Preparing Teachers for Democratic Mathematics Education

Mark Ellis
mellis@exchange.fullerton.edu
Assistant Professor, Secondary Education, California State University-Fullerton
Carol E. Malloy
cmalloy@email.unc.edu
Associate Professor, Mathematics Education, University of North Carolina at
Chapel Hill

Abstract

This paper first offers an explication of the notion of democratic education and how this is applied in the mathematics classroom. Next we present examples of educators who have made efforts to establish democratic mathematics learning environments and discuss how their actions both clarify and complicate this notion. Finally, we offer and critique our efforts to prepare mathematics teachers both *through* democratic practices and *for* democratic classrooms.

Introduction

Moses and Cobb (2001) make a compelling argument that access to mathematics, especially algebra and advanced mathematics, is a civil right no less important than the right to vote in the twenty-first century United States. The limited access of poor and minority students to algebra and advanced mathematics mirrors the global concern about students having democratic access to powerful mathematical ideas. Reasons that students reject or are rejected by mathematics are numerous including teacher/societal perceptions of ability, cultural discontinuity in learning and instruction, tracking, poverty and school finance, and low expectations of teachers, parents, or society (Gutierrez, 2007; Tate and Rousseau, 2002; Volmink, 1994)—practices that are inherently undemocratic. As a result many students never become enculturated into doing mathematics and empowered as users of mathematics (Malloy & Malloy, 1998).

Standing in stark relief to the norm, there have been several recent examples of the enactment of practices aimed at helping students of mathematics to develop content knowledge in ways that also promote students' abilities to critique the communities of which they are members (Gutstein, 2003; Gutstein & Peterson, 2005; Turner & Font Strawhun, 2007; Vithal, 1999). Understanding that such work offers possibilities for reformed practice, the issue for us as mathematics educators becomes that of how to prepare teachers of mathematics who are capable of creating democratic learning environments for their own students.

In the service of generating insights into this query, we first offer an explication of the notion of democratic education and how this is applied in the mathematics classroom. Examples of educators who have made efforts to establish democratic mathematics learning environments will both clarify and complicate this notion. Finally, efforts taken by the authors to prepare mathematics teachers both *through* democratic practices and *for* democratic classrooms will be offered and critiqued.

Democratic Education

Democratic education is a process where teachers and students work collaboratively to reconstruct curriculum to be inclusive of diversity. Each classroom will differ in its attributes because the interactions of democratic classrooms are based on student experiences and community and educational context. In democratic mathematics classrooms there is no one way or context through which mathematics is taught. There are concepts, topics, and processes that must be learned, but individual teachers and learners will approach mathematics based on their

needs, preferences, and experiences. Democratic education is accessible to all students, rests on the assumption that all students can learn given the right circumstances, provides students with an avenue through which they can learn substantial mathematics, and helps students develop the tools to become productive and active citizens (Malloy, In press).

The literature on democratic education consistently identifies distinguishing qualities of democratic classrooms to include: (a) problem solving curriculum, (b) inclusivity and rights, (c) equal participation in decisions, and (d) equal encouragement for success (Beyer, 1996; Pearl and Knight, 1999; Wilbur, 1998). These qualities do not define the curriculum but serve as the basis for classroom interactions and discussions of overriding issues and questions through the use of specific and integrated knowledge of content areas. Below, these four qualities are framed in terms of the mathematics classroom through an adaptation of the work of Beyer (1996), Pearl and Knight (1999), and Wilbur (1998) (Malloy, In press).

a. Problem solving curriculum. Students should be presented with a curriculum in mathematics that allows them to draw on their accumulated knowledge to solve problems important to their lives and society. They should have experiences that help them to locate relevant information cognitively, gather additional information from other sources, and to visualize multiple representations to access new meanings. Through a process of collaboration, they should have experiences that develop their ability to analyze, critique, and evaluate mathematical options.

b. Inclusivity and rights. Students should be taught using approaches that provide a range of opportunities for accessing and processing mathematical ideas. Mathematics should be examined from multiple perspectives affirming the worth of diverse experiences and approaches in solving problems.

c. Equal participation in decisions that affect student lives. Students should be able to use the mathematics classroom as a forum for open discussions of mathematical and social issues and ideas, because through such discussions students are able to create, clarify, and reevaluate their ideas and understand the ideas of others. Students should be adept at communicating their mathematical ideas to others with care and respect in a process of accuracy, persuasion, and negotiation.

d. Equal encouragement for success. Students should have access to materials that engage them actively in the learning of mathematics. They should be encouraged equally as they develop the habits of mind to draw conclusions and critically evaluate implications from mathematical data for personal and social action.

The learning experiences and processes represented by these four qualities resemble the goals of many reform-oriented mathematics programs. Pearl and Knight (1999) purposefully recognize the importance of mathematical knowledge and the utility of mathematics through problem solving stating, "It is impossible to be a democratic citizen and not be proficient in mathematics. Every decision that a citizen must make requires complicated calculations" (p. 119). In addition, as Hannaford (1998) so powerfully argues, democratic mathematics education can provide the groundwork for democratic participation in society and the lack thereof is detrimental to this goal.

