Journal of Urban Mathematics Education
July 2015, Vol. 8, No. 1, pp. 24–30

COMMENTARY

Mathematics and Social Justice: A Symbiotic Pedagogy

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Mathematics can be defined as "the science of pattern and order" (Van de Walle, Folk, Karp, & Bay-Williams, 2009, p. 10). But because there is often a perceived spectrum of approachability to mathematics (based on common misconceptions that envision the subject as a sort of elitist wizardry) it is important to bear in mind different definitions of mathematics when exploring applications of mathematics in the classroom. This is especially true when considering the instruction of mathematics for social justice.

Traditional stigmas have led many to view mathematics and social justice as being positioned on opposing ends of a spectrum describing quantitative and qualitative reasoning and, thus, unsuitable for integration. Garii and Appova (2013) noted that many new teachers struggle with the idea of integrating mathematics and science with social justice issues because their own limited understandings of mathematics (and science) cannot accommodate the notion. It is this fundamental comprehension of mathematics as an approachable and understandable science that can shatter the illusion of academic segregation and begin the integration of mathematical understanding into a realistic and holistic field of academic study. The study of social justice is increasingly in need of empirical methods to describe, defend, and advise the critical analysis of the systems of domination and subjugation that permeate human power structures. The study of mathematics, which often needs a meaningful context in which abstraction and anxiety can be nullified, is the ideal symbiotic partner for the study of social justice in the greater pursuit of equipping students with the effective tools needed to thrive in the 21st century. Without a literacy of mathematics and social justice, students will be at the mercy of sociopolitical and economic systems of oppression.

To make the science of mathematics available to every student, teachers should first create a classroom environment in which the learning of mathematics is accessible to all students. Van de Walle and colleagues (2009) explored the issue of unequal accessibility (in the context of gender) and posit that such problems are "largely a function of the educational environment" (p. 101). Indeed, the "tradition-

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al" classroom environment in which North American school children learn mathematics has produced a dominance of White men in mathematical arenas (Steele, James, & Barnett, 2002). As curricula mandate an approach of equal opportunity (e.g., Saskatchewan Ministry of Education, 2010), it is vital that all students be given inclusive and engaging mathematical instruction. Van de Walle and colleagues (2009) affirmed this mandate by their assertion that the inclusivity of mathematics education must be addressed by changes in the classroom environment. Teachers must shift the traditional environment of the classroom significantly to facilitate an equitable accessibility for all students.

The need for an alternative approach is clear. The National Council of Teachers of Mathematics' (NCTM) recommendations for mathematics education outlined in the *Principles and Standards for School Mathematics* (2000) suggest that teachers focus on five process standards in their classrooms: problem solving, reasoning and proof, communication, connections, and representations (Bossé, Lee, Swinson, & Faulconer, 2010, p. 263). This approach decentralizes the teacher's authoritative role and places much of the learning in the hands of the students as they communicate and critique their reasons and representations among each other. This decentralizing increases the chances for students to make meaningful connections with the material and reduces the risk of instructional bias, on a personal or institutional scale, from excluding historical marginalized groups in classrooms. It is not difficult to understand how these process standards can be a step toward teaching mathematics in an equitable manner. However, mathematical skills learned in this way are still at risk of being abstracted, devoid of authentic context, and isolated from applications to social justice.

Taking into consideration particular NCTM goals, set, arguably, as a "first step" toward weaving the studies of mathematics and social justice, teachers should ensure that the mathematical problems and concepts presented can provide insights into authentic social justice issues within the context of the learners' communities. There are surely skeptics who doubt that this can be done effectively. Fortunately, the Radical Math website (see http://www.radicalmath.org) provides a wealth of free lesson plans, which effectively integrates the interests of mathematics and social justice within the fabric of community (see also Gutstein & Peterson, 2013). One such lesson, "Community Voices Heard: Statistics – Survey Project," examines age, gender, sex, and economics in the community with the statistically informed critical lens of social justice (Osler, 2007). The study begins with an exploration of the statistical processes through some engaging problem solving and discussion. Ultimately, the students are responsible for surveying people in their own community or school on critically relevant topics. A result of this approach, according to one of the project's rubrics, is to provide students with the ability to "compare relevant sets of data" with a variety of tables and graphs created with the very data they collected; in order to, as stated by the authors, "determine Key Findings

from [the] data" (p. 32). The mathematical demands of the rubric are ambitious and the focus of the activities gives the students significant and empirical insights into the authentic and pertinent social justice issues within their communities. When mathematics is taught in this way, it may move beyond a passively equitable implementation toward an active one, that is, an instructional method in which the dynamic, authentic, and critical approaches potentially reflect the subjects of study. Embracing an actively progressive approach toward teaching mathematics for social justice also has the potential to arm students with the authentic tasks and tools needed to develop their mathematical and critical abilities. This type of learning may also perpetuate itself, as both students and teachers become active in creating increasingly interrelated "real-world" connections with mathematics and social justice in their communities.

