaching and daily living.

One year after engaging in the research project, Jenn and I have come to realize that we are critically transforming as mathematics educators. It is hard to believe that prior to this research project, we viewed mathematics and social justice as separate entities. The idea of enacting change through examining societal inequalities in mathematics continues to transform both our classes and the pre-service teachers with whom we engage. Today, we share a formulaic definition of social justice in the mathematics classroom: Critical Mathematics + Societal Inequity Investigations = Transformative Change for All.

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