Preface to "Equity in Mathematics Education: Unions and Intersections of Feminist and Social Justice Literature"

Laura Jacobsen

> The evidence is clear that groups of girls continue to be disadvantaged by previously identified dimensions—the mathematics curriculum, classroom practices, and assessment practices—as well as with respect to newer aspects including the adoption of technology into mathematics pedagogy. (Leder and Forgasz 2008, p. 518)

In recent years, research examining results from tests of mathematics performance has generally documented small or reduced gaps between male and female students (e.g., Else-Quest et al. 2010; Hyde et al. 2008; McGraw et al. 2006). However, this is not always the case. For example, research exploring the gender gap among high-achieving high school students, using data from the American Mathematics Competitions, has indicated that the gender gap widens dramatically at very high percentiles and that the highest-achieving girls are concentrated in a very small set of elite schools (Ellison and Swanson 2010). A study by Fryer and Levitt (2010) documented the emergence of a substantial mathematics gender gap in the early years of schooling in the United States, documenting that girls lose more than two-tenths of a standard deviation relative to boys over the first six years of school, across every strata of society.

Analyses of disparities in students' mathematical achievement on standardized tests have sometimes been referred to as "gap gazing" and have been used to assess whether schools offer equitable opportunities by race, gender, income, or other demographics (Lubienski 2008). Such analyses have sometimes shaped public opinion and informed educational policy. However, despite their routine use as tools for educational analyses, as Gutiérrez (2008) indicated, an achievement gap focus offers only a static picture of inequities and constructs some groups as "failures" relative to other groups. Describing the popular use of the "racial achievement gap" in mainstream mathematics education research, policy, and practice, Martin (2009) similarly indicated that attempts to compare population groups serve to sort students

L. Jacobsen (✉)
Radford University, Radford, VA, USA
e-mail: ljacobsen@radford.edu

Formerly Laura Spielman.

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into those who know, and those who do not know, mathematics and treats race as a causal variable for mathematics achievement. Students' racialized forms of experience are not addressed through mainstream mathematics education efforts.

Similar arguments can be made for why achievement gap studies in mathematics education by gender are likewise inadequate. Leder and Forgasz (2008) suggested that such studies sometimes overlook explanations for why scores vary little by gender. For example, Leder and Forgasz explained how by focusing heavily on lower cognitive level items, tests of mathematics performance may provide a limited database for analysis. The United Nations Educational, Scientific and Cultural Organization (UNESCO) reviewed international approaches to analysis of gender-disaggregated data (Huyer and Westholm 2007). Huyer and Westholm indicated that women's participation in science, engineering and technology contributed to increasing enrollments of up to 20–25% in many countries, but cautioned that the numbers have declined by approximately 10–15% since 2000. Given the serious impact this may have internationally, especially on developing countries (Huyer and Westholm 2007), clearly a broadened database beyond test scores and continued attention are needed to promote gender equity, as well as other forms of equity, in mathematics education.

In my original publication, "Equity in mathematics education: Unions and intersections of feminist and social justice literature" (Spielman 2008), I situated gender equity in mathematics within broader international equity concerns. I described connections between gender inequities and differences also by social class and race/ethnicity, and I also related gender inequities in mathematics to overarching inequities with respect to economic participation, economic opportunity, political empowerment, educational attainment, and health and well-being (Lopez-Claros and Zahidi 2006). I suggested the need for mathematics education to transform its largely decontextualized and impersonal traditions by fostering new goals supporting equity and serving broader public interest goals both in the U.S. and abroad. I argued that to secure a transformative and sustainable impact on equity, mathematics needs to be treated as an integral component of a larger system producing educated citizens, making the case that mathematics as a discipline must be reconstructed, beginning with the question, "What is the purpose of schooling?" Longstanding disciplinary boundaries must be torn down in favor of a newly constituted mathematics that rewrites traditional practices in the field in favor of a new "common sense" that integrates the learning of mathematics with social critique and with community relations and actions.

Since publication of Spielman (2008), the focus of my research efforts has been in the development of the *Mathematics Education in the Public Interest* (MEPI) project[1] with my colleague, Jean Mistele. The MEPI project aims to put into practice the theoretical framework described in that publication, and has three overarching goals: (1) To support equity and social justice in mathematics education, (2) To

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diversify student interest and participation in mathematics, and (3) To broaden and enrich the ways mathematics is viewed as a discipline. Gender equity is included as one aspect within the project's emphasis on equity.

