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Anastasia Brelias
Assistant Professor of Education
Northeastern Illinois University
USA

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209
Email: info@atiner.gr URL: www.atiner.gr
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Anastasia Brelias
Assistant Professor of Education
Northeastern Illinois University
USA

Abstract

Critical education scholars contend that schools ought to play a role in the transformation of inequitable institutions and social arrangements. In part, this entails educating students in the academic disciplines, viewed as powerful lenses through which students might see the world in order to better understand why things are the way they are and how they might be different. Using a critical theoretical perspective on mathematics literacy, this study examined high school students' views of mathematics in light of their experiences with mathematical investigations of social problems.

Qualitative research methods were used in data collection and analysis. Data were gathered in a statistics class and a mathematical modeling class during fifty days of classroom observations, interviews with sixty students and two teachers, and a review of student work. Spradley's analytic techniques, known as domain analysis, were used to identify themes in the data.

Students in this study indicated that their classroom experiences caused them to rethink their ideas about mathematics. They described mathematics as an indispensable tool for disclosing social injustices. Some students stated that prior to their investigations they took equality in the US for granted. Even students who suspected biases in social practices had not figured on the subtle form they sometimes take. At the same time, they indicated that applying mathematics to social problems is not unambiguous, unproblematic, and as objective as they had previously thought. As a result, applications should be scrutinized with respect to their assumptions, methods, and conclusions.

Critical scholars argue that students will construct views of mathematics and society that are less mystified if they experience the use of mathematics as a tool for social critique in the classroom. This study supports their argument.

Keywords:

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Introduction

What shall we teach in the secondary mathematics curriculum? This question is the subject of considerable debate in conversations about curricular reform in US high schools. Critical mathematics education scholars proffer this answer: Teach students how to use mathematics as a tool for social critique. At the same time, teach them to critique societal uses of mathematics. The gravity of the social problems that confront humankind requires that citizens of the world bring all manner of disciplinary knowledge, including mathematics, to bear on their resolution. Furthermore, technological progress ensures the continued mathematization of our lives. It does not ensure a more just social order, however. As a result, applications of mathematics must be scrutinized.

The mathematics curriculum in secondary schools is a key influence on students' thinking about mathematics, and arguably, their thinking about the world through their mathematical investigations of it (NCTM, 2000). Regrettably, after years of schooling, far too many students in the US "see the social utility of mathematics not in terms of citizenship and life skills, but instead merely as a ticket to a good job and success" (Wilkins, 2000, p. 414).

Furthermore, youth surveyed in the international Citizenship Education Policy Study Project, felt that what they were studying in school had little bearing on their lives outside of school and that the connections between school subjects and their lives were seldom explicitly made in the classroom (Cogan, J., 2000). These findings suggest that schools are failing to provide many students with sufficient opportunities to develop the kind of mathematics literacy that is suitable for understanding social problems, and the disposition to use mathematics to solve them.

In recent years, recommendations for the reform of the high school mathematics curriculum in the US have emphasized the importance of providing high school students with ample opportunities to investigate societal problems (NCTM 2000). This paper is based on a study that examined high school students' views of mathematics in light of their classroom experiences using mathematics to investigate a wide range of social issues. Furthermore, it examines their views using a critical theoretical perspective on mathematics literacy.

Literature Review and Conceptual Framework

Critical Mathematics Literacy

While a general consensus exists regarding its importance in contemporary society, what mathematics literacy should encompass is not self-evident. Underlying the different conceptions of mathematics literacy that compete for power in schools and public discourses regarding education reform are different social agendas and ideologies, comprised of fundamentally different perceptions of social reality, the purpose of schools, the nature of mathematics, and aims for mathematics education (Ernest, 1991). Of interest to this study is a conception of mathematics literacy that has been termed "critical mathematics literacy" (Frankenstein, 1990), and the kind of mathematics curriculum that supports its development.