Within the democratic mathematics classroom, students should see themselves in the curriculum and link mathematics to their everyday lives; they should see that mathematics is connected to social needs of the community; and that mathematics can expand and deepen their own democratic possibilities (Ladson-Billings, 1994; Malloy & Malloy, 1998; Tate, 1994; Woodrow, 1997). As Gutstein and Peterson (2005) explain, "Students can understand their own power as active citizens in building a democratic society and becoming equipped to play a more active role in that society" (p. 2).

From Rhetoric to Reality: The Complementarity of Democracy and Authority
Even with all of its positive benefits, democratic practices of mathematics education are far from prevalent. South African educator Renuka Vithal (1999) suggests that much of the work toward

democratic mathematics education is simply theoretical and has not been actively implemented in classrooms. In order to better understand why this is so, Vithal engaged in classroom-based research aimed at elucidating the potential and the challenges of democracy in the mathematics classroom. During one school year spent in a project-based mathematics classroom, data were collected across three discursive domains: whole class, group work, and teacher/student and teacher/researcher interaction.

Through her analyses, it became clear that tensions arose largely due to the oppositional concepts of authority and democracy that influenced interactions in the classroom. Following a thorough description of interactions within each of the three domains, Vithal summarizes her observations:

> In the project work situation described here we see how democracy is brought into the lives of groups and individuals in a classroom and school as it becomes a microcosm of society. … Pupils voted on project ideas, elected group leaders, acted out that leadership; questioned different kinds of authority, mathematised some aspect of reality; explained it to their fellow citizens; related to a mathematisation from other citizens; distributed work in diverse groups; faced questions about acting with fairness; and tried to get the work done for assessment. They have lived through the many difficulties and dilemmas of democratic life (pp. 32-33).

This provides a measure of support for Hannaford's (1998) contention that, "If children are taught mathematics well, it will teach them much of the freedom, skills, and of course the disciplines of expression, dissent and tolerance, that democracy needs to succeed" (p. 186). For Vithal, when students can learn about and through democracy in a mathematics classroom, they are more likely to act (or demand the space to act) democratically in their own societies. Although this was substantiated by her data, she also found that students had to navigate between the authority of the teacher and the authoritarianism of the school as they spoke out against undemocratic practices. This led her to characterize the relationship between democracy and authority as a complementarity in that "pupils learn about democratic values, attitude and competence precisely when they show a lack of these" (p. 33). As they experienced the tension between democracy and authority, students developed deeper insights into each of these concepts and became more reflective about the degree to which their own actions were democratic.

The Preparation of Democratic Teachers of Mathematics
Teacher preparation programs represent a critical space within which to model a democratic approach to mathematics education. It is here that we can disrupt traditional habits of teaching, open opportunities for discussion and debate, implement strategies that develop student authority, and draw connections between mathematics and community and societal issues. What follows are examples of some initial steps toward this work that have been taken in a methods course for pre-service teachers of mathematics.

An important aspect of preparing teachers of mathematics is to provide them with opportunities to revisit old ideas in new ways. This is essential in mathematics, a subject that has been made to appear static and narrowly defined within the school curriculum (Ernest, 1994; Stodolsky, 1988; Walkerdine, 1998; Walshaw, 2002). The activities below represent efforts toward disrupting students' preconceived ideas about what mathematics is and how it is learned.

> Problem of the Day—These require students to generate multiple solution paths and/or to uncover the justifications for taken-for-granted mathematics procedures. Collaborative discussions expose students to alternative ways of thinking and help them develop skill in expressing ideas and justifying their reasoning.

Mathematics Autobiography—Pre-service teachers describe their experiences with mathematics throughout their lives both as a learner (in and out of school) and as a teacher. They might include mention of their earliest recollection of "doing math," and people who influenced their thinking about mathematics and their abilities in mathematics. This leads to discussions about the varied experiences students in the class have had with mathematics and moves them toward understanding their personal experience is not universal.

It is also critical that pre-service teachers are given opportunities to participate in dialogic discourse (Freire, 1998; Roy & Swaminathan, 2002) about the nature of schooling and the role of mathematics education in that process. This includes skills of locating and reading research, engaging in debates about teaching and curricula, and taking action to effect change within various spheres of influence (e.g., classroom, department, school, district, and so on). As Fraser (1997) explains, teacher preparation programs must "[help] teachers to be fully empowered critical intellectuals, able to understand the nature of knowledge and the process of passing it on in the specific cultural context of the schools in which they teach" (p. 190).

School Profile—Pre-service teachers research the history of the schools to which they are assigned for observations and teaching. The intent is for them to learn about the communities of which they will become members. They collect information by reviewing online public databases, talking to school employees, looking at school yearbooks, and inquiring to local community members. They investigate demographic changes in population over time, challenges and successes of the school and school community, perceptions of the school from the inside and outside, and aspirations of both teachers and students in the school.

