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When setting standards and creating mathematics curricula, policymakers and curriculum designers must make choices about what kinds of mathematics are included in our state or national standards as well as in our textbooks. A persistent question in the field of mathematics education is why and how these choices are made, to which there does not appear to be any clear, consistent answer (Harouni, 2015). However, a recent movement within the mathematics education community has shifted the conversation about the purpose and goals of school mathematics. Professional organizations, including the Association of Mathematics Teacher Educators (AMTE), the National Council of Supervisors of Mathematics (NCSM), TODOS: Mathematics for ALL (TODOS), and the National Council of Teachers of Mathematics (NCTM), have begun highlighting equity and social justice as top priorities within the field (AMTE, 2015, 2016; NCSM/TODOS, 2016; NCTM, 2012). The emphasis on social justice as a key aspect of teaching mathematics is now being considered both as a priority of professional organizations and as a focus of conferences within the field. This movement, described by some as a sociopolitical turn, has pushed mathematics education in the 21st century into a new era (Gutierrez, 2013; Stinson & Bullock, 2012), focusing school mathematics on social and political issues and solutions.

Despite these exciting changes, some critics have expressed skepticism about the effectiveness of school mathematics as a tool to illuminate and address issues of social justice (Martin, 2013). In alignment with Martin's argument that current efforts have not effectively challenged current power structures in society, I will consider issues of equity and social justice through a historical and political framework in order to articulate why mathematics cannot (in its current form) complete the sociopolitical turn. Furthermore, I will suggest directions for school mathematics and educational policy that can increase the effectiveness of current efforts in critical mathematics (Frankenstein, 1983, 2009; Stinson & Bullock, 2012) and social justice pedagogy (Gutstein, 2006) to tackle relevant social and political issues.

The Fundamental Problem

Mathematics education, in its current form, cannot be fully used as a tool for critiquing society. The fundamental problem becomes clear if one considers the historical context through which school mathematics has emerged and developed. Harouni (2005, 2015), through an analysis of that context, created a categorization of school mathematics that described the four types of mathematics (and mathematics problems) that have developed over the course of human civilization: (a) philosophical, (b) artisanal, (c) commercial administrative, and (d) socio-analytical. He argues that these categories developed as a result of both economic and political forces, and that the (word) problems that we see in mathematics textbooks emerge from those categories and are a reflection of the political and economic climate of their time.

Briefly, philosophical mathematics is focused on the abstract and used to understand logic and patterns without concern for their context. In practice, philosophical mathematics is more an intellectual exercise than a tool for finding solutions to real-life problems. Artisanal mathematics is concerned with problems in the workplace, such those faced by engineers, architects, and tailors; unlike philosophical mathematics, it is focused on dealing with practical, real-life situations. For example, it is used by a carpenter building a table and involves many variables. The carpenter must decide what type of wood to use, how to cut it, and how to make sure the table will remain upright.

Commercial-administrative mathematics focuses on the work of the merchant and is rooted in the activities of buying, selling, and trading. Unlike artisans, who are concerned with problems involved in measuring, merchants are interested in issues related to counting. Finally, socio-analytical mathematics moves beyond numbers and uses the solutions to mathematical problems to spark discussions about the implications of the mathematics for society, allowing for a critique of the status quo. While a mathematics problem on the growth of the federal minimum wage versus the cost of living might deal with some quantitative comparisons, the socio-analytical perspective compels the mathematician to consider the social impact of the results of those comparisons and the justice of the socio-economic system in which they are situated. Harouni (2015) describes each of these categories of mathematics and their historical roots at length.

There has been a push by researchers and practitioners to forefront political tensions in mathematics education—a movement that has been termed a sociopolitical turn (Gutierrez, 2013). Such a movement would require a greater focus on socio-analytical mathematics. However, I argue that the current form of mathematics education has instead forefronted commercial-administrative mathematics and has limited the appearance and importance of other forms, including socio-analytical mathematics (AMTE 2015, 2016; Gutierrez, 2013; Martin, 2013; NCSM/TODOS, 2016; NCTM, 2012, Stinson & Bullock, 2012). While I believe that philosophical and artisanal mathematics also deserve a place in school mathematics, the focus of this paper will be on ways in which socio-analytical mathematics can be forefronted more within school mathematics. In the following section, I will explain why I believe that school mathematics is currently most focused on commercial-administrative mathematics, and how this might be changed to increase the focus on the socio-analytical perspective.