Skovsmose (1994a) defines critical mathematics literacy as the competence needed to be able to take a justified position in deliberations of civic issues in which mathematics plays a part. The issues are many, for ours is a "data-drenched" society (Forman & Steen, 2000, p. 129). Thus, many political decisions made democratically are likely to be less informed decisions in the absence of some mathematical competence. Mathematics may illuminate; however, it may also obscure (Porter, 1995). Citizens need to know what lies below the surface of many social, economic, and political issues that are framed mathematically in order to truly understand them. They also need to know what mathematics can (and cannot) contribute to a better understanding of these issues. This requires "critical" mathematics literacy.

The connotation of "critical," rooted in the Enlightenment conception of instrumental rationality, underlies many conceptions of mathematics literacy (Bohl, 1998; Skovsmose, 1994b). Critical mathematics literacy in this sense embodies a technical competence in using mathematical concepts and procedures to achieve a goal. Critique of mathematics applications is confined to a critique of the mathematical techniques used to achieve the goal from the standpoint of the discipline of mathematics. It does not address the value of the goal itself.

For critical mathematics education scholars, however, mathematics literacy that is "critical" embodies the connotation of the term that is rooted in critical theory, whose origins are in the Frankfurt School. In this theory, achieving the democratic ideal requires critiquing existing societal structures and systems together with the ideologies that maintain inequitable social arrangements. In this expanded conception of mathematics literacy, mathematics is a tool for "ideology-critique" (Burbules, 1995, p. 53), specifically, ideological claims regarding social equality. Mathematics can provide evidence in support of arguments that many problems are due to inequitable social arrangements rather than individual failure (Frankenstein, 1990; Gutstein, 2003, 2006).

Furthermore, critical mathematics literacy so conceived requires more than knowing mathematics. It is "knowledge of mathematical content embedded in a contextual framework" (Wilkins, 2000, p. 406) that incorporates social, economic, and political realities. It is understanding the role of mathematics in society—together with the values, assumptions, ideologies and interests—that influence the development and application of mathematical knowledge (Apple, 1992, 1995; Frankenstein, 1990, 1995; Gellert, Jablonka, & Keitel, 2001; Noddings, 1993; Skovsmose, 1994a, 1994b; Tate, 1995).

Critical mathematics education scholars argue that mathematics applications are insufficiently scrutinized in our society in large part because of mathematics' reputation as an infallible tool (Ernest, 1991; Skovsmose, 1994b). Currently, as a consequence of their experiences with mathematics in school, most people view mathematics as the paradigmatic discipline of certain knowledge. In recent years, scholars have challenged this absolutist view of mathematics knowledge (Ernest, 1991 Skovsmose, 1994b). They assert that mathematics does not attain the ideals of certainty, absolute truth, objectivity, and neutrality typically ascribed to it and presumably assured by mathematical proof. When attributes typically associated with an absolutist view of mathematics knowledge (e.g., certainty, objectivity, neutrality, value-free) are uncritically ascribed to applications of mathematics, mathematics becomes mystified. Borba and Skovsmose (1997) refer to mathematics' functioning as "ideology of certainty" (p. 17) in Western societies: mathematics can be used to make sense of virtually any situation, and its use in a situation vouches for the certainty of results obtained. Yet, certainty is not always attainable when mathematics is applied to real-world problems. The certainty of statistics is compromised by errors and limits of confidence, for example. Moreover, mathematics does not always provide solutions to problems of social import (Borba & Skovsmose, 1997). For instance, free and fair elections are a crucial component of the political machinery in a democracy. Yet, mathematics cannot determine the optimal voting method. Kenneth Arrow, a mathematical economist proved that a perfectly fair voting method in a democracy is a mathematical impossibility. In voting theory, this fact is known as Arrow's impossibility theorem.

