Making Learning to Problem-Solve Count

Critical Use of Mathematics to Bring about Social Justice

Thomas A. Lucey & Madalina Tanase

Introduction

Educating for social justice requires teaching and learning practices that prompt critical thinking about the assumptions that guide mainstream social thinking. For example, education for contemporary capitalist society employs the myth of meritocracy to claim that social advancement occurs only through hard work and honest behavior.

Consider Kennedy's (1995) identification of four myths about money:

1. There is only one type of growth;
2. We pay interest only if we borrow money;
3. In the present monetary system we are all equally affected by interest; and
4. Inflation is an integral part of free market economics.

Such myths are evidence of the ignorance that can occur when our educational processes limit opportunities for students to question and explore patterns of knowledge that exist outside the realm of general social and political convention and acceptance. To counter such patterns and for social justice to occur, educators must create learning environments that invite candid and critical dialogue about social structures and the institutions that support them (Prince, 2008). Toward this end this article aims to extend the concept and goal of critical social education into the field of mathematics teaching and learning.

Mathematics represents a curricular area that typically is left out of the discussion of social justice education. After all, what is the social relevance of plotting points on an x-y axis? Or of the formula to determine the slope of a line? Or of the distance between two points (x and y)? Or of the intercepts of the graphs of the given equation?

These are the questions and concepts that mathematics teachers commonly ask and teach as they seek to condition student acceptance of facts associated with these simple relationships that offer unsophisticated solutions to complex problems. In mainstream mathematics instruction the responses to these questions will provide the basis for determining which students will be labeled by teachers as achievers or non-achievers. If a student accepts and memorizes the provided information, educators praise and uphold that individual as an exemplary student.

At the same time, educators often identify students who question or challenge these mathematics concepts as an academic risk, possibly with special learning needs. Yet teaching for social justice requires that educators reframe these classroom conventions in a manner that will invite student engagement in thinking, dialogue, and action, rather than the traditional reliance on rote memorization and replication.

Overcoming the Isolation of Mathematics

The educational emphasis on numeric processing and geographic representation isolates mathematics content from that of other curricular areas and thereby limits students' opportunities to contemplate relevant associations. When there is any curricular crossover, mathematical encounters in science or social studies are typically limited to simple graphical representations that illustrate commonly accepted scientific theories or social relationships.

Yet by guiding students' investigation of these depictions and exploring associations to other content areas of the curriculum, teachers can stimulate students' interest in social and economic problems and the importance of their potential roles toward correcting such problems.

For example, the first author (Lucey & Grant, 2010) has developed a lesson plan which facilitates students' access and processing of data concerning patterns of corporate polluters and population characteristics, thereby providing opportunities for students to hypothesize and test mathematical patterns that interpret these social relationships. By encouraging students' critical inquiry in this way a teacher may share mathematical patterns that help reframe students' understandings of important social relationships.

Seeking Student-Focused Inquiry

By facilitating safe classroom environments that encourage social questioning and inquiry, mathematics teachers may invite conversation that changes core social assumptions. Tupper's (2008) discussion of "commonsense" notions in education and their roles in maintaining the social position of the dominant culture provides a reminder that learning processes breed culturally aligned patterns of achievement.

The traditional classroom environment perpetuates patterns of judgment that utilize culturally-biased assessment measures which lack theoretical and developmental validity (Shepard, 2000). With regard to mathematics learning, traditional teacher-centered teaching and learning processes leave little opportunity for students to question the methods utilized and content presented by the teacher "expert." Student-focused inquiry processes value the students' abilities to analyze and collaborate in developing solutions to the problems presented (Silver & Stein, 1996).

Such student-focused processes also require that teachers treat students with basic dignity. Battey's (2012) account of a teacher who disrespected socially underrepresented students in her classroom

Thomas A. Lucey is an associate professor in the Department of Curriculum and Instruction at Illinois State University, Normal, Illinois. Madalina Tanase is an assistant professor in the Department of Foundations and Secondary Education at the University of North Florida, Jacksonville, Florida.

illustrates the importance of valuing students and respecting their social identity. Empowering socially underrepresented children and youth requires the use of teaching behaviors and strategies that inform recognition and understanding of social/financial injustice and motivate the pursuit of social change.