Thus far, the focus of the project has been in elementary and middle school teacher education. Our primary project objective involves curriculum and course development for a new junior-level course for preservice teachers (PSTs), *Elementary and Middle Grades Mathematics for Social Analysis* (*Math for Social Analysis*), offered through the Department of Mathematics and Statistics at Radford University. Our secondary objective involves conducting and disseminating related mathematics education research examining PSTs' learning and experiences in *Math for Social Analysis*. We have also begun work to create an online MEPI activities and resources center. Because nearly all PSTs in the elementary education program, in particular, are female, the MEPI project has primarily involved female PSTs as participants. In the remainder of this preface I describe progress on our two main objectives.

1 Introduction to Math for Social Analysis

Math for Social Analysis focuses foremost on mathematics content, but dualistically aims: (1) to have the learning of interdisciplinary applications and important social issues to strengthen and reinforce mathematical understandings and (2) to have the mathematical activities and projects to reinforce and strengthen understandings of the interdisciplinary applications and important social issues. Interdisciplinary content and choice of social issues vary depending on current events, student interest, and text selection. Interdisciplinary content always includes many diverse relationships to science, social studies, and language arts. Course content includes discussions of political, social, and economic challenges and implications associated with understanding and even changing the world using mathematics.

Curriculum units from the course have included: (1) A global economy unit addressing topics such as poverty and the distribution of wealth and sweatshop labor, (2) An environmental unit addressing topics such as water and energy conservation, mountaintop removal coal mining in Appalachia, and rain forest depletion, and (3) A gender equity unit addressing topics such as salary distribution in the workforce, international differences in mathematics participation and achievement by gender and other demographics, gendered media images, and stereotyped roles and expectations for women. We aim to help PSTs learn about and conduct research on these issues while simultaneously deepening their understanding of the mathematics needed for critical analysis of these issues. As instructors, we determine some mathematical concepts to be addressed within these social issues, and we also offer opportunities for PSTs to pose and try to answer their own questions about these issues, using mathematics. Although we face a constant struggle, and a wide range of successes and failures in doing so, we maintain a goal of creating and responding to questions for which citizens would care about the answer, rather than creating textbook-style, artificial word problems.

2 Introduction to MEPI Research

We have documented some of the issues and struggles PSTs face as they learn MEPI ideas in *Math for Social Analysis*. For example, when PSTs created their own MEPI lesson plans as part of a semester-long project, they struggled to balance emphases on mathematics, reform-based pedagogy, and social issues (Jacobsen and Mistele 2010). Some PSTs' projects *applied* various mathematical concepts, but failed to *teach* any of the mathematics being used; others had interesting projects, but used primarily traditional and/or non-challenging mathematics. Some PSTs focused on the mathematics, but gave only cursory attention to the meaningful aspects of the social issues; others created lessons with disconnect, or artificial connections, between social issues and the mathematics.

Despite these many challenges, on the whole, we have been very pleased with student feedback from *Math for Social Analysis*, especially feedback from students who described previous struggles with or dislike for mathematics. Many PSTs enter *Math for Social Analysis* describing high levels of mathematics anxiety. In Mistele and Spielman (2009), we communicated the course's overall success at reducing PSTs' mathematics anxiety and generating positive attitudes toward mathematics and toward mathematics teaching by increasing the utility of mathematics, redirecting attention away from anxiety, and building confidence to teach. PSTs universally label this course as their first extended experience with learning mathematics in connection with multiple meaningful real-world applications and social issues. Class discussions about the social issue units are often rich with enthusiasm, critique, and questions. For example, in analyzing salary data across many professions during the gender equity unit described above, PSTs have raised and debated questions regarding why teachers' salaries are low. They have discussed the role of societal gender inequity in producing teaching as a second-tier status profession in many nations.

One course strength has been that PSTs develop greater understanding of how to integrate social issues and mathematics, and most describe their interest in incorporating social issues into their mathematics classrooms in the future. For example, one PST, Allie, explained:

> When I become a teacher I will be able to look back on this course and remember how easy it is to teach about a social issue and also about a math lesson. Teaching a social issue will engage the student to be interested in the math lesson. . . . My students will not only be excellent math whizzes but they will also know what is going on with the world. I will encourage them to use the newspaper, book, Internet, and current issues in their learning experience. I hope to also show other teachers at my future elementary school the different ways they can help and teach their students. I now hope that all teachers will use current issues to teach the children.