Critical mathematics education scholars contest other beliefs associated with a mystified image of mathematics. They argue that mathematics is non-neutral and value-laden in its applications because it does not exist apart from how and why it is used, and in whose interest it is used—thus necessarily reflecting values, relations of power and competing interests (Frankenstein, 1995; Gellert, Jablonka, & Keitel, 2001; Skovsmose, 1994b; Tate, 1996). Critical mathematics education scholars also argue that mathematics in its applications is not objective, insofar as objectivity is traditionally conceived. Applications of mathematics reflect myriad choices, both mathematical and non-mathematical. The creation of a particular model typically forces the problem solver to translate an imprecise and complex situation into a simpler and more clearly defined mathematical structure. Influenced by real-world constraints, choices are made about which elements of the real-world situation (and their relationships) to include, and about what mathematical tools can best express them. As a result of this simplification and because mathematics objects have understood properties and behaviors, a mathematics model of a real-world situation has the potential to provide insights that are not discernible during a nonmathematical investigation of the same situation. However, some of the choices made during the model's development may be linked to the social agendas, political values, or ideological assumptions of the problem-solver (Bohl, 1998; Christiansen, 1996; Skovsmose, 1994b; Tate, 1996). Because factors external to the discipline (as well as internal to it) influence how mathematics is applied, mathematics is not the objective tool it is commonly perceived to be.

From a critical perspective, a troubling consequence of the mystification of mathematics in the ways previously discussed is that it inhibits the questioning of knowledge received about mathematics, its applications, the functions mathematics performs in technologically advanced societies, and the consequences of its use in structuring our life experiences and influencing our judgments (Apple, 1992; Davis, 1993; Gellert, Jablonka,, & Keitel, 2001; Skovsmose, 1994b). Therefore, a mathematics literacy that is truly critical requires a demystified image of mathematics.

Reflection on Mathematics Applications

For Skovsmose (1994b), scrutinizing or reflecting on an application of mathematics to a problem in the world outside the classroom entails examining (a) the assumptions underlying the application, (b) the processes involved in the application's development, and (c) the effects of using mathematics to address the problem. Other critical education mathematics scholars have argued the importance of interrogating these aspects of mathematics applications to being critically literate about the uses of mathematics in society (Bohl, 1998; Christiansen, 1996; Frankenstein, 1995).

Applications of mathematics to real-world problems embody assumptions emanating from system descriptions, theories (and perhaps biases), and methodologies. Reflection on mathematics applications requires questioning their assumptions—assessing their reasonableness while uncovering choices involved in their adoption, the basis of these choices, and whose interests or agendas they serve (Bohl, 1998; Skovsmose, 1994b; Tate, 1996). The point in laying bare the assumptions in a mathematics application is not to eliminate them, as they cannot be eliminated, but rather to subject them to scrutiny.

Reflecting on a mathematics application requires keeping a close watch on the different processes involved in its design and implementation. Skovsmose (1994b) contends that there are inherent "problems and uncertainties connected with the transitions" (p. 111) among processes involved in the development of a model due in part to the different languages they employ. He distinguishes among four basic languages in mathematical modeling: natural, systemic, mathematical, and algorithmic. In mathematical modeling, natural language gives rise to a problem, situation, or issue in need of better understanding or resolution by means of the model. Systemic language highlights relevant aspects of reality that are often depicted using technical terms based on a particular theoretical framework. These aspects of reality become part of a system, the conceptualization of reality for the application's purposes. Mathematical language is used to describe relationships among parameters that are theorized in systemic language, thus formalizing these relationships. Finally, algorithmic language provides a series of steps for determining a numerical value. Reflection on mathematics applications thus requires monitoring an application's development to evaluate what has been lost and/or gained in the transitions among the different processes involved (Skovsmose, 1994b).

Reflecting on mathematics applications requires evaluating the effects of using mathematics to address a real-world problem. It entails reflecting on what mathematics has to offer a problem in need of a solution or better understanding. This may include questioning the relevance of a mathematical approach to the problem-solving process: one might ask whether it would be possible to solve the problem without mathematics. One might also reflect on whether the mathematical approach used was reliable or whether a better mathematical approach could have been used (Gellert, Jablonka, & Keitel, 2001; Skovsmose, 1994b). Skovsmose (1994b) argues that one of the effects of using mathematics in a problem situation is that it constrains "problem identification," "the structure of argumentation," "the basis for critique," and "the scope of possible actions" (pp. 111-113).