The basic social dignity represented by such educational approaches is essential for motivating underrepresented students to learn skills and knowledge essential for social empowerment. Martin's (2007) concerns with "(1) ideologies and systems of oppression…and (2) the ways that these ideologies influence research and policy responses to…who should teach mathematics…" (p. 9) convey the challenges of developing critically-minded mathematical thinkers.

Accomplishing the goals Martin suggests is very difficult when the teaching force (1) largely originates from the dominant culture, (2) relies predominately on teacher-centered instruction that depends on texts for information, and (3) views noncompliant students who question these processes as problems, rather than learning resources.

Teaching for Social Justice

This article focuses on the potential relevance of mathematical conceptions to justice-oriented teaching. Culturally responsive mathematics teaching requires the holding of high expectations for students' engagement in critical thinking abilities by respecting their backgrounds and engaging their contemplation and analysis of the mathematical relationships that characterize their environments. Developing a broad awareness of content and its interdisciplinary nature represents a necessary step toward conceptualizing the interconnected nature of humanity and the global community in which it resides.

In order to create these rich learning opportunities, elementary, middle-level, and high-school preservice and in-service teachers must realize the connections among mathematics, financial literacy, and social justice issues. They must apply this knowledge in ways that empower their students. Mathematics and financial literacy can be empowering concepts for understanding and combating social injustices and fulfilling educators' responsibilities for empowering socially marginalized students.

To help inform the educational community about these issues, in this article we discuss literature that supports these processes, we describe a classroom approach for implementation, and we provide a model lesson. The literature section explores the currently narrow conceptions of mathematics typically held by preservice teachers, and postulates the need to foster alternative conceptions in which mathematics becomes a tool for engendering justice-oriented thinking.

We also explain the terms "democratic mathematics" and "critical mathematics" in order to present Borich's (2011) cooperative classroom approach, an approach which enables teachers' facilitation of students' critical perspective of social injustices.

The article concludes with an example of classroom application of Borich's approach, through which students can identify a social concern (i.e., unjust education funding), discuss the conventional and justice-oriented perspectives on this social issue, and further examine available mathematical patterns that support each point of view.

From the Literature

Conceptions of Mathematics

Pre-service and in-service teachers generally view mathematics as a fixed set of rules and procedures that students should memorize and regurgitate (Clemens, 1991; Lloyd & Frykholm, 2000; Philipp, 2008). Recently, Ward et al. (2010) discussed the perceived misconceptions about mathematics held by preservice teachers, indicating that they still believe that mathematics is about memorization of formulas and calculating with numbers. Moreover, research reveals that mathematics is considered a discipline of its own by preservice teachers, consisting of algebra, geometry, and calculus, and having "no relation with people and their everyday lives in society" (Valero, 2009, p. 237). Based on these reports, it appears that educators continue to view mathematics in isolation from other content areas.

Traditionally taught as a set of rules with little application to real-life contexts, mathematics teaches students "discrete operations" (Carnevale & Desrochers, 2003, p. 21). This conception prompts a view of mathematics as an individual series of work processes. For example, a lesson that determines how to calculate how many handshakes occur at a gathering employs mathematical reasoning; however it applies the action in a manner that conveys social triviality, rather than substance.

Fostering Alternative Conceptions

By providing students with opportunities to seek and find critical solutions for social problems, teachers can infuse elements of social agency as well as financial literacy. Teachers can engage students in dialogues that examine dishonest practice and inaccurate judgments that bring about or prompt financial differences. For example, Brantlinger's (2008) engagement of urban high school students in dialogues about social issues motivated further analysis of these conversations. Yet Brantlinger questions if these conversations prompt more sophisticated mathematical knowledge among these secondary students.

Knowledge of the content represents a paramount tenet of teaching. Just as a factory worker cannot understand distribution processes for goods produced without being exposured to a larger view of the operation, a student cannot develop a thicker knowledge of mathematics than a simple understanding of numeric mechanics unless that student receives information that broadens this vision.

We (Tanase & Lucey, 2011) have previously argued that needed social change requires a comprehensive interpretation of mathematics, including its associations with financial literacy and social justice. To affect social change, teacher educators should prepare their candidates to appreciate a justice-oriented vision that recognizes these interrelationships.

Democratic Mathematics

Developing critical literacy requires the analysis of information sources and their presentations and interpretations of numeric relationships. This will not occur in classrooms that engender deficit attitudes toward students' social thinking (James, 2008) and treat textbooks as absolute information sources (e. g., Loewen, 2007). To foster a fully participatory democratic society requires development of socialization skills among students so that they can evaluate and respond to different concepts and ideas.