Based on MEPI research, we have also reported on survey results providing evidence that PSTs' views about mathematics and about mathematics teaching changed over the semester (Spielman 2009). They came to see mathematics as increasingly useful for understanding and engaging with important issues and increasingly connected to home and community experiences. Further, we concluded that interwoven mechanisms supporting PSTs' engagement with and reframing of mathematics included: (1) Learning the relevance of mathematics to something they care about;

(2) Developing interest in mathematical applications and in supporting their future students' interest and learning in mathematics; and (3) Shifting their perspectives on mathematics by changing prior assumptions and instructional goals. As PSTs increasingly saw mathematics as relevant and important in social issues, they developed new teaching goals to help students integrate mathematics with other subjects and the world outside of school. Finally, they developed a new sense of agency to create mathematical learning opportunities that students will find interesting and relevant.

The majority of our PSTs describe support for having the mathematics situated within relevant social, economic and political contexts—such as in using mathematics to analyze gender equity. However, some PSTs do not support the course's emphases on mathematics in connection with social issues, and reject the new ideas outright or make comments such as, "I think that social issues are mostly for a political science and social science class to take care of" (Annie). This may be due largely to their prior experiences in mathematics classrooms having traditional classroom norms that do not include a public interest emphasis. In addition, some students—particularly those who hope to teach in the lower elementary grades—raise concerns about the potential relevance of social issues in their future classrooms. Others question whether an interdisciplinary approach to teaching mathematics is feasible given time constraints for lesson planning and implementation. They additionally have concerns regarding whether teaching mathematics using social issues is beneficial to students' academic performance on mandatory state standardized tests in mathematics. We continually adapt course design to address the concerns raised by our students.

3 Theoretical and Practical Challenges

We can represent the various practical challenges that we, as mathematics teacher educators, face in course design and implementation as three types of balancing acts, balancing emphases on: (1) Mathematics content and social critique; (2) Mathematics content and pedagogy; and (3) In-class and out-of-class experiences and learning.

Balancing Mathematics Content and Social Critique The greatest challenge we face as teacher educators is finding appropriate balance in depth and breadth of emphases on helping PSTs learn mathematics while helping them critically engage with social issues. Nolan (2009) explained how the "statistics and figures" content approach that takes mathematics as usual and appends social justice concepts will not be enough (p. 207). *Math for Social Analysis* addresses all five NCTM content strands, yet number and operations and statistical concepts generally align more easily with social issues than others. We struggle to balance time spent examining mathematical concepts for deep understanding with time spent engaging PSTs with social issues that does not trivialize either or produce artificial connections between them.

Balancing Mathematics Content and Pedagogy We dualistically aim to balance PSTs' personal experiences with learning rich mathematics within the context of social issues, while: (1) critiquing their own understanding of mathematics as a discipline in relation to the democratic purposes of schooling and (2) building new pedagogical content knowledge embedded in MEPI principles. Finding an appropriate balance has been a constant challenge.

Balancing In-Class and Out-of-Class Experiences and Learning Our challenges extend outside of the classroom as we strive to balance the in-class and out-of-class experience through mathematics service learning for PSTs in several after school programs, which requires that PSTs create and implement MEPI activities with children. We strive to balance the needs of our service learning partner and our course goals. Our service learning partner takes responsibility for the scheduling and assessment of our PSTs, and their feedback becomes a component of the PSTs' course grade. PSTs complete reflective journals periodically throughout the semester, and they submit their activity write-ups and reflections to their course instructor.

4 Final Thoughts

The theoretical outline for a new mathematics education posited in Spielman (2008) has been, and will continue to be, challenging but invigorating to explore and research at a practical level in the mathematics classroom. In the MEPI project, we have aimed to address gender equity issues as a component of broader equity and social justice considerations both in the U.S. and globally. We have aimed to invite participation, interest, and success in mathematics through changing the face of the mathematics itself and what it means to do mathematics in the classroom. Thus far, we have primarily done this by incorporating relevant and contextualized social issue mathematics units for PSTs into the *Math for Social Analysis* classroom and by having small group and whole class discussions about equity and social justice issues—including gender equity issues. Clearly, this is just a starting point for the project, and we hope to use our research to continue to develop our course and project in ways that further, and even more effectively, promote equity both in and outside of mathematics education.

It can be intimidating for teacher educators and researchers, including myself, to communicate practical attempts to apply theoretical principles, given that our idealistic notions for what is needed in mathematics education is extraordinarily challenging to visualize and actualize in the classroom. No attempts will be perfect, but each of us engaged in this sort of work must continue weaving and meshing theory and practice so that we may transform mathematics education to better support equity and social justice. We must further make clear that such work is not simply about making the curriculum more relevant, but instead, doing something important with our curriculum toward supporting democratic citizenship that the individual disciplines themselves would not be able to accomplish.

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