The Relationship Between Commercial-Administrative Mathematics and Socio-Analytical Mathematics

Since merchants were among the first users of mathematics, commercial-administrative mathematics has been employed widely from the beginning of civilization. The use of mathematics in this form facilitated buying, selling, and trading through counting. Thus, at its roots, the practical use of mathematics is most readily obvious in economic contexts. One need only consider the common pedagogical approach of helping students make sense of a mathematical concept that they do not understand by “bringing it back to money.” Out of necessity, most everyone in capitalistic societies recognizes money and understands how to interact with it. One cannot, in general, function in such societies without a working knowledge of how to buy, sell, and trade. The implicit importance of knowing how to accumulate or distribute goods is clear when we look at the types of problems that we commonly find in school mathematics. For example, in elementary school, the use of both join and separate word problems (Carpenter, Franke, & Levi, 2003) commonly involves students using addition and subtraction to accumulate, distribute, or remove something. Consider the following word problems, which were presented to children in grades 1 through 3:

- Wally had 3 pennies. His father gave him 5 more pennies. How many pennies did Wally have altogether?
- Tim had 8 candies. He gave 3 to Martha. How many candies did Tim have left? (Hiebert, Carpenter, & Moser, 1982, p. 87)

Students are thus introduced to mathematics through the process of accumulating and sharing goods. Those who have studied secondary mathematics may have been assigned problems involving simple and compound interest or calculating the cost of cell phone plans. Teachers bring students back to situations involving buying, selling, and trading because this is what they are used to. Furthermore, these "real-life" contexts are assumed to be very relevant to students' lives.

On the other hand, teachers and researchers have expressed interest in expanding the content of mathematics beyond what has traditionally been taught in school (i.e., the commercial-administrative perspective of mathematics). Some studies have investigated ways in which school mathematics can be used as a tool to challenge inequities in society. Work in a variety of areas has emerged to support the use of mathematics as a tool to address social injustices, including with pedagogies described as culturally relevant (Ladson-Billings, 1995), culturally responsive (Gay, 2010), culturally specific (Leonard, 2008), and culturally sustaining (Paris & Alim, 2014) as well as with critical mathematics pedagogy (Frankenstein, 1983; 2009; Skovsmose, 2014) and social justice pedagogy (Gutstein, 2003, 2006; Gutstein et al., 2005), among others. This work has involved redefining the purpose of school mathematics to include promoting not only what Gutstein (2006) has described as functional literacy (i.e., being able to do mathematics in the traditional sense), but also critical literacy, which involves approaching knowledge critically and developing the agency to act in order to make changes in the world. However, consider the following problem:

> Last June, about 250 students graduated from Simón Bolivar high school. Could the cost of one B-2 bomber give those graduates a free ride to the UW [University of Wisconsin–Madison] for four years? (Gutstein, 2006, p. 247)

This problem *could* be used to foster conversation about the amount of money that is spent on the military and how else that money could be spent (and if money could be used differently to benefit society). However, even if this problem presents opportunities for rich discussion and analysis of our society's decisions around funding (i.e., for students to engage in socio-analytical mathematics), it is ultimately still tied to commercial-administrative foundation of mathematics. By design, this problem requires students to reduce a complex societal issue to a comparison of the monetary value of the bomber and the cost of the college education. Even though such problems provide opportunities for students to engage in socio-analytical mathematics, they are still grounded in the same commercial-administrative perspective that students are accustomed to. Some researchers therefore argue that this pedagogical approach does not actually challenge deeper underlying societal issues such as institutional racism and income inequality (Martin, 2013). Martin states that critical analyses of market-oriented projects have typically left underlying racial projects unanalyzed, and that mathematics education itself is an instantiation of a White institutional space. He states that mathematics educators must continue to question what kind of project mathematics education is, and whose interests are served by the field.