In mathematics education, a dependency on textbooks that emphasize problem mechanics is the equivalent of imprinting a routine that inhibits creativity. In contrast, engaging students in peer-based discussion that critically interprets social assumptions will provide a classroom environment that offers potential for democratic thinking.

A push for the "democratization" of mathematics was addressed by Carnevale and Desrochers (2003), who argued that mathematics should become responsive to the needs of *all* students in order to fulfill

its cultural and economic role. This can be accomplished by integrating mathematics into other disciplines, as well as matching the mathematics curricula to cultural, political, and economic concerns and goals.

For example, Maxwell (2008) discussed how teacher candidates' awareness that knowledge of financial literacy is a powerful tool will help teachers in their own personal finances, while also providing them with the needed skills to teach their students about the "mathematical underpinnings of financial literacy through life examples and experiences" (p.165). Financial literacy represents an area that potentially benefits students from all economic contexts.

In order for mathematics to become democratic by responding to the needs of *all* students (Carnevale & Descrochers, 2003), teachers should foster learning environments in which they engage all their students in the learning process, helping them understand mathematical connections with the various conditions of their lives (i.e., finances, social agency). Using democratic processes to determine and examine the tenets of financial literacy provides a rich opportunity to explore the strengths and weaknesses of social principles that undergird the U.S.

If mathematics continues to follow "an isolated trajectory" (Carnevale & Desrochers, 2003, p. 21) in the school curriculum, it will fail to prepare students for its use as a tool to participate in society and to understand their potential as agents of change. As expressed by Lucey (2007),

> . . . an urban society comprised of culturally diverse populations should not ignore its multicultural financial learning patterns. Failure to do so leaves underrepresented socioeconomic groups at risk. (p. 269)

Engaging students from underrepresented groups in conversation about various social conditions and prompting their mathematical inquiries into these conditions bridges the gap between mathematical theory and practice while providing authentic problems for students to engage with and solve.

Quantitative Literacy

Mathematics conceptions require that an element of "quantitative literacy" be associated with financial literacy, thus leading to an understanding of social justice. When teachers craft lessons that engage students in authentic situations that relate to their lives, they develop students' reasoning and problem-solving skills, and prompt those students to ask questions and to critique new information. In this way the students "will be prepared to participate equally as citizens and consumers" (Malloy, 2002).

As a result, students may not only strive to create better lives for themselves and their families, but they may also question inequitable societal situations and challenge the practices that are in place as they seek to remedy the disadvantages suffered by populations who have been traditionally marginalized from the larger society. Teachers should have the professional integrity to respect the cultural contexts that affect these educational processes. In Martin's (2007) view,

> …neither strong mathematics content knowledge nor strong pedagogical skill alone is sufficient for answering this question: nor is the combination of the two…teacher dispositions, racial competence, and commitment to anti-oppressive and anti-racist teaching are just as important as knowledge of the subject matter. (p. 10)

Implementing democratic mathematics requires that teachers recognize and apply respectful and safe learning environments that enable all students' full participation and engagement in the learning process.

Critical Mathematics

A critical approach to mathematics teaching and learning involves engagement of students in the examination of mathematical relationships that define the social environments that they occupy. De Frietas (2008) points out that while critical mathematics has been employed through various methods to re-examine facets of social power structures, this approach elicits much resistance from those teachers who cling to traditional instructional approaches.

Atwah and Brady (2009) claim that most mathematical content understandings have developed in isolation from moral considerations. They argue for an ethical approach to mathematics education, pointing out that there is a general ignorance of the mathematical sophistication of the field of economics, an overrated relationship between mathematical process knowledge and employment, and the perpetuation of social structures through mathematical repetition. They argue that the necessary relevance of mathematics education is the ability to change community through the synthesis of numeric relationships, rather than to interpret the community through application of memorized numeric formula.

Through the use of critical mathematics, teachers can facilitate students' development of social consciousness, thus empowering their students to view themselves as "actors capable of working with others to effect change towards social justice" (Gutstein, 2009, p. 353). The outcomes from these processes will result in community betterment, which leads to individual fulfillment. Mathematics then becomes an analytical tool through which teachers engage students in problems that encourage them to "read and write the world with mathematics" (Gutstein, 2006, p. 4).