In conceptualizing reflection on mathematics as a problem-solving tool, Christiansen distinguishes between reflections guided by "technological purpose[s]" and those guided by "a critical interest in recognizing what is restrictive and oppressive" (Christiansen, 1996, p. 125). This paper refers to the former reflections as technically-oriented reflections and the latter as critically-oriented reflections. The goal of technically-oriented reflections is to obtain the highest quality model for a problem situation. As a result, these reflections are concerned with such matters as whether the application's calculations address the right problem (often narrowly defined) and have been performed correctly, the reasonableness of assumptions and methods in view of what was to be mathematized, and the reliability of results obtained.

In contrast, critically-oriented reflections unite social, political, and ethical concerns with technical considerations in appraising a mathematics application. Critically-oriented reflections also address the broader consequences of using mathematics to address a problem. Therefore, they examine such things as how mathematics affects the perception of the problem, what the actual purpose of using mathematics in this situation is, and what functions mathematics performs. It is important to note that these more critically-oriented reflections are frequently the kind of reflections that are silenced, dismissed, marginalized, or supplanted by technical concerns when mathematical applications are discussed, both in schools and outside of schools (Bohl, 1998; Christiansen, 1996; Skovsmose, 1994b; Tate, 1996).

The Mathematics Curriculum

Critical mathematics education scholars have argued that mathematics applications in the curriculum that address socially relevant problems and highlight social injustices (local, national and/or global in scope) are indispensable instruments of social criticism and that they can positively impact students' critical social awareness (Brantlinger, 2007; Christiansen, 1996; Frankenstein, 1995; Gutstein, 2003, 2006; Skovsmose, 1994b; Tate, 1995; Turner, 2003). Empirical studies of mathematics applications involving concrete instances of discrimination and exploitation (or privileging), based on class, race, gender, and other social group identifiers support critical scholars' claims that they enhance students' social awareness (Frankenstein, 1995; Gutstein, 2003, 2006; Tate, 1995; Skovsmose, 1994b; Turner, 2003). By surfacing some of the contradictions between sociopolitical ideals and lived experiences, these mathematical investigations led to changes in students' perceptions of social life that are consonant with an emerging critical social awareness. Furthermore, a positive change occurs in most students' perceptions of the utility of mathematics and importance of knowing it in order to understand the social world when they have engaged in social inquiry with mathematics (Brantlinger, 2007; Christiansen, 1996; Frankenstein, 1995; Gutstein, 2003; Tate, 1995; Turner, 2003).

There is a dearth of studies of high school students' views of mathematics as a tool for social critique, however (Brantlinger, 2007). Moreover, US field studies of critical mathematics literacy have been conducted largely in segregated schools serving traditionally underachieving or underrepresented social groups in mathematics—students of color, particularly African-American and Mexican-American students; and low-income students (Brantlinger, 2007; Gutstein, 2003; Tate, 1995; Turner, 2003). The research reported in this paper addresses this gap in the research literature. Collectively, the students in this study are quite diverse with respect to race, ethnicity, social class, and mathematical achievement and interest. Although teaching for critical literacy originated as a "pedagogy for the oppressed" (Freire, 1995), it must be a pedagogy for all. There is a danger in limiting the contexts in which critical mathematics literacy is promoted and studied, and that is its marginalization as a tool for democratic citizenship.

Methods and Data Sources

Qualitative research enables the "documentation of the concrete details of practice" as well as a rich description of the "meaning-perspectives" of participants in that practice (Erickson, 1986, p. 121). Thus, qualitative research methods were well suited for the purposes of this empirical study and were used for both data collection and data analysis.

Research Sites and Participants

The research sites for this study were two mathematics classes- Mathematics Modeling and Statistics, in two selective enrollment public high schools in the US. Admission to both schools is highly competitive and is based on student grades and performance on nationally normed tests. Both schools are committed to a diverse student body, so race and other demographic factors are also considered in admitting students. Mathematics

Modeling and Statistics are among the most application-driven courses in the high school mathematics curriculum and, thereby, promising courses for engaging students in mathematically-based investigations of social problems. Between them, the curricula at the two research sites encompassed a wide range of applications with respect to mathematical content and social issues. A profile of student participants is provided in Table 1. The teacher participants have more than 10 years of mathematics teaching experience and created the applications included in this study.

