Teaching Mathematics for Social Justice and its Effects on Affluent Students

by

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A thesis submitted in conformity with the requirements for the degree of Master of Arts

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University of Toronto

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Abstract

There is a crisis in mathematics education (National Research Council, 1989). This crisis has caused stakeholders to question the purpose of mathematics education. Teaching mathematics for social justice is a pedagogy that uses mathematics as a tool to expose students to issues concerning power, resource inequities, and disparate opportunities between different social groups to illicit social and political action (Gutstein, 2006).

This study uses action research to explore the effects of incorporating social justice issues in mathematics with affluent, middle school students. Findings indicate that integrating social justice issues into mathematics affected some students’ cognitive and affective domains and in some cases led to empowerment and action. The study also found that students’ perception of responsibility, their age and personal connections along with the amount of teacher direction may have affected students’ development of social agency. These findings help to inform teachers’ practices and contribute to literature on critical mathematics.
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Chapter 1: Introduction and Overview

The Need for Teaching Mathematics for Social Justice

There is a sense of crisis in mathematics education (National Research Council, 1989):

The widening gap between those who are mathematically literate and those who are not coincides, to a frightening degree, with racial and economic categories. We are at risk of becoming a divided nation in which knowledge of mathematics supports a productive, technologically powerful elite while a dependent, semiliterate majority, disproportionately Hispanic and Black, find economic and political power beyond their reach. Unless corrected, innumeracy and illiteracy will drive America apart. (p. 14)

This crisis has caused researchers, teachers, and other stakeholders to question the purpose of mathematics education. Typically, mathematics is seen as the gatekeeper to future economic opportunities (Aguirrez, 2009; Gutierrez, 2002; Moses, Kamii, Swap & Howard, 1989) and necessary for appropriate function in society (Gutstein, 2006). Traditional mathematics approaches and curriculum have resulted in low participation rates (Dossey, Mullis, Lindquist & Chambers, 1988; Mullis, Dossey, Owen & Phillips, 1991) and poor performance on assessments of mathematical proficiency especially among minority students (Bourque & Garrison, 1991; Robitaille & Garden, 1989). To address the participation rates and performance on assessments reform mathematics was introduced (NCTM, 1989). Reform mathematics aims to shift the emphasis from basic computational skills, memorization, and repetition to one that emphasizes reasoning, problem solving, and communication. In addition to expanding the range of pedagogical strategies used reform mathematics also aims to find ways to connect mathematics with students’ lives and their experiences outside of school. Reform mathematics has the ability to engage a broader cross-section of society in mathematics, and as a result:
We may see more equity in the kinds of students who identify with the practice of mathematics or who participate in mathematics while in school ... however, in its current state, I do not see that reform mathematics necessarily positions students to consider issues of power in society, something that is at the core of equity. (Gutierrez, 2002, p. 150)

Although current reform efforts have focused on improving accessibility, quality, and relevance of mathematics instruction these efforts do not change the educational and societal structures that perpetuate the status quo (Gutierrez, 2002; Anyon, 2006, Gutstein, 2006).

The current reform movement does not place teachers and students in a position where they have the power or the knowledge to “rectify fundamental structural inequalities through their participation in civil society, both within and outside of educational areas” (Gutstein, 2006, p. 13). Without power and an understanding of injustices against them, marginalized groups will not take action to change federal policies and practices that perpetuate the inequities we see in education (Anyon, 2006). In order to promote change, stakeholders, such as parents, teachers, administrators and students need to be empowered to change oppressive structures (Gutstein, 2006; Gutierrez, 2002; Anyon, 2006; Moses, Kamii, Swap & Howard, 1989; Frankenstein, 1995; Banks, 2008; Freire, 1970/2003). Teaching mathematics for social justice is a pedagogy that uses mathematics as a tool to expose students to issues concerning “relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences” (Gutstein, 2006, p.26). When students are “increasingly posed with problems related to themselves in the world and with the world”, they “feel increasingly challenged and obliged to respond to the challenge” (Freire, 1970/2003, p. 81) through action.
Even though, there are a number of programs and studies that aim to improve accessibility and quality (Moses et al., 1989; Silver, Smith & Nelson, 1995; Phillips & Ebrahimi, 1993; Campbell, 1996; Lubienski, 2007; Chiznik, 2001; Boaler; 2007), as well as relevance (Banks, 2006; Tate, 1995; Ladson-Billings), there are few studies that examine the effectiveness of integrating social justice issues into mathematics to promote social agency (Gutierrez, 2002). Gutstein (2006), Frankenstein (1995), and Brantlinger (2007) are among the few teachers who have applied critical mathematics pedagogy into their teaching practices and observed its effect over an extended period of time. However, these researchers only studied the effects of critical mathematics pedagogy on marginalized groups of students who were relatively homogeneous. To my knowledge there are no studies conducted on dominant groups or in heterogeneous settings. Of the three studies only one noted any development of social agency (Gutstein, 2006). When researchers discuss issues of equity, they mainly focus on marginalized students. However it is important to consider how mathematics education for dominant groups can use their power and status to achieve equity. As a teacher at an independent school, I wonder how the integration of social justice issues into mathematics might affect a class of affluent students whose ethnic backgrounds are non-homogeneous. Would affluent students be affected by social justice issues in the same way as marginalized students? How can I promote the development of social agency in students whose lives are not directly affected by social injustices?