What kinds of questions should students examine in classrooms to empower their mathematical creativity? The following suggestions represent some examples that teachers can use to undertake classroom activities that focus on critical and democratic mathematics.

- Conduct a mathematical analysis of military vs. domestic expenditures to understand and critique societal fiscal priorities. (Frankenstein, 1987)
- Research and analyze social issues (such as racism and water rights) to examine of power relations and unequal resource allocations. (Gutstein, 2003)
- Investigate why female students, students of color, and low-income students score lower on SAT and ACT exams. (Gutstein, 2003)

Cooperative Classroom Approach

Developing a critical perspective of social injustices through democratic mathematics requires the creation and maintenance of a cooperative learning environment in the classroom. Such an environment fosters collaboration with students "to design, teach, study, assess, and discuss social justice mathematics" (Gutstein, 2009, p. 364).

Engagement of students in critical mathematics fosters their development as learner-researchers, as they enhance their social consciousness and understand and critique societal injustices. Advocates of critical mathematics (Gutstein, 2003; Leonard, Broooks, Barnes-Johnson, & Berry, 2010) present numerous examples of classroom activities that teachers can use to engage their students in looking at the world through mathematics lenses. In such activities, the teacher and students raise questions about social injustices that

they encounter, use data to make judgments about complex societal situations, work in groups to compare and contrast the data, and generate solutions to these problems.

When discussing the effect of engaging his students in critical mathematics activities, Gutstein (2003) states:

> My students almost all also developed mathematical power. As a class, they invented their own solution methods, they solved problems in multiple ways, generated multiple solutions when appropriate, reasoned mathematically, communicated their findings both orally and in writing, and developed their mathematical and personal confidence. (p. 54)

By engaging students in critical mathematics-based thinking about social issues that are important to them, teachers develop cooperative learners who build community by respecting peers as teammates.

Developing community can then reoccur through a scaffolded process. In a cooperative learning environment, the teacher promotes pro-social behavior, critical thinking, and problem solving, all in order to improve collaborative skills and increase student achievement (Borich, 2011). Such an environment emphasizes student-student interaction, with the teacher assuming more the role of a guide in the learning process. In order for meaningful student-student interaction to occur, both teacher and students need clarification of student roles and responsibilities, and a clear understanding of the task at hand (activities, time, division of labor).

While group formation and leadership may develop with time, efficient use of classroom resources necessitates a learning sequence that optimizes process efficiency. Borich's (2011) five steps for developing a task structure form a framework for facilitating mathematically-related critical social inquiry. These five steps, as listed below, provide a deliberate process for students to explore the determined social topics in a structured manner, allowing them investigative freedom.

Step 1, *Specifying the Goal*, provides direction to the endeavor. The classroom determines the topic, and agrees upon standards for behavior and expectations for outcomes.

Step 2, *Structuring the Task*, defines the cooperative process, because it concerns the characteristics of the groups and members' responsibilities. Decisions about group size, composition, responsibilities, incentives, and time spent on task may be made through teacher/student interfacing. As guided by the student experience with cooperative learning, teachers may present a recommended structure and invite discussion about its modification.

Step 3, *Teaching and Evaluating the Cooperative Process*, ensures that students realize that cooperative learning requires a different set of behavioral expectations than does traditional instructional methods. Communication about thoughts and emotions should occur in respectful manners that acknowledge all persons' points of view.

Step 4, *Monitoring the Group Performance*, represents a difficult step for teachers because it requires a focus on the learning process. Teachers emphasize facilitation of student inquiry, guiding their efforts, but not providing solutions. Rather, the emphasis involves encouraging community and building the cooperativeness needed to achieve the common goal.

Step 5, *Debriefing*, provides an opportunity for students to discuss the experience in terms of the learning the content and processes. It may be the most important step in that provides students with an opportunity to discuss reasons for successes and ideas for revisions and next steps. It should be an opportunity for encouraging further exploration and reflection on previous efforts.

Borich's five steps align closely with Gutstein's (2003) critical mathematics approach described above. Table 1 compares both Gutstein's and Borich's approaches with those of the National Council of Teachers of Mathematics.