I argue that school mathematics has developed in such a way that commercial-administrative mathematics forms its foundation, and that deep critiques of society have been placed in a secondary position within this system. The centrality of a commercial-administrative perspective has given it a privileged position in the teaching of mathematics in the United States over other perspectives that might allow mathematics education to serve a different and perhaps deeper purpose. This begs the question: What would school mathematics look like without a foundation in commercial-administrative mathematics? Would it be possible to create a system where we instead begin with socio-analytical mathematics as the foundation from which school mathematics emerges and develops? In what other ways could students' early mathematics experiences be shaped? The following section will address these questions, elaborating on what might be possible if we reframe students' early experiences in mathematics to forefront the socio-analytical perspective.

Envisioning a Socio-Analytical Approach to Mathematics Education

In order to truly embrace moving school mathematics toward the sociopolitical turn, we must use a more balanced approach that introduces the socio-analytical perspective at the beginning of a student's education. If we wait, we fall into the same patterns that have hindered progress in making that turn. I believe real, effective change involves considering the most fundamental aspects of mathematics from the socio-analytical perspective.

Mainstream mathematics education in the United States (and in many other countries) begins with the four basic operations: addition, subtraction, multiplication, and division. Students then are asked to use the operations in order to find values they will obtain as a result of using these operations (i.e. 3 plus 4 equals 7). Such a framing communicates to students that "equals" is used to indicate that the following quantity is the result of a mathematical operation. This framing, however, is limited, and does not account for other situations that students encounter later in mathematics (e.g. when dealing with algebraic expressions, multiple expressions set equal to each other, or equations where the unknown is not the right-most quantity). Students' early misconceptions resulting from this initial use of the equal sign can lead to misconceptions that need to be addressed in later mathematics courses.

Recently, there has been a focus on making sure that students know what the equal sign "means" (Powell, 2012). Although children often think of the equal sign as operational (i.e., used when one has done a calculation and found the answer), mathematics education researchers have advocated for helping students instead see the equal sign as showing a relationship between the expressions on each side of the equation (i.e., that the two expressions have the same value), either in situations where they must compare existing expressions, or ones where they must generate their own expressions in order to create equality. Students can understand the use of the equal sign as a relational symbol rather than an operational symbol to deepen their early understanding of mathematics, and reframing their understanding of this symbol can have positive benefits as they move toward more advanced topics.

While the use of the equal sign as a relational symbol can deepen students' understanding of this mathematical symbol, I argue that such a framing of equality can be expanded further, in a way that might facilitate early discussion of issues relevant to socio-analytical mathematics. Clearly, mathematics has a strong interest in equality, as we begin using the equal sign explicitly as early as elementary school and continue to use it in the most advanced mathematics. In many mathematics textbooks, you are likely to see equality in most, if not every, chapter. Students are not often asked how this mathematical concept relates to the real-life concept of equality. For example, students in mathematics classrooms are not typically asked the question "Why is equality desirable, and why is it useful to be able to recognize or create it?"

The concept of equality has important value inside and outside of mathematics, and discourse around equality can connect these in a meaningful way, starting at an early level. For example, students in mathematics classes who are learning about equal sharing division might be asked to consider why we want to give an equal number of our 20 candies to each of four people, as opposed to giving everyone a different amount? Why is this a good way of distributing them versus any other? A student who is working on comparing the area of two rectangular plots of land with different dimensions given to two farmers might be asked about what questions might be considered when deciding how much land each should get and in what contexts it might be justified in not receiving the same area of land in situations where the total amount of land is limited.

The socio-analytical perspective around equality is an example of a way that such conversations can begin at an early age for mathematics students, and I argue that these types of discussions can continue to happen at all levels of school mathematics. Meaningful discussion around socio-analytical mathematics can be extended to include more advanced concepts throughout the K-12 curriculum around topics such as fractions, proportional reasoning, and geometry. However, I argue that the current structure of school mathematics is not arranged in a way that facilitates this development, and that there are a number of steps that might be taken in order to support a sociopolitical turn towards a more socio-analytical form of school mathematics. The following section offers a set of steps that might be taken in order to support such a form of school mathematics.

Steps Toward a Socio-Analytical Approach to Mathematics Education

The steps and examples discussed in this section refer to the current structure of mathematics education in the United States, but the underlying principles could be adapted to be relevant to school mathematics in any context. Here I will describe a set of steps that could be effective in moving school mathematics in the United States toward the sociopolitical turn.