Data Collection

Data were gathered through (1) classroom observations, (2) semi-structured interviews, and (3) a review of student work. Interviews were conducted with both of the teacher participants in this study and with all student participants who consented to be interviewed and were available for interviews: 93% of students (28 out of 30) in the Modeling class and 82% of students (32 out of 39) in the Statistics class. Lessons involving seventeen socially relevant mathematics applications were observed. The applications, nine at North High School and eight at Central High School are listed by social issue in Table 2.They addressed a wide range of issues of either the students' or teachers' choosing and incorporated mathematics topics mainly from the advanced algebra and AP statistics curricula. A sample of students was interviewed individually or in groups following each application. A sample of student work (from at least 5 students) was collected for each application.

Data Analysis

An inductive approach was used in the analysis of students' views of mathematics as a tool for social inquiry. Spradley's analytic techniques, known as domain analysis, were used to generate "categories of meaning" (1980, p. 88) which culminated in the identification of themes in students' views. The domains or categories emerged from the study's data even as some categories were foretold by the research literature and the study's interview questions.

A domain incorporates "included terms" and a "cover term" linked by a semantic relationship (Spradley, 1980). Included terms specify members of the domain. A cover term names the domain to which the included terms belong. While cover terms were generally researcher-generated, included terms were terms that students used to describe mathematics. For example, a domain in this study was "image" (cover term). It contained the following members (among others): "objective," "precise," "untrustworthy" (included terms). The semantic relationship for this domain was "attribution." Each of the included terms was an "attribute" or characteristic of the "image" of math that students voiced. The examples in Table 2 illustrate some semantic relationships used to generate the initial categories for data analysis.

Seven major categories (with subcategories) resulted from the consolidation of hundreds of categories generated by domain analysis: (1) attributes of mathematics, (2) value of mathematics, (3) uses of mathematics, (4) challenges of developing mathematics applications, (5) influences on the mathematics applications, (6) influence of applications on student thinking about mathematics and social issues, and (7) evaluation of mathematics applications. These categories were further consolidated into the following three categories - benefits, shortcomings, and evaluation, each of which contained multiple sub-categories and were the basis of themes in students' views of mathematics.

Results and Discussion/Conclusion

Three primary themes in students' descriptions of mathematics as a tool for social critique emerged from data analysis.

1. Mathematics is an indispensable tool for understanding social issues and effecting social change.

For students in this study, mathematics is an essential tool for social critique because (1) It determines the "facts" of the matter, (2) It is an "objective" tool, and (3) It provides a compelling justification for individual and societal beliefs and actions.

2. A mathematical inquiry is necessarily an incomplete inquiry about a social issue, and may even be an inappropriate one.

Students indicated that mathematics has shortcomings as a tool for social critique: (1) It oversimplifies social issues, (2) It objectifies human beings, (3) It offers inadequate explanations for societal problems, (4) It is irrelevant for moral questions, and (5) It is inaccessible to the general public and largely underutilized as an instrument for social change.

3. It is important to carefully examine the methods used and the motives underlying applications of mathematics to social issues.

Students consistently mentioned the need to be "critical" about mathematics' use as a tool for social critique. Being "critical" means scrutinizing an application's assumptions, methods, and conclusions and the "intentions" of the developer or user of the application.

These three themes were true for every student interviewed and consistent across both research settings. That is to say, all students identified some situations in which mathematics would be an indispensable tool for examining social issues (theme 1), or an inadequate one (theme 2). Furthermore, all students indicated that it was important to scrutinize applications of mathematics to social issues. Although there was consistency in the content of some descriptions related to these themes, there was variation in others. That is to say, some ideas supporting these themes were articulated by all students or the majority of students, and other ideas were expressed by a few students, or a lone student at each research site. In the following discussion, I examine students' views of mathematics from a critical theoretical perspective. In so doing, I focus on the ways in which they challenged hegemonic ideas about society and mathematics.