Conclusions

The role of mathematics should include the empowerment of students to live successful lives by enabling them to appreciate their role as agents of change and use mathematics as a tool to affect societal justice. Educators should abandon traditional conceptions of mathematics as an isolated trajectory in the curriculum (Carnevale & Desrochers, 2003, p. 21). In order to help students meaningfully apply mathematics, teachers should recognize

Table 1
Cooperative Approaches and Steps for Mathematics Classrooms

	National Council of Teachers of Mathematics (2009)	*Gutstein's (2003) Approach*	*Borich's (2011) Steps for Coooperative Learning*
Steps	Teacher and students draw on knowledge from a wide variety of mathematical topics.	Students invent their own solution methods.	Specifying the goal: the classroom determines the topic, and agrees upon standards for behavior and expectations for outcomes.
	Students approach the same problem from different mathematical perspectives or represent the mathematics in different ways until they find methods that enable them to make progress.	Students solve problems in multiple ways.	Structuring the task: concerns the characteristics of the groups and members' responsibilities. Decisions are made about group size, composition, responsibilities, incentives, and time spent on task.
			Teaching and evaluating the cooperative process: communication about thoughts and emotions should occur in respectful manners that acknowledge all persons' the points of view.
	Students work alone or in groups productively and reflectively, under the guidance of their teachers.	Students generate multiple solutions, and reason mathematically.	Monitoring the group performance: teachers emphasize facilitation of student inquiry, guiding their efforts, but not providing solutions. Rather, the emphasis involves encouraging community and building the cooperativeness needed to achieve the common goal.
	Orally and in writing, students communicate their ideas and results.	Students communicate their findings both orally and in writing, developing their mathematical confidence.	Debriefing: provides an opportunity for students to discuss the experience in terms of the learning the content and processes.

and facilitate inquiry into the interrelationships among mathematics, social justice, and financial issues.

In order to create opportunities for their students to understand their role as agents of change, these teachers—including teachers of mathematics—need to engage their students in projects "that provide students context, history, and opportunities to learn about and be engaged in aspects of social justice as well as social movements—using and learning mathematics at the same time" (Gutstein, 2009, p. 367).

Teachers should foster alternative conceptions of mathematics by involving their students in critical and democratic processes that enable acquisition of relevant mathematics content, develop critical thinking and problem-solving skills (Malloy, 2002), and question the social injustices encountered every day. By providing their students with opportunities embedded in critical and democratic mathematics, teachers can prepare their students to "think about, and act on, the world" (Gutstein, 2009, p. 352).

A synthesis of Gutstein's (2003) and Borich's (2011) models may provide an approach to critical mathematics for teachers and teacher educators that will engage their students in the learning of mathematics content along with the development of critical thinking skills that expose and seek to rectify societal injustices. Students thus will develop an appreciation and understanding for mathematics as a tool to change the world, rather than simply as a discipline that teaches them isolate facts that have little apparent application in the real world.

In conclusion and as an example, we offer the description of a model lesson plan based on the work of both Gutstein and Borich (see Appendix) through which students can explore a problematic social issue. This approach can easily be used to focus on any issue of interest and relevance to teachers and students.

References

Atwah, B., & Brady, K. (2009). Socially responseable mathematics education: Implications of an ethical approach. *Eurasia Journal of Mathematics, Science, and Technology Education, 5*(3), 267-276.

Baker, B., & Duncombe, W. (2004). Balancing district needs and student needs: The roles of economies of scale adjustments and pupil need weights in school finance formulas. *Journal of Education Finance*, *29*(3), 195-222.

Battey, D. (2012). "Good" mathematics teaching for students of color and those in poverty: The importance of relational interactions within instruction. *Educational Studies in Mathematics*. Retrieved May 11, 2012 from: http://dx.doi.org/10.1007/s10649-012-9412-z

Borich, G. D. (2011). *Effective teaching methods. Research-based practice (7th ed.)*. Boston: Pearson.

Brantlinger, A. (2008). Economic inequality and secondary mathematics. In T. A. Lucey & K. S. Cooter (Eds.), *Financial literacy for children and youth* (pp. 276- 297). Athens, GA: Digitaltextbooks.

Carnevale, A. P., & Desrochers, D. M. (2003). The democratization of mathematics. In B. L. Madison & L. A. Steen (Eds.), *Quantitative literacy: Why numeracy matters for schools and colleges* (pp.21-31). Princeton, NJ: The National Council on Education and Disciplines.

Clemens, H. (1991). What do math teachers need to be? In M. Kennedy (Ed.), *Teaching academic subjects to diverse learners* (pp. 84-96). New York: Teachers College Press.