1. Standards must be adapted to support the socio-analytical perspective

   The Common Core State Standards of Mathematics (National Governors Association Center for Best Practices, & Council of Chief State School Officers, 2010) have currently assumed a prominent position in mathematics in the United States. Since curriculum developers often work with the current content and practice standards in mind (whether or not these are explicitly listed within the textbooks associated with the curriculum), they play a vital role in how the mathematics curriculum is created and how the curricular content is presented. There has been criticism of the Common Core State Standards of Mathematics (CCSSM) and its effectiveness (e.g. Martin, 2013), just as there have been critics of standards for decades (e.g. Darling-Hammond & Wise, 1985). My critique of the CCSSM is not based on the quality or effectiveness of the CCSSM as currently envisioned or implemented, but instead on the belief that the implementation of these standards, as currently designed, does not offer opportunities for a socio-analytical approach to teaching mathematics in schools.

   Currently, none of the CCSSM practice standards directly address issues that are central to socio-analytical mathematics. Critique, a basic element of socio-analytical thinking, is addressed in Practice Standard 3: "Construct viable arguments and critique the reasoning of others" (National Governors Association Center for Best Practice, & Council of Chief State School Officers, 2010). However, the elaboration of this standard does not include any reference to using this critique to address issues of inequality or inequities in society. For example, a teacher may ask students to choose the "best" way to distribute a limited set of resources among a number of individuals or groups and then defend their choice to the whole class, which may have groups who support a different distribution. Such a discussion may be very rich, as deep conversations may develop as students form their opinions based on different assumptions about what is fairest or most desirable. The current form of this standard, however, does not ask this of teachers or of students, and so one can very reasonably address the current standard without having meaningful discussion around issues of social justice. Adjusting the standard to include examples such as the one above can encourage the inclusion of such socio-analytical discussion in mathematics classroom discussions.

   Similarly, content standards must be rewritten to incorporate goals of challenging or upending the status quo. Currently, content standards exist that support the use of commercial-administrative mathematics, but not of socio-analytical mathematics. Consider the following examples given in the CCSSM for K–12 mathematics topics:

   - Grade 7 – Proportional Relationships: simple interest, tax, markups and markdowns, gratuities, commissions, and fees

   - High School – Algebra: calculation of mortgage payments to derive the formula for the sum of a finite geometric series (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, n.pag.)

   Additionally, consider the following contexts given for teaching content standards within the CCSSM:

- Grade 7 – Real-life problems: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50
- High School – Functions: Calculating the number of person-hours it takes to assemble "n" engines in a factory
- High School – Modeling: Designing stalls at a fair to maximize profit and modeling savings account balance or investment growth (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, n.pag.)

Clearly, even with recent math curriculum reforms, in our content standards there is still much attention paid to issues related to commercial and administrative work. While there are a few examples in the content standards of contexts that might be considered socio-analytical (such as in discussing how water and food might be distributed or in analyzing risk in pandemics or terrorist attacks), there are no standards that require students to engage in this type of analysis. Furthermore, the socio-analytical aspect of this work (e.g., discussions of how resources might be distributed) is not even mentioned in the standards. Therefore, even if socio-analytical contexts are used, it is possible that no critical analysis will be done beyond the mathematical calculations required to solve a given problem (e.g., calculating the number of gallons of water each household is given following a disaster, if resources are evenly distributed).

2. The content of mathematics curriculum must change

As mentioned before, the word problems that are currently part of mathematics curriculum are most often grounded in the commercial-administrative perspective. In order to change the status quo, problems that investigate issues of social justice, equity, and equality must be presented at all grade levels. Consider the following problem:

> Tim has 10 cookies. His teacher said that he should share his cookies with Bill and Kevin because they do not have any cookies. How many cookies should Bill and Kevin be given in order to be fair?

This question does not necessarily have a straightforward answer. We might consider a few options. If Tim wanted to distribute the cookies equally to Bill and Kevin, they should each get five. However, that might not be fair, because then Tim would have none for himself. He could give three each to Bill and to Kevin and keep three for himself, but then there would be the question of what to do with the tenth cookie. One possibility would be to break the last cookie into thirds, which would result in all of the cookies being divided equally. Another problem could involve toys (which cannot be broken into pieces) instead of cookies; then there would be the issue of what to do with the tenth toy. Perhaps one could argue that Tim should keep it, since all the toys were his to begin with. One might also consider whether Tim is obligated to share his toys at all. Should he have to give them up because other children don't have as many (or any)?