**Possible Contributions**

Through my research, I hope to make contributions to literature and teaching of mathematics for social justice. Firstly, I hope to expand our knowledge on teaching mathematics for social justice. It is an idea that stems from Paulo Freire’s critical pedagogy from the 1970s. Even after 40 years, only a small number of educators have implemented some form of critical
mathematics (e.g. Tate, 1995; Gutstein, 2006; Brantlinger, 2007; Frankenstein, 1995). The research mostly looks at the effects of developing social agency through the use of social justice issues in marginalized groups of students, especially those students of lower social class or those who represent a racial minority in the United States. My research will offer new information as it focuses on affluent students in Canada.

Secondly, I hope that my findings will help to improve the practice of teaching mathematics for social justice. Because I have used practitioner research, I hope that it will be accessible to other teachers and that my findings will help them to move towards the integration of social justice issues into their instruction. This study will also lead to new questions and areas to be explored that may contribute to teaching mathematics for social justice.

Finally, the ultimate goal of teaching mathematics for social justice is to create equity through action. Through the use of this pedagogy, I hope to empower and motivate my students and others to take action in order to create a more equitable world. Hopefully this will inspire others (i.e. students, teachers, administrators, parents) to act, as well.
Chapter 2: Literature Review

This chapter examines the literature that provides the basis for teaching mathematics for social justice. The chapter begins with defining equity in mathematics. Gutierrez’s definition of equity will be used to frame the literature on achieving equity in mathematics. This definition of equity includes: acquisition of classical mathematical knowledge, integration of community knowledge, and acquisition of critical knowledge. Finally, the chapter ends with Gutierrez’s vision of large-scale change to erase inequities among people, mathematics, and the globe through action.

Defining Equity in Mathematics

Among researchers, educators, and other stakeholders there exists a tension as to how equity should be achieved in mathematics education (Gutierrez, 2007). This disparity results from the lack of consensus on the definition of equity. According to Fennema and Meyer (1989), equity can be defined as: equal education opportunity, equal educational treatment; or equal education outcome. These definitions of equity are widely used in the mathematics community (Kreinberg, 1989; Grant, 1989, National Science Board Commission, 1983; National Council of Teachers in Mathematics, 1980; NCTM, 1989; NCTM, 2008). However these relatively classical definitions of equity are based on the learning of dominant mathematics. Gutierrez (2007) proposes an alternative definition of equity that challenges what is taught in mathematics and that moves beyond schooling. I will begin by discussing the classical definitions of equity and finish with Gutierrez’s definition.

Firstly, equity can be defined as equal educational opportunity, with all students having equal opportunity to take mathematics courses and not being tracked into different mathematics
courses or classrooms based on gender, race, or socioeconomic status. Even when different groups of students have equal opportunity to take mathematics courses, it has been found that females, minorities, and students with low socioeconomic status (SES) were less likely to enroll in higher level mathematics courses than males, whites, and students with higher SES (Meyer, 1989a). Although equal educational opportunity may be important to some degree in achieving equity among various groups of students, it is not sufficient for a just mathematics education (Fennema, 1990; Gutierrez, 2007). Students’ life experiences, SES, identities, and other factors play a role in achieving a just mathematics education. Even if we offer all students equal education opportunity to all mathematics courses, we cannot ensure that students will be successful in these courses, if we have not acknowledged the role these factors play in student learning.

Secondly, equity can be defined as equal educational treatment. This implies that all students are treated equally in classrooms regardless of gender, race, or SES. This definition of equity is used to describe the NCTM’s (2008) position on equity in mathematics education:

Excellence in mathematics education rests on equity—high expectations, respect, understanding, and strong support for all students. Policies, practices, attitudes, and beliefs related to mathematics teaching and learning must be assessed continually to ensure that all students have equal access to the resources with the greatest potential to promote learning. A culture of equity maximizes the learning potential of all students.

(NCTM Position, para. 1)

The NCTM’s position emphasizes that high expectations, respect, understanding, support, and equal access to resources would result in equity in mathematics. There is evidence of unequal treatment of students based on gender, race, or SES (Ladson-Billings, 1995; Peterson &
African American students felt that they were often inappropriately streamed into general and basic level classes by teachers and guidance counselors because of biases towards them. They felt that this streaming led to limited future opportunities (Dei et al., 2004). Students who are treated as competent individuals are more likely to demonstrate competence in the classroom (Ladson-Billings, 1995).

Conversely, Lubienski (2007) found that equal treatment can lead to a form of inequity. In a study where Lubienski compared lower-SES and higher-SES students’ experiences with two teaching strategies (whole-class discussions and open-ended mathematical problems), she found that lower-SES students were confused by conflicting ideas during discussions and the open-endedness of the problems presented. In addition, when presented with contextualized problems, lower-SES students became engaged in the context of the problem and as a result missed the intended mathematical purpose. Even though Lubienski presented students of both socioeconomic class with the same strategies and expected the same results, she found a difference in the outcomes. She found that “holding high expectations for all students is necessary but not sufficient to produce equitable instructional practices. Researchers and educators should not assume that learning mathematics through problem solving and discussion is equally ‘natural’ for all students” (p. 21). Other studies have shown that instructional strategies and assessment can affect students differently based on race, gender, or SES (Chizhik, 2001; Belcher, Coates, Franco & Mayfield-Ingram, 1997, Meyer, 1989a; Fennema & Meyer, 1989; Boaler, 2007). Likewise, Gutierrez (2007) echoed a similar opinion: Although equity means “justice” or “fairness,” it is often blurred with equality, which means “sameness.”…However, in order to redress past injustices and account for different home resources, student identities, and other contextual factors, students need
different (not the same) resources, and treatment in order to achieve “fairness.”