Having witnessed a successful demonstration of mathematics and social justice working in conjunction, some skeptics may still question the need to integrate these two fields of study. In addition to the strong case that can be made regarding the powerful intrinsic motivations that can arise within learners through such a partnering of subjects, a critical understanding of economics must also be considered a primary reason for integration. A survey of financial literacy across 28 nations by Jump$tart Coalition for Personal Financial Literacy (2013) showed that the vast majority of teenaged students are worried about the impact of the economic recession and would like to learn about finances in school before entering into the possibility of losing money in the real world. The study also showed that in the United States the average credit card debt is $15,266.00, the average mortgage debt is $149,667.00, and the average student loan debt is $32,559.00. Clearly, an understanding of the mathematics involved in debt and other financial operations is required. A thoughtfully crafted lesson could utilize a variety of local financial actions and entities in a comprehensive and critical study. Such a lesson could provide a window of understanding, in advance, of the pitfalls and responsibilities of adult expectations within the sphere of modern economics. It could also address the need for the basic skill set required to function within the current financial parameters of a given community. However, the critical aspect of such a lesson might not be sufficient.

Social justice is, ultimately, about understanding and correcting the macrosystemic power dynamics that perpetuate the conditions in which we live. By conducting a critical study of one's community, students can reach a partial understanding of such global power systems. To fully embrace an integrated approach of mathematics and social justice, teachers could contextualize the functions and limitations of their students' communities with these broad global power systems—and they could do so with the empirical science of mathematics. This integration presents a unique challenge, as the size and scope of such massive power structures exist at a near abstract level of complexity and size. Cox (2003) described how this

void of understanding exists in American tax systems: "big statements like, 'The benefits … go mainly to households in the top 1 percent tax bracket,' tend not to tell the whole story" (¶ 4). The numbers are so large, and the distribution so skewed, that simple sentences fail to deliver accurate meaning. Cox suggested that a reconciliation of understanding could be achieved by constructing "a scale model of household income in America" (¶ 5). This could be an excellent project for a classroom struggling to conceptualize debt, wages, unemployment, and industry in their own community.

Gutstein (2006), in his observations of mathematics and social justice in a classroom environment, noted that mathematics evolved into a "necessary and powerful analytical tool that students used to study their sociopolitical existence" (p. 70). This critical approach, contextualizing authentic social justice issues with mathematical representation, enhances student understandings of local authentic entities and systems. But, more importantly, it solidifies or creates knowledge of hitherto abstract global entities and systems. By integrating, through inquiry-driven projects, an understanding of power systems and community within a mathematical context, students continually expand their mathematical abilities; they gain increasingly more powerful insights into the power systems that permeate the world and define the contexts in which their local communities exist (Garii & Appova, 2013). This deep understanding of the contexts that governs an individual within a community, within a nation, within global organizations of power, can provide students with distinct advantages. In addition to mathematical prowess, such students can be equipped with an awareness and understanding that might help them utilize the forces that shape events within their local sociopolitical and economic communities.

It is important to keep the goals of social justice education firmly in mind. Although social justice may seem like a secondary goal to a teacher who wishes their students to know their "basic math facts," it is of primary importance and should not be isolated, in any way, from other goals in the mathematics classroom. Bartell (2013) described education as being "intricately linked to economic, political, and social power structures in society that serve to perpetuate inequality in both schools and society" (p. 129). Because the classroom itself is one of the primary sources of the socialization that shapes social inequality, an uncritical pedagogy serves only to enforce existing systems of dominance and inequity. If, as the Saskatchewan Curriculum (2010) *Broad Areas of Learning* suggest, teachers should aim to inspire "engaged citizens" with a "passion for lifelong learning" who will contribute to the "environmental, social, and economic sustainability of local and global communities" (p. 22), students, then, should understand, at the very least, and not be marginalized by the systemic dominance associated with race, age, religion, gender, sex, and all other aspects of society. Ideally, mathematics and social justice should be used to arm all students with the tools to not only succeed in so-

ciety but also to critique social systems, disrupt inequalities, and be engaged in social transformation.