Other questions can be asked as we develop mathematics for higher grades. For example, is it fair to distribute everything equally, or are there cases where we ought to divide things proportionally?

In the US Congress, we choose to do both, with proportional representation in the House, based on population, and equal representation in the Senate. Why do we do both? What does this choice tell us about what we value as a society? With regard to the current political issue of tax reform, some would argue that proportional approaches make more sense than "equal" amounts of tax, and yet, we have tax brackets where people at different levels pay different percentages of their incomes in taxes. Is this fair? What does this choice say about us as a society, and does this need to be reformed?

I argue that such questions can and should be asked in socio-analytical mathematics classrooms. However, without standards that push curriculum developers to create materials to support this approach (and with no incentive for teachers to do so), it is unlikely that it will gain any significant traction in the near future.

3. Standardized assessments must be changed (or removed)

Finally, we must consider how we can assess socio-analytical mathematics knowledge. Often, the effectiveness of teachers and schools in implementing standards is based on how students perform on assessments that frequently take the form of high-stakes standardized testing. The SAT exam is an important high-stakes exam, as it is taken by many high school students and is often a requirement for college admissions. The mathematics section of the exam currently features calculator and non-calculator sections covering three areas of math: Algebra, Problem Solving and Analysis, and Passports to Advanced Math. These sections are designed to provide real world skills that can be applied to college courses, jobs, and students' personal life (College Board, 2019). The SAT test has undergone many changes over the years, and the latest shift of the exam has intentionally moved it towards testing the mathematics covered in the CCSSM to more accurately represent the mathematics covered during students' schooling. Because the current SAT exam is a reflection of the CCSSM, the limitations of the standards themselves are thus transferred to the college admissions process, further extending the reach of the current system.

If the current standards were adjusted, however, assessments that currently are gatekeepers to higher education access might also be adjusted in order to reflect a shift in school mathematics. In response to changes in the CCSSM, high-stakes standardized tests such as the SAT might begin to include open-ended questions that require students to both solve a mathematical problem and offer an articulate justification of their reasoning, allowing an assessment of both mathematical and writing ability at the same time. For example, given information about the population distribution in Flint, Michigan, and the amount of water available there, students could be asked to write a plan in which they discuss how resources could be distributed (and over what time period) to ensure that the public has clean drinking water as changes are made to the infrastructure of the city. To create the plan, students would have to use mathematical calculations and provide justification for their decisions. These types of questions would address standards that incorporate socio-analytical mathematics skills and assess the extent to which students have met these standards. As it stands, however, current assessment practices continue to perpetuate the commercial-administrative focus that dominates school mathematics. While it would be possible to eliminate this issue by simply removing high-stakes testing from the college admissions process, it seems unlikely that this would be a realistic option within the current US educational system.

The relationship between standards, curricula, and assessments is complex and is controlled by a variety of societal, political, and economic forces. For this reason, large-scale systemic change must be a result of change in all three of these areas. It is only through a holistic overhaul of school mathematics that the discipline can embrace a greater use of socio-analytical mathematics and move towards a substantive, lasting sociopolitical turn.

Conclusion

The current educational landscape has developed in such a way that the commercial-administrative perspective has been given a privileged status, and other perspectives have often been neglected. Although a number of mathematics approaches, such as social justice mathematics and critical mathematics, have attempted to take the sociopolitical turn, they often do not effectively create a meaningful challenge to the status quo (Martin, 2013). I argue that our current vision of school mathematics hinders our ability to use mathematics for a truly significant critique of inequities and injustices in society. This paper presented options for how mathematics education might be re-envisioned to support a new school of mathematics, with more balance.

By developing an approach that forefronts socio-analytical mathematics from the ground up, and which is supported by modified standards, curricula, and assessments, the field can support the movement toward the sociopolitical turn, which will support students' ability to meaningfully discuss inequities in society and to develop ways to challenge them.

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