(Gutierrez, 2007, pp. 40-41)

Therefore, even though some kinds of differential treatments do hinder student learning and promote inequity. “Treating all students the same will not necessarily meet their needs nor provide justice” (Hart, 2003, p. 29).

Thirdly, equity can be defined as equal educational outcomes. According to Fennema (1990):

At the end of schooling, there should be no differences in what females and males have learned, nor should there be any gender differences in how students feel about themselves as learners of mathematics. Males and females should be equally willing to pursue mathematics-related careers and should be equally able to learn new mathematics as it is required. The definition of equity as the achievement of equal outcomes offers the greatest promise for achieving true justice. (p. 5)

Although Fennema speaks solely of males and females, this definition applies to all students regardless of their gender, race, and SES. And “only when there is sufficient variation within groups and no clear patterns associated with power or status in society between groups can we conclude that this aspect of equity is being addressed” (Gutierrez, 2007, p. 42).

Meyer (1989b) argues that this is the only definition of equity that can address justice; a criterion deemed important in achieving equity (Secada, 1989). Secada views equity as “our judgments about whether or not a given state of affairs is just” (p. 68). In other words:

Equity gauges the results of actions directly against standards of justice, and it is used to decide whether or not what is being done is just. Educational equity, therefore, should be
construed as a check on the justice of specific actions that are carried out within the educational arena and the arrangements that results from those actions. (pp. 68-69)

Hence, if equity was being achieved we should be unable to predict students’ achievement and participation based on cultural markers such as race, gender, class, ethnicity, beliefs, and language (Gutierrez, 2007).

Although equal educational outcomes are an important aspect of achieving equity, this definition of equity only addresses the acquisition of classical mathematical knowledge. This includes “mathematical power and competencies needed to make meaning in the world, pass gate-keeping educational and vocational tests, and pursue advanced mathematics and mathematics-related careers” (Aguirre, 2009, p. 299). If we continue to accept the notion that equity can be achieved through equal educational outcomes alone, mathematics education would continue to value dominant mathematics. Gutierrez defines dominant mathematics as mathematics:

That reflects the status quo in society, that gets valued in high-stakes testing and credentialing, that privileges a static formalism in mathematics, and that is involved in making sense of a world that favors the views and perspectives of relatively elite group. (2007, p. 39)

Thus, dominant mathematics perpetuates the values of the powerful and dominant. In order for marginalized students to acquire classical mathematical knowledge they are expected to compromise their cultural identities. Schools often force members of ethnic groups to experience “self alienation” in order to be successful (Dickeman, 1973). In other words, members of some ethnic and racial groups often deny their ethnic identities, language, and family in order to assimilate and participate more fully in institutions (Alba & Nee, 2003). Thus,
providing students with equal educational outcomes to participate in an unjust society does not create equity. To create justice students’ life experiences and cultural identities need to be acknowledged and valued.

Gutierrez (2007) proposes an alternative definition of equity that not only addresses the acquisition of dominant mathematics, but also focuses on ‘critical mathematics’:

Mathematics that squarely acknowledges the positioning of students as members of a society rife with issues of power and domination. Critical mathematics takes students’ cultural identities and builds mathematics around them in ways that address social and political issues in society, especially highlighting the perspectives of marginalized groups. (p. 40)

By incorporating critical mathematics into mathematics, students would be able to analyze the world and develop a critical eye on knowledge, without compromising their cultural identities. It should be impossible to predict students’ ability to analyze, reason about, and critique knowledge and events in the world regardless of factors such as race, class, ethnicity, gender, beliefs, and language proficiency (Gutierrez, 2007). However, she argues that even though students may be able to identify inequities through the use of mathematics it does not necessarily translate into change. In other words, acquisition of classical mathematical knowledge and critical stances to society are necessary but insufficient to change the oppressive social structures that perpetuate inequities. To do this we must erase the “inequities between people, mathematics, and the globe” (Gutierrez, 2007, p. 48).

Creating a more equitable society requires us to move from inside the classroom to outside the school. The government policies, practices, and structures which help to maintain inequities must be changed through social activism (Anyon, 2006). This vision of a large-scale
change is influenced by the notion that mathematics can play an important role in achieving freedom and justice in society:

It is an undeniable right of every human being to have access to all the natural and cultural goods needed for her or his material survival and intellectual enhancement…I see mathematics playing an important role in achieving the high humanitarian ideals of a new civilization with equity, justice, and dignity for the entire human species without distinction of race, gender, beliefs and creeds, nationalities, and cultures. (D’Ambrosio, 1999, pp. 142-143)

Therefore equity means that there is shared wealth distribution, and mathematics is not used as a means for oppression or destruction, but for achieving humanitarian ideals.