Reading Facilitation and Research Review—Pre-service teachers work in pairs to develop a set of discussion questions (in collaboration with the instructor) that they will use to facilitate a class discussion for an assigned class reading (e.g., journal article). These are peer-evaluated using a rubric.

Finally, there must be fostered a perspective toward democracy as something more than exercising one's right to vote. Rather, principles of equity, access, and activism must be visited.

Concluding Thoughts

In implementing the strategies described above, we have had to navigate Vithal's complimentarity between democracy and authority. As program advisors our position relative to our pre-service teachers carries greater authority. In turn, students entering the methods course are often surprised at being asked to take on roles typically associated with the teacher—explaining problems, leading discussions, and evaluating the performance of others. The tension this generates is taken as a positive sign that a move toward a more democratic community has been made. As the work toward building democracy has no ending point, we will continue to reflect on and refine these practices in response to our students' needs, preferences, and experiences.

Democratic mathematics education confronts students with meaningful issues for the common good to which a mathematical lens can profitably be applied. When students use and apply mathematical knowledge in such situations, they are learning to think critically about world issues and their environment through mathematics. Such democratic development leads to emancipation—mathematics as a tool to use the present to shape the future. Emancipation helps students to become aware of social inequities, to understand the motivation for policy decisions and solutions, and to take an active role in this process. This is the basis for democratic social action.

References

Beyer, L. E. (Ed.). (1996). *Creating democratic classrooms: The struggle to integrate theory and practice*. New York: Teachers College Press.

Ernest, P. (1994). *Constructing mathematical knowledge: Epistemology and mathematical education*. Bristol, PA: The Falmer Press.

Freire, P. (1998). *Pedagogy of the oppressed*. New York: Continuum Publishing Co.

Greene, M. (1986). In search of a critical pedagogy. *Harvard Educational Review, 56*(4), 427-41.

Gutierrez, R. (2007). (Re)defining equity: The importance of a critical perspective. In N. S. Nasir & P. Cobb (Eds.), *Improving Access to Mathematics: Diversity and Equity in the Classroom* (pp. 37-50). New York: Teachers College Press.

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education, 34*(1), 37-73.

Gutstein, E. & Peterson, B. (2005). *Rethinking mathematics: Teaching social justice by the numbers.* Milwaukee, WI: Rethinking Schools.

Ladson-Billings, G. (1994). *The dreamkeepers: Successful teachers of African American children.* San Francisco, CA: Jossey-Bass.

Malloy, C. (In press). Looking throughout the world for democratic access to mathematics. In L. D. English, (Ed.) *Handbook of International Research in Mathematics Education, Second Edition.* Mahwah, NJ: LEA.

Malloy, C., & Malloy, W. (1998). Issues of culture in mathematics teaching and learning. *The Urban Review, 30*(3), 245-257.

Moses, R. P., & Cobb, Jr., C. E. (2001). *Radical equations: Math literacy and civil rights.* Boston; Beacon Press.

Pearl, A., & Knight, T. (1999). *The democratic classroom: Theory to inform practice.* Cresskill, NJ: Hampton Press.

Price, J. N. & Ball, D. L. (1997). There's always another agenda: Marshalling resources for mathematics reform. *Journal of Curriculum Studies, 29*(6), 637-666.

Roy, K., & Swaminathan, R. (2002). School relations: Moving from monologue to dialogue. *The High School Journal, 85*(4), 40-51.

Stodolsky, S. (1988). *The subject matters: Classroom activity in math and social studies.* Chicago: University of Chicago Press.

Tate, W. F. (1994). Race, retrenchment, and the reform of school mathematics. *Phi Delta Kappan, 75*, 477-484.

Turner, E. E., & Font Strawhun, B. T. (2007). Posing problems that matter: Investigating school overcrowding. *Teaching Children Mathematics, 13*(9), 457-463.

Vithal, R. (1999). Democracy and authority: A complementarity in mathematics education? *Zentralblatt für Didaktik der Mathematik*, *98*(6), 27-36.

Volmink, J. (1994). Mathematics by all. In S. Lerman (Ed.), *Cultural Perspectives on the Mathematics Classroom* (pp. 51-68). Dordrecht, Netherlands: Kluwer Academic Publishers.

Walkerdine, V. (1988). *The mastery of reason: Cognitive development and the production of rationality*. London: Routledge.

Walshaw, M. (2002). Epistemic terrains and epistemic responsibility. *Philosophy of Mathematics Education Journal, 16*. Retrieved March 23, 2003, from http://www.ex.ac.uk/~PErnest/pome16/epistemic.htm.

Wilbur, G. (1998). Schools as equal cultures. *Journal of Curriculum and Instruction, 13*(2), 123-147.

Woodrow, D. (1997). Democratic education: Does it exist—especially for mathematics education? *For the Learning of Mathematics*, *17*(3), 11-17.