De Frietas, E. (2008). Critical mathematics education: Recognizing the ethical dimension of problem solving. *International Electronic Journal of Mathematics Education, 3*(2), 79-95.

Duncombe, W., Lukemeyer, A., & Yinger, J. (2003). *Financing an adequate education: A case study of New York.* Faculty Publications (SEPA). Retrieved on April 10, 2012 from http://digitalcommons.library.unlv.edu/sea_fac_articles/253.

Frankenstein, M. (1987). Critical mathematics education: An application of Paolo Freire's epistemology. In I. Shor (Ed.), *Freire for the classroom: A Sourcebook for liberatory teaching* (pp. 180-210). Portsmouth, NH: Boyton/Cook.

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. (2006). *Reading and writing the world with mathematics: Towards pedagogy for social justice*. New York: Routledge.

Gutstein, E. (2009). Possibilities and challenges in teaching mathematics for social justice. In P. Ernest, B. Greer, & B. Sriraman (Eds.), *Critical issues in mathematics education* (pp.351-373). Charlotte, NC: Information Age Publishing Inc., & The Montana Council of Teachers of Mathematics.

James, J. H. (2008). Teachers as protectors: Making sense of methods students' resistance to interpretation in elementary history teaching. *Theory and Research in Social Education, 36*(3), 172-205.

Kennedy, M. (1995). *Interest and inflation free money. Creating an exchange medium that work for everybody and protects the earth*. Okemos, MI: Seva International.

Leonard, J., Broooks, W., Barnes-Johnson, J., & Berry, R.Q. III. (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal of Teacher Education*, *61*(3), 261-270.

Lloyd, G. M., & Frykholm, J. A. (2000). How innovative middle school mathematics can change prospective elementary teachers' conceptions. *Education*, *120*(3), 575-580.

Loewen, J. W. (2007). *Lies my teacher told me. Everything your American history textbook got wrong* (Revised Ed.). New York: Touchstone.

Lucey, T. A. (2007). The art of relating moral education to financial education: An equity imperative. *Social Studies Research and Practice, 2*(3), 486-500

Lucey, T. A., & Grant, M. M. (2010). Using technology to prepare critically thinking global citizens. *Social Studies Research and Practice, 5*(3), 119-138.

Malloy, C. E. (2002). Democratic access to mathematics through democratic education. An introduction. In L. D. English (Ed.), *Handbook of international research in mathematics education* (pp.17-25). Mahwah, NJ: Lawrence Erlbaum Associates.

Martin, D. B. (2007). Beyond missionaries or cannibals: Who should teach mathematics to African American children? *The High School Journal*, *91*(1), 6-28.

Maxwell, S. A. (2008). Mathematics and financial literacy: Collaboration or conflict? What are mathematic educators' responsibilities? In T. A. Lucey & K. S. Cooter (Eds.), *Financial literacy for children and youth* (pp.149-169). Athens, GA: Digitaltextbooks.

National Council of Teachers of Mathematics. (2009). *Principles and standards of school mathematics. A vision for school mathematics. Executive Summary*. Retrieved on May 20, 2012 from www.standards.nctm.org.

Odden, A., & Picus, L. (2007). *School finance: A policy perspective (4th ed.)*. New York: McGraw-Hill.

Park, J. (2004). More different than alike: State strategies for funding education. *The Journal of School Business Management*, *16*(2), 14-26.

Philipp, R. A. (2008). Motivating prospective mathematics school teachers to learn mathematics by focusing upon children's mathematical thinking. *Issues in Teacher Education, 17*(2), 7-26.

Prince, G. S. (2008). *Teach them to challenge authority. Educating for healthy societies*. New York: Continuum International Publishing.

Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational Researcher, 29*(7), 4-14.

Silver, E. A., & Stein, M. K. (1996). The Quasar Project: The "Revolution of the Possible" in mathematics instructional reform in urban middle schools. *Urban Education, 30*(4), 476-521.

Tanase, M., & Lucey, T. A. (2011, April). Interdisciplinary connections: How mathematics relates to financial literacy and social justice issues. Presentation at Annual Meeting of the American Educational Research Association, New Orleans, LA.

Toutkoushian, R., & Michael, R. (2008). The impacts of school funding formula modifications on equity, fiscal neutrality, and adequacy. *Journal of Education Finance*, *33*(4), 352-381.