Although many (Aguirre, 2009, Banks, 2008; D’Ambrosio, 1999; Fennema, 1990; Gutierrez; Gutstein, 2006; Ladson-Billings, 1995; Peterson, 2006) would agree that marginalized students would benefit from critical mathematics, as it acknowledges that their knowledge is valid, addresses social injustices that affect them directly, and provides them with the tools to promote social change, I wonder how it might affect affluent, White students. If the intention of critical mathematics is to reduce the achievement gap between marginalized groups and affluent, White students and to change social structures that promote inequities, does promoting critical mathematics inadvertently create another inequitable situation? As a result, marginalized students’ achievement levels should increase, while affluent, White students’ achievement levels remained the same. In addition, critical mathematics is meant to change social structures that promote inequities among marginalized students. Both of these effects are ‘unfair’ to those students with power, as they are not benefiting from critical mathematics or changes to social
structures. These are issues that have yet to be addressed, but need to be considered to achieve equity for all students regardless of gender, race, socioeconomic status, or language.

There is little consensus in the definition of equity within the field of mathematics education. The definition of equity “is struggled over, in the same way that concepts such as democracy are subject to different senses by differing groups with sometimes radically different ideological and educational agendas” (Apple, 1995, p. 335). Equity, equality, and justice can mean different things to different people and in different contexts. As a result, the approaches to achieving equity vary. In my discussion of equity, I will use Gutierrez’s definitions as my conceptual framework. Although the other definitions may address inequities on a school-level, they do not address societal injustices that exist and that help to perpetuate injustices in the school system.

**Achieving Equity in Mathematics**

Because of the lack of consensus in the definition of equity there are multiple approaches to achieving equity. The goals of these approaches can be separated into three main categories: acquisition of classical mathematical knowledge, critical mathematics, and the development of social agency. Although each approach on their own does not help to achieve Gutierrez’s vision of equity, together they create equity in mathematics. Firstly, I will examine the programs designed to help marginalized students acquire classical mathematical knowledge in order to become successful in the current school structure. Secondly, I will look at how culturally relevant curricula and the use of social justice issues, and components of critical mathematics, help achieve equity in mathematics. Finally, we will look at how mathematics can be used to develop social agency among students in order to achieve Gutierrez’s vision of equity.
Achieving equity in mathematics by acquiring classical mathematical knowledge.

Disproportionate numbers of poor, African American, Latino/a, and Native American students drop out of mathematics and perform below standard on tests of mathematical competency (Schoenfeld, 2002). As a result of this these students are denied access to opportunities that may change their SES (Schoenfeld, 2002). In order to reduce the variation in achievement and participation between groups based on cultural markers such as race, gender, class, ethnicity, beliefs, and language, programs have been developed to provide these students with the opportunities to acquire classical mathematical knowledge (Moses, Kamii, Swap, & Howard, 1989; Silver, Smith, & Nelson, 1995). Classical mathematical knowledge focuses on the development of students’ conceptual understanding, adaptive reasoning, strategic competence, productive disposition, and procedure fluency (Aguirre, 2009).

Many proponents of reform mathematics (e.g., Boaler, 2002; Moses et al., 1989; Silver et al., 1995) argue that equity can be achieved by providing marginalized students with opportunities to acquire classical mathematical knowledge using a reform approach. This acquisition of classical mathematical knowledge can help close the achievement gap between dominant and marginalized students. In one longitudinal study (Boaler, 2002), researchers followed three hundred students from two schools that taught mathematics using different approaches; traditional and reform-oriented. For over three years, researchers found students at Phoenix Park, the school that taught mathematics using a reform approach, performed better on mathematics assessments than their Amber Hill counterpart, a school that used a traditional, procedural approach. Researchers also found reform-oriented mathematics reduced the achievement gap between males and females. Not only does a reform approach to teaching mathematics reduce the achievement gap between males and females, it can also affect social
change. If more students can acquire the classical mathematical knowledge necessary to enroll in advanced mathematics courses and pursue mathematics-related careers, students may be able to use their power to change inequitable social structures (Moses et al., 1989).

The Algebra Project (Moses, Kamii, Swap & Howard, 1989), QUASAR (Silver, Smith & Nelson, 1995), Project Seed (Phillips & Ebrahimi, 1993), and Project Impact (Campbell, 1996) are a few examples of projects aimed at providing marginalized students with the opportunity to develop the classical mathematical knowledge necessary to pursue advanced mathematics or mathematics-related careers. These projects share some commonalities such as adopting different methods of teaching, parental involvement, elimination of remediation, providing adequate teacher training, setting high expectations and creating a positive learning environment. Davis and West (2000, as cited in Davis, Maxwell West, Greeno, Gresalfi & Martin, 2006) conducted a study and found that in schools that offered the Algebra Project students were twice as likely to enroll in college-preparatory mathematics courses in grades 9 and 10, than non-Algebra Project students in the same districts. Similarly, the other projects show narrowing of the achievement gap (Secada & Williams Berman, 1999; Gutierrez, 2002; Campbell, 1996). Although these reform-based programs show some success in achieving part of Gutierrez’s vision of equity in educational outcomes, they do not address Gutierrez’s vision of equity in its entirety.