Mathematics: A Tool for "Ideology-Critique"?

Critical mathematics education scholars argue that mathematics is an invaluable tool for "explod[ing] the myths" (Frankenstein, 1994, p. 25) about social life by revealing the contradictions between professed American values and the lived experiences of oppressed social groups. It is an essential tool for exposing social injustice because of the relevance of quantitative information to the justification of social policies and practices in contemporary society.

Students' overwhelmingly concurred with critical education theorists on this point. Their reflections on classroom inquiries demonstrate that they believed that fundamental social inequalities persist in our country and that statistics provide "hard evidence" of them (Gian). Some students reflected that prior to some investigations they did indeed take equality in the United States for granted. Even students who suspected biases in institutions and social practices, had not figured on the subtle form they sometimes take. All students indicated that their inquiries enabled them to see things as they are. Some reported being "troubled" by their findings.

Mathematics: An "Ideology of Certainty"?

In the dominant view of mathematics, mathematics is certain, objective, neutral, value-free, authoritative, and all-powerful. Borba and Skovsmose (1997) refer to this view as an "ideology of certainty" (p. 17). Students largely contested the dominant view of mathematics in its applications to social issues. They reflected that mathematical inquiries are subject to a number of uncertainties. For example, the certainty of conclusions is compromised by limits of confidence. Furthermore, students were unanimous in the view that many social issues could not be unproblematically mathematized. In the "transition" from social issue to its mathematization, things have a tendency to get "muddled," as Dinesh put it. Students' recognition of this recalls Skovsmose's discussion of the importance of awareness of "the problems and uncertainties connected with transitions between the different…language[s]…

involved" in the process of developing a mathematics application (Skovsmose, 1994b, p. 111).

Students viewed inquiries which revealed statistically significant imbalances as a starting point, not an endpoint to a discussion about the fairness of social practices. The knowledge we obtain from them, though extremely useful, is necessarily partial. Moreover, students did not see mathematics as a relevant tool for answering some of the all-important questions that might be asked, thereby challenging the myth of mathematics as an all-powerful tool. So, for example, although mathematics can tell us how the death penalty is working, it cannot in and of itself settle the larger question of whether we should have a death penalty, students said. These students essentially recognized that "mathematics does not allow for normative discourse" (Skovsmose, 1994b, p. 110). Thus, although students embraced the conclusions established by their mathematically-driven inquiries, these conclusions appeared less certain and less powerful than they once might have. Students seemed to accept these conclusions as truths, to be sure, however, as tentative rather than absolute truths.

Critical mathematics education theorists argue that mathematics applications are not objective as the term as objective is traditionally conceived. Students also contested the objectivity of mathematics applications. Because people "put part of themselves in the math" (Matthew), mathematical inquiries about social issues cannot be "entirely objective" (Gabriel). All students indicated that there was often more than one way to mathematize problem situations involving social justice issues. The transformation of these issues into mathematics problems to solve required making many choices, both mathematical and non-mathematical. So, while, logic and the mathematics tools themselves were perceived as neutral and value-free, their use was not. Some students indicated that one can selectively feature evidence that confirms what one expects to find, or one can overstate the conclusion that can be drawn from the inquiry to advance one's agenda. For Bohl (1998), mathematics applications are strongly influenced by the broader social and political contexts in which they are developed and used. Issues of domination, power, and ideology embedded in these contexts must be addressed through a questioning of the factors that shape the application of mathematics knowledge. While students understood that the interests and values of individuals influence mathematics applications, they did not tie these individuals to social groups and ideas about how domination works. Doing so would have made their reflections on subjectivity more fully "critical."

Critical mathematics education scholars assert that a troubling consequence of the mystification of mathematics is that it inhibits the questioning of applications of mathematics and the consequences of their use. This point was not lost on students. As Madison observed, "They take advantage of people who aren't going to look into things better, not taking the time to look, or not going to know to look."