Tupper, J. (2008). Interrogating citizenship and democracy in education: The implications

for disrupting universal values. In D. Lund & P. Carr (Eds.), *Conceptualizing and doing democracy in education: Moving beyond elections toward political literacy,* (pp. 71-84). New York: Peter Lang.

Valero, P. (2009). What has power got to do with mathematics education? In P. Ernest, B. Greer, & B. Sriraman (Eds.), *Critical issues in mathematics education* (pp. 237-254). Charlotte, NC: Information Age Publishing.

Vesely, R.S., Crampton, F.E., Obiakor, F.E., & Sapp, M. (2008). The role of states in funding education to achieve social justice. *Journal of Education Finance*, *34*(1), 56-74.

Ward, B. B., Campbell, S. R, Goodloe, M. R., Miller, A. J., Kleja, K. M, Kombe, E. M., Torres, R.E. (2010). Assessing a mathematical inquiry course: So students gain an appreciation for mathematics? *Problems, Resources, and Issues in Mathematics Undergraduate Studies, 20*(3), 183-203.

Appendix
Example/Model Lesson Plan

The following lesson outline employs Gutstein's (2003) methods and Borich's (2011) task structure framework to facilitate a cooperative learning activity by which students can examine a problematic social issue.

1. Students identify social concern.

Enable students to come up with an issue they find interesting and they would like to solve.

Example: Unjust Education Funding

2. Students discuss the conventional and justice-oriented view.

Structure the process to optimize students' cooperative learning and teach students the proper behaviors for conducting themselves and listening to others.

Example:

Conventional View: Occurs at the local level with distribution related to property tax contributions. Those who have the resources contribute more to the system and are entitled resources that are commensurate with the resources provided.

Justice-Oriented View: Existing funding structures are the outcomes of historical efforts to maintain wealth control within the dominant culture. Equal opportunity to education requires that all students receive access the same quality and quantity resources to achieve academic success. School districts have a responsibility to provide for equitable learning conditions among all students.

3. Students examine sources of mathematical patterns that support each point of view.

Monitor the processes to ensure students are on task, to provide emotional support when needed. Redirect students when necessary, but do not solve their problems.

Example:

Conventional View: Every state uses a formula for distributing resources for higher education (Baker & Duncomber, 2004; Odden & Picus, 2007). States currently use funding formulas to distribute money to public school districts (Park, 2004). Despite the fact that according to such formulas, "the foundation level" (per pupil dollar amount is set higher for districts with more at risk students (Toutkoushian & Michael, 2008), states use modifications in these formulas. These overlay provisions (modifications to the formulas) could "create new inequities in funding, reduce incentives for schools to become more efficient, and hurt growing school districts by not providing enough money to cover their rising educational costs" (Toutkaoushian & Michael, 2008, p. 355).

Justice Oriented View: Vertical equity, (or the unequal treatment of unequals), proposes that at-risk students need additional resources to be successful academically (Vesely, Crampton, Obiakor, & Sapp, 2008). In a 2003 study, Duncombe, Lukemeyer, and Yinger found that Limited English Proficient (LEP) and low-income students would need twice the fiscal resources regular students need to pass the state standards. However, in an analysis of funding distributed for education by states in the 1998-1999 school year, researchers found that for students with disabilities and racial minorities, states reduced their funding efforts (Vesely et al., 2008).

4. Students discuss the conditions that explain patterns of thinking behind each view.

This may take the form of a class debate, in which teams of students familiarize themselves with the facts associated with both views. Students attempt to synthesize these facts reach a consensus for a socially just approach. Another possibility would be to simulate or role-play examples that illustrate the contexts that influence patterns of thinking.

5. Decide on a strategy for responding to the unjust education funding.

Use oral discussions, reflective writings or development of art works to prompt student expression about their findings and the learning process. They may decide on a strategy for responding to the social concern.

Example: Students may look at education funding distribution in different states, analyze vertical equity (different funding for districts with different needs), or horizontal equity (equal funding provided by states for equal districts). For example, Toutkoushian and Michael (2008) study the example of unequal funding in Indiana. Baker and Duncomber (2004) discuss the balance of funding in the rural and large urban districts in Kansas and Texas. Duncombe Lukemeyer, and Yinger (2003) discuss financing an adequate education in New York. Other examples may be found in the literature, or existing resource and allocation difficulties in their own school community could be the basis of student analysis.