**Achieving equity using critical mathematics.**

Although acquisition of classical mathematical knowledge may lead to more opportunities and social change, it does not address the issue of justice. In order for marginalized students to be successful in the current system of mathematics and in society, many students must compromise their cultural identities and political stances. Therefore, to address
the issue of justice, Gutierrez proposes the use of critical mathematics. As mentioned earlier, critical mathematics acknowledges students’ cultural identities and builds mathematics around social and political issues that affect marginalized groups.

Curriculum and teaching strategies must address students’ cultural differences in order to promote student learning (Tate, 1995; Civil, 2006; Ladson-Billings, 1995; Lubienski, 2007; Silver, Smith & Nelson, 1995). In *Making Mathematics Meaningful in Multicultural Contexts*, Ladson-Billings (1995) illustrates the importance of using teaching methods that attend to students’ cultural differences. Ladson-Billings describes a group of inner-city African American students whose learning was negatively affected by the context of the question. When presented with the following problem: “It costs $1.50 to travel each way on the city bus. A transit system ‘fast pass’ costs $65 a month. Which is the more economical way to get to work, the daily fare or the fast pass?” (p. 131). White, middle-class, suburban youngsters were able to extract a mathematical concept from the context and suggest it was cheaper to pay the daily fare for a total $60, rather than buy the “fast pass”. However the inner-city students felt that they were not given enough information to solve the problem. They wanted to know how many jobs the person had, because based on their life experiences, people often held several jobs. Therefore, the context in this particular situation posed an obstacle that prevented students from extracting the mathematical purpose of the question. In another study, Tate (1994, as cited in Tate, 1995) describes how a group of African American students was penalized for integrating their home experiences with the mathematics problem-solving process and not using a White middle-class frame of reference. These studies show that in order to achieve equity, teachers need to modify the ways and the content of their teaching to facilitate the academic achievement of students from diverse backgrounds. “Failing to provide African American students with mathematics
curriculum, instruction, and assessment centered on their experiences, culture, and traditions is a major obstacle to achieving equity in mathematics education” (Tate, 1995, pp. 167-168). The current mathematics curriculum continues to adversely affect students of colour:

The Anglocentric curriculum negatively affects many students of color because they often find the school culture alien, hostile, and self-defeating. Because of the negative ways in which students of color and their cultures are often viewed by educators and the negative experiences of these students in their communities and in the schools, many of them do not attain the skills needed to function successfully in a highly technological, knowledge-oriented society. (Banks, 2008, p. 2)

Similarly, a number of reports related to mathematics education addressed the diverse needs of a multicultural student population. However the recommendations given by these documents failed to articulate a method to accomplish this goal (Meyer. 1989b). Therefore there is some consensus that the diverse nature of students must be addressed to achieve equity.

There are a number of approaches used to integrate community knowledge into mathematics education. These approaches include the use of household and community knowledge as the foundation of the mathematics program, the integration of cultural knowledge and the use of culturally responsive teaching strategies in mathematics, and teaching mathematics for social justice. Regardless of the approach used, each of the methods discussed share one common objective and that is a connection to students’ cultural identities.

**Household and community knowledge.**

Funds of Knowledge is a program that uses household and community knowledge as resources for classroom practice (Civil, 2007). The program challenges the status quo by acknowledging that community knowledge has a legitimate place in mathematics education.
Teacher-researchers go out into the community to learn firsthand about students and their families, and then use this knowledge as the foundation of their mathematics curriculum. Fundamental to Funds of Knowledge is the notion that household knowledge is influenced by history and culture. Therefore teacher-researchers go out into the community to develop relationships with the people and learn about their cultures directly.

Although Civil (2007) was able to bring in knowledge from the community to make mathematics more meaningful and relevant for students, she found that at times, the community knowledge dominated the classical mathematics knowledge. This is particularly problematic when working with marginalized students. When community knowledge determines or restricts the classical knowledge that is taught in mathematics, marginalized students may become disadvantaged because they do not acquire the knowledge necessary to pass gate-keeping tests. This limits their ability to pursue advanced mathematics and mathematics-related careers. Thus, in an attempt to make mathematics more relevant and to promote student learning through the use of community knowledge, teachers may actually counter its positive effects by putting less of an emphasis on classical mathematical knowledge. Although there is tension between the acquisition of classical mathematical and the integration of community knowledge, the Funds of Knowledge approach is authentic because it represents the realities of the people within the community.

* Cultural knowledge & culturally relevant teaching strategies.*

Similar to the proponents of Funds of Knowledge, multicultural theorists and researchers also argue that knowledge construction is influenced by peoples’ life experiences and culture (Ladson-Billings, 1995; Lubienski, 2007; Silver et al., 1995; Banks, 2008, Tate, 1995; Civil, 2006; Freire, 1970/2003). Therefore mathematics curriculum and instruction strategies must
center on students’ experiences, culture, and traditions (Tate, 1995). Even though multicultural education and Funds of Knowledge both value the importance of students’ life experiences and culture, their approaches are different. While the Funds of Knowledge builds on the knowledge and skills of students’ immediate community, multicultural education has a broader goal that not only addresses Gutierrez’s notion of critical mathematics, but social agency, which I will discuss in the next section.

Multicultural education is a reform movement designed to restructure curricula and educational institutions so that they reflect the experiences and perspectives of the diverse cultures and groups found in our school systems (Banks, 2008). Studies have found that members of ethnic and racial groups compromise their identities to assimilate and participate in the current school system (Brodkin, 2008; Jacobson, 1998). Not only do these groups of people become alienated by their own families because they try to assimilate and participate in mainstream institutions (Banks, 2008), but some groups even experience psychological stress and conflict when they deny and reject their family and their ethnic languages, symbols, behaviours, and beliefs (Brodkin, 1998). Therefore, it is necessary to provide students with opportunities to acquire classical mathematical knowledge, while providing them with a curriculum that acknowledges their cultural identities in order to achieve the goals of multicultural education.

Banks describes multicultural education as having three main goals: (1) an educational reform movement whose aim is to create equal opportunities for all students, (2) an ideology whose aim is to actualize American democratic ideals, such as equality, justice, and human rights, and (3) a process that never ends because there will always be a discrepancy between democratic ideas and school and societal practices. The first two multicultural education goals
address Gutierrez’s vision of equity. Multicultural education helps students acquire classical mathematical knowledge without compromising their cultural identities. Also, multicultural education aims to achieve justice by changing school and societal practices.

In order to achieve Gutierrez’s definition of equity, Banks proposes that multicultural schools use the transformation approach or the social action approach to integrate cultural content into the school curriculum and to address critical knowledge. In the transformation approach, the curriculum structure is actually changed so that students can view concepts, events, issues, and themes from the perspective of diverse ethnic and cultural groups. In other words cultural content is not an “add on”. Students are also given the opportunity to formulate and justify their own versions of events and situations. Most importantly, students are taught to think critically and develop the skills to formulate and support their own conclusions and generalizations. The social action approach extends beyond the transformation approach by encouraging students to take personal, social and civic actions related to concepts, problems and issues that were studied as part of the curriculum. This will be discussed in the next section as the development of social agency is essential in achieving Gutierrez’s definition of equity.

Banks suggests that cultural content integration can be difficult and less effective in mathematics and science and thus suggests implementing equity pedagogy or culturally responsive teaching strategies as an alternative. Culturally responsive teaching strategies are teaching techniques that are responsive to the learning and the cultural characteristics of diverse groups. These strategies help facilitate the academic achievement of students from diverse racial, ethnic, and socioeconomic groups. Culturally responsive teaching strategies can increase student motivation and help students learn mathematics and science curricula (Gonzalez, Moll & Amanti, 2005; Mahiri, 2004). Also, Cohen (1994) found that cooperative learning techniques
had a positive effect on the achievement of African American students in college calculus. Although Banks encourages the use of cultural responsive teaching strategies, he also states that it is important to integrate multicultural content when appropriate and not to eliminate it entirely from the curriculum.

Although both multicultural education and Funds of Knowledge approach community knowledge in different ways, they both contribute to the achievement of equity. In the next section, I will present the literature on teaching mathematics for social justice and discuss how this approach addresses Gutierrez’s vision of equity. I will also show how teaching mathematics for social justice shares elements from multicultural education and Funds of Knowledge.

**Teaching mathematics for social justice.**

Teaching mathematics for social justice is an approach greatly influenced by Freire (1970/2003). In teaching mathematics for social justice, educators use mathematics as a tool to analyze injustices affecting marginalized peoples. These injustices may come from students’ communities, cultures, and life experiences. Although there is an emphasis on critical mathematics when teaching mathematics for social justice, educators need to find a balance among the three elements (classical mathematical knowledge, cultural identities and community knowledge), and teaching for social justice; in order to achieve equity.

Teaching mathematics for social justice is greatly influenced by Freire’s (1970/2003) work in liberatory pedagogy. Freire believed that oppressed peoples could only be liberated from the oppressors through action and reflection upon their world. Only then would the oppressed be able to transform their reality and become more fully human. He proposed that it is only through problem-posing education that “men and women develop their power to perceive critically the way they exist in the world with which and in which they find themselves; they
come to see the world not as a static reality but as a reality in the process of transformation” (Freire, 1970/2003, p. 12). Problem-posing education allows teachers and students to work together as co-investigators to realize, critique, and transform injustices.

Although Freire’s work focused on literacy, his ideas have influenced many mathematics educators (e.g., Gutstein, 2007; Brantlinger, 2007; Frankenstein, 1987; Gutstein & Peterson, 2006; Aguirre, 2009). Teaching mathematics for social justice originates from Freire’s vision of reading the word and the world. Freire (1970/2003) felt that reading the word and the world needed to happen together, and could not happen in isolation of each other. He also emphasized the importance of beginning from the peoples’ realities:

> We must never merely discourse on the present situation, must never provide the people with programs which have little or nothing to do with their own preoccupations, doubts, hopes, and fears - programs which at times in fact increase the fears of the oppressed consciousness. It is not our role to speak to the people about our own view of the world, nor to attempt to impose that view on them, but rather to dialogue with the people about their view and ours. We must realize that their view of the world, manifested variously in their action, reflects their situation in the world. Educational and political action which is not critically aware of this situation runs the risk either of "banking" or of preaching in the desert. (Freire, 1970/2003, p. 96)