Bartell (2013) asserted that for effective integration of social justice in classrooms to occur, oppression must be fought "with, not for" (p. 131) the oppressed. Furthermore, Adair (2008) insisted that when integrating social justice into the curriculum, pedagogy "should depend on the community context in which we are teaching and with the individual experiences of our students" (pp. 413–414). In other words, mathematics and social justice must be studied in authentic contexts (e.g., community-based projects). Social justice must also be taught with authentic empathy in the classroom. This means diversifying instructional methods to provide multiple entry points for personal connections with the mathematical content being presented. These entry points should be student centered; therefore, a considerable effort is required to facilitate an understanding of each student's sociocultural and sociohistorical lived experiences. The monitoring of student progress with consistent and dynamic feedback is also necessary. This approach aims to *self*-empower marginalized "voices" in the classroom and provides a starting point for teaching social justice *with* (not for) the oppressed. Honoring and valuing student voice through input, feedback, and authenticity is a pedagogical practice that embodies social justice and decentralizes teacher-centric authority. It is democratic.

Too often the great fault of social justice is that as a stand-alone qualitative social science it often widens the divide between practitioners and deniers; practitioners are often aggressive in their pursuit of justice to the point where deniers feel vilified and become aggressively defensive. Because socialized dominance is a controversial and dissonant subject, much of the discussion surrounding it degrades to an intersection of opposing opinions. Skovsmose (1994) claimed that mathematics provides a system for analyzing and understanding injustices in society. Because mathematics, as a science, has a practical foundation in observation and representation, these characteristics can establish a dialogue that circumvents, or at least deemphasizes, emotional connections to socially critical arguments. For example, by employing the empirical facilities of mathematics in data collection, statistical interpretation, and graphical representation, one might make an argument that can only be rebutted with an equally well-researched presentation. The lengthy time involved in the formulation of such presentations also helps to reduce the chances of emotionally charged and reactionary responses. Nolan (2009) described the same mathematical niche from a different perspective. She claimed that students are at a disadvantage when striving to understand, communicate, and argue social justice issues without literacy in the scientific methods of mathematics. Nolan's argument described the need for a unity in social justice and mathematics with greater strength because she recognizes that mathematics is beyond simply useful—it is necessary for constructive participation in social justice dialogues.

Mathematics can be the light that illuminates the writing on the wall. Increasingly, academics, government and civic organizations, and the media are presenting mathematically derived findings that describe dangerous power inequities in North American society. Fischer, Colton, Kleiman, and Schimke (2004) produced a report on the economic hardships of the middle and lower classes in New York that called for regulations and accountability in the economic sector well before the Crash of 2008. Killewald (2013) published a study which, contrary to a widespread misconception that racism has ended or is declining, documented the greatest disparity in 25 years between median household wealth values among White and Black families in 2009: a ratio of 20:1. While compelling arguments exist for the integration of mathematics and social justice in pedagogy and content, it is ultimately each individual teacher's decision. This ultimate decision presents a problem because many new teachers struggle to see mathematics as anything beyond "a tool to find a correct answer to a problem, rather than a way to characterize community decision making or understanding" (Garii & Appova, p. 206). A further complication that Darling-Hammond, French, and Garcia-Lopez (2002) explained is the "lifelong" commitment of "effort, perseverance, and reflection" that is required of social justice teachers (p. 4). Learning how to teach for social justice is neither quick nor easy; learning to reinvent the traditional conceptualizations and applications of mathematics is difficult, bordering on anathematic to many. This difficulty presents a formidable barrier to the establishment of socially critical mathematics.

In spite of traditional misconceptions to the contrary, mathematics and social justice are two fields of study that can exist in a truly symbiotic pedagogy. Mathematics is a uniquely well-suited partner with social justice because it can model, through replicable and empirical demonstrations, the nature and intersections of global and local power systems in a way that students can comprehend. Social justice provides engaging, empowering, and authentic contexts for projects in which mathematics skill sets can come alive and transcend the traditional limited and abstract operations that have isolated and discouraged too many students for too long. Mathematics can be employed to argue social justice issues without the succumbing to the pitfalls of emotional backlash. Social justice can elicit intrinsic motivation in students, which inspires growth far beyond the basic traditionally requisite mathematical skill set. The two strands are best contextualized authentically within the local community. Social justice presents unique challenges for teachers because it is a lifelong and dynamic process. It requires the maintenance of extensive and constantly evolving understandings of every student in a given classroom. Teachers of social justice must also be dedicated to applying socially critical pedagogies within the classroom environment. Mathematics has been so heavily conditioned into many teachers' minds as an abstract calculation tool that many will blindly defend it as such while others, alienated by the traditional approach, will openly declare their hatred of the subject. The problems that suppress the integration of mathemat-

ics and social justice pedagogy and content are eclipsed only by the ever-increasing need for such pedagogy and content to be unilaterally implemented in schools. Students need socially critical mathematics and local, national, and global communities need students (i.e., citizens) who can interpret, articulate, and act upon social justice issues with the science of mathematics at their command.

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