The questioning of knowledge received about mathematics and its uses, regardless of the source of this knowledge, is central to a mathematics literacy that is “critical.” All students mentioned the importance of closely examining a mathematical inquiry and deciding on the merits of the inquiry whether to accept its claims as true. “A lot of people think because it’s math, it must be true,” stated Lauren when it might well be “meaningless,” added Adam. In viewing people as the final judges of the assertions of a mathematical inquiry, students contested a dominant myth of mathematics as an “above-all referee…one that is above humans” (Borba & Skovsmose, 1997, p. 17).

At the same time, students expressed doubt that most people (themselves included) could judge all aspects of a social inquiry involving mathematics. Doing so requires knowledge of the subject matter and mathematical tools that most of the population lacks. Thus, reliance on the judgments of experts is unavoidable. This reflection echoes Skovsmose’s discussion of one effect of the use of mathematics on social problem solving: it limits the number of people who can participate in a comprehensive critique of a mathematics application.

In conclusion, the students in this study, who had had multiple experiences applying mathematics to social issues, were very receptive to using mathematics as a tool for social critique. They saw the benefits of mathematical inquiry about social problems. At the same time, they recognized the limitations and the potential dangers of mathematics’ use for that purpose. Students neither romanticized nor rejected mathematics as a tool for social inquiry. Their views of mathematics were more complex and nuanced than simplistic. Thus, collectively, their views of mathematics were critical in important ways. Critical mathematics education scholars argue that students’ views of mathematics and society will be less mystified if they experience the use of mathematics as a tool for social critique. This study’s support this relationship between classroom experiences and students’ views of mathematics and the social world.

Implications

There is very little information in the research literature about high school students’ views of mathematics, specifically as a tool for social inquiry. This study contributes a rich description of these views that is grounded in students’ classroom experiences using mathematics to investigate social issues. For example, when students described mathematics as subjective or powerful in the study on which this paper is based, they cited experiences with specific classroom inquiries as a basis for their views. It is noteworthy that all students in this study indicated that these inquiries afforded them their first opportunity to explore social justice issues with mathematics in the classroom.

This study also contributes to the literature an examination of students’ views from a critical theoretical perspective on mathematics literacy.

In linking mathematical competencies to an enhanced consciousness of the social world and in recognizing the affordances and constraints of mathematics as a tool for social critique, critical mathematics literacy is a mathematics literacy that promotes social justice and thereby, the liberation of the potential of all human beings. The perspective of the critical education tradition has been mostly absent from public and professional discourses on mathematics education reform. By investigating students' views of mathematics from the standpoint of this tradition, this study informs ongoing conversations regarding a mathematics literacy for all students that better serves students and the public good.

Table 1. *Class Profiles*

CLASS CHARACTERISTICs	NORTH HIGH SCHOOL	CENTRAL HIGH SCHOOL
Class size	30	39
Race/Ethnicity (%)		
White	24%	74%
Asian Pacific	7%	21%
Black	33%	5%
Hispanic	23%	0%
Bi-racial	13%	0%
Gender (%)		
Female	37%	49%
Male	63%	51%
SES	Mostly poor and working class	Mostly middle and upper class
Achievement/Interest	Mostly underachievers at their school with little interest in math	Mixed achievement levels and interest

Table 2. *Semantic Relationships in Student Descriptions of Mathematics*

SEMANTIC RELATIONSHIP	INCLUDED TERMS	FORM	COVER TERM
Attribution	Objectivity	is an attribute of	Image
Attribution	Precision	is an attribute of	Image
Attribution	Untrustworthy	is an attribute of	Image
Strict Inclusion	"Translating fairness into math"	is a kind of	Challenge
Strict Inclusion	"When they're ethical problems, math doesn't help"	is a kind of	Limitation
Strict Inclusion	"Proves hunches true"	is a kind of	Strength
Means-end	"Check any assumptions made	is a way to	Scrutinize applications

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