This view is also echoed by proponents of using mathematics to teach social justice (Brantlinger, 2007; Gutstein; 2006; Aguirre, 2009), who believe that equity cannot be achieved without acknowledging the importance of classical mathematical knowledge, cultural identities and community knowledge, and teaching for social justice. Therefore teaching mathematics for social justice aims to not only help students acquire classical mathematical knowledge but to
read and write the world with mathematics without compromising their cultural and social identities (Gutstein, 2006). To read the world and write the world means:

To use mathematics to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences. Further, it means to dissect and deconstruct media and other forms of representation. It means to use mathematics to examine these various phenomena both in one’s immediate life and in the broader social world and to identify relationships and make connections between them. (p. 45)

Gutstein (2003), who was greatly influenced by Freire’s (1970/2003) ideas in Pedagogy of the Oppressed, proposes that mathematics should teach students to read the world. A social justice approach to mathematics can result in many positive outcomes: (1) students recognize the power of mathematics as a tool to understand and to potentially change the world, (2) students develop an understanding of social issues, (3) students can connect mathematics to their own cultural and community histories and can develop an appreciation for the contributions of other cultures and peoples to the field of mathematics, (4) students can understand their own power as active citizens in building a democratic society, and (5) students can become more motivated to learn important mathematics (Gutstein and Peterson, 2006). These outcomes help to achieve Gutierrez’s vision of equity, where students are able to connect their cultural identities and their community knowledge to mathematics, to use their analytical skills to critique injustices, and are empowered to take action.

In classrooms where social justice issues have been incorporated into mathematics curriculum, teachers have found that students have shown increased interest, a better understanding of social issues, and increased learning (Peterson, 2006; Steele, 2006; Turner &
Font Strawhun, 2006; Staples, 2006). However, only one of these studies was conducted with affluent and privileged students. Staples (2006), who taught AP calculus class at a prestigious boarding school, introduced the GINI index, a measure of income distribution across a population to show a real-world application of integrals. When she asked students about income distribution in the United States, she found that the students were alarmed by the values of median income in each quintile. She also found that:

Students had so little sense of their economic positions relative to the rest of society – this was despite all their community service, attention to issues to race and class in their history and literature classes, and interactions with classmates who were there on scholarships. (p. 105)

Staples’ study on social justice issues and affluent, privileged students reinforces the need for additional studies to be conducted on the effects of teaching mathematics for social justice on affluent and privileged students.

Although there are a number of examples of how social justice issues are incorporated into mathematics curriculum there are only a few of these examples that have been researched (Brantlinger, 2007; Gutstein, 2006; Frankenstein, 1995). These studies show some effectiveness in the integration of social justice issues into mathematics, as well as the tension that exists among classical mathematical knowledge, cultural identities and community knowledge, and teaching for social justice. In a study conducted by Frankenstein (1995) working class, adult students enrolled at a community college mathematics course were exposed to a variety of teaching strategies used to raise their consciousness about the inequities of class structure. These teaching strategies included: (1) empowering learning activities (activities that led to the development of self confidence), (2) challenging widely held concepts about how one learns
math and about what counts as mathematical knowledge, and (3) analyzing data to reveal the class structure and inequities in the United States. Although some students felt that what they learned in class was useful and there was some indication of raised consciousness, there was a sense that there was a class struggle that needed to be addressed. Overall the students felt that the injustices were isolated and not systematic. I think that one of the reasons why Frankenstein was not able to help students realize that class inequities were a result of systematic inequities was because she did not begin with the students’ realities. If students accepted the notion that class structure resulted from systematic injustices, Frankenstein’s students would also have to accept the reality that even if they worked harder they may not achieve higher socioeconomic status. Even though students were critical about issues surrounding class injustices many were not able to make a personal connection to the information and thus were not empowered by the information.

In another study, Brantlinger (2007) studied the effects of integrating social justice issues into secondary school mathematics in an urban school. He found that some students appeared to have found critical activities to be more engaging and meaningful than standards-based activities and that students who rarely participated in classroom discussions began to show interest and participate during conversations about racism and discrimination. However, he also found that students who were active during reform activities tended to resist social justice activities. Although the study shows some benefits of integrating social justice issues into mathematics, Brantlinger’s curriculum was not based on dialogue that he had had with his students. Therefore, his curriculum did not begin with a direct connection to his students’ cultural identities and community knowledge, which is a vital component of critical mathematics. Instead, Brantlinger designed his curriculum based on his observations of other classrooms in the area:
My I & A Project did not emerge from Freirean analyses of students’ lived experiences, rather from a chapter written by statisticians and critical scholars William and Joseph (1993). Based on my recent exposure to disparities between schools in wealthier and poorer CPS areas, I believed the topic of economic justice was relevant to my lower-income students even if it had not emerged from a deep Freirean analysis of their actual life situations per se. (p. 170)

The other activities used in his study were also created without engaging in a dialogue with his students. This approach compromises the effectiveness of integrating social justice in mathematics by undermining the importance of students’ interests, life experiences and cultural identities, which are essential in achieving Gutierrez’s second aspect of equity. Before his study Brantlinger believed that mathematics could be used as a tool to address equity through critical literacy, reading and writing the world. He also felt that students could learn classical mathematics knowledge while analyzing social injustices. In other words, he believed that the emphasis on social issues would support rather than distract from mathematical preparation. During his study, Brantlinger found that in several critical mathematical activities, students focused on the critical real world theme without fully understanding the real world data in a mathematical sense. He also found that critical mathematics was addressed separately from classical mathematical knowledge. Finally, at the end of his study Brantlinger noted the tension between teaching for social justice and the acquisition of classical mathematical knowledge.

Brantlinger wrote in his journal that by:

Targeting certain students for “mathematics for political empowerment,” I was helping to (re)produce the social order. I was relegating the low-income students of color in my
non-specialist course to mathematics curriculum that failed to deliver the fullest preparation possible for college mathematics. (p. 194).

Brantlinger felt that students were not receiving the classical mathematical knowledge they needed to be successful in the current system, taking into consideration that marginalized students are already disadvantaged compared to their dominant counterparts. This tension is also acknowledged by Gutierrez (2002), Gutstein (2006), and Lubienski (2008).

The most successful of the studies was one conducted by Gutstein (2006). He studied the effects of teaching mathematics for social justice on Latina/Latino middle school students. Overall, he saw growth in students’ capacity to understand complex aspects of society. “The point is that mathematics became a necessary and powerful analytical tool that students used to study their sociopolitical existence. Mathematics also became an entry point into deeper investigations and more questions” (p. 70). A survey completed by Paulina, an eighth-grade student helps to illustrate the effects of teaching mathematics for social justice:

I liked the way you taught math using real life issues, that is interesting because we had never done anything like that, it got everyone thinking for themselves. It made some people come up with powerful things to say about the math involving those problems. I liked the projects we did because we thought beyond candy, music, soda and it brought out another side of us …. All my views have changed, the world before wasn’t very interesting to me because I wasn’t aware about all the issues that were happening. Now, math has made everyone interested in the real world because it’s something new that catches everyone’s attention (p. 70).

Although Gutstein’s study shows how teaching mathematics for social justice can help to achieve Gutierrez’s second aspect of equity more research needs to be conducted. To date, very
few studies examine both dominant and critical mathematics (Gutierrez, 2002). Many research projects report the challenge for teachers in striving to teach both dominant and critical mathematics, especially when the mathematics becomes more advanced (Frankenstein, 1995; Silver et al., 1995). Therefore, research needs to be conducted at the high school level, as most of the current research has been conducted on mathematics at the middle school and community college levels (Frankenstein, 1995; Gutstein, 2006; Brantlinger, 2007). In addition, there is little research on the effects of teaching mathematics for social justice on affluent and privileged students (Staples, 2006) and it is unclear whether these same tensions or benefits would exist.

**Achieving equity through social agency.**

Although the acquisition of classical mathematical knowledge, integration of cultural identities and community knowledge, and integration of social justice issues are necessary to achieve equity, these approaches alone are insufficient conditions for change. “Just because students can problem-solve, reason about their surroundings, and identify inequities through mathematics does not ensure that they will choose (or be able) to act upon the findings of their critical analyses” (Gutierrez, 2007, p. 48). In order to promote equity, we need to initiate action that results in change:

A society that has sharp divisions between the rich and the poor, and between Whites and people of color, is not a stable one. It contains stresses and tensions that can lead to societal upheavals and racial polarization and conflict. Thus, education for the 21st century must not only help students to become literate and reflective citizens who can participate productively in the workforce, but it must also teach them to care about other people in their communities, and to take personal, social, and civic action to create a more human and just society. (as cited in Banks, 2008, p. 97)
Thus, only when students use critical mathematics to transform society, can we achieve equity and justice for all peoples (Gutstein, 2006; Frankenstein, 1995; Gutierrez, 2002; Aguirre, 2009; Banks, 2008).

*Writing the world* with mathematics, which uses mathematics to change the world, can be used to achieve Gutierrez’s vision of equity. By using mathematics as a tool to promote change we can help students develop a sense of social agency. Gutstein (2006) defines sense of social agency as students’ self perception of the capacity to contribute to social change. As students learn to *read the world* with mathematics, they will become more involved in *writing the world* with mathematics:

Students, as they are increasingly posed with problems related to themselves in the world and with the world, will feel increasingly challenged and obliged to respond to that challenge…. Their response to the challenge evokes new challenges, followed by new understandings; and gradually the students come to regard themselves as committed. (Freire, 1970/2003, p. 62)

Therefore, by posing problems that relate to students’ life experiences and realities, teachers can use mathematics as a tool to promote change.

Very few studies have been conducted that show how teaching mathematics for social justice can lead to social agency (Gutstein, 2006; Tate, 1994). In a study of middle school students in an African American community the use of social justice issues in mathematics helped students develop a sense of social agency (Tate, 1995). Students used mathematics to build a case on the disproportionate number of liquor stores within their school community which they presented to city council. The actions of the students led to 200 citations, and 2 liquor stores being closed down.
In another study, Latina/Latino middle school students showed a range of emotions towards two projects where social justice issues were integrated into mathematics (Gutstein, 2006). In the first project students used mathematics to examine the effects of gentrification in their community. In the second project students critiqued knowledge by examining how area was portrayed on two different world maps. In both of these projects, Gutstein found that many students were empowered and motivated to change the situation. While studying about gentrification, some students attended city hearings and rallies. In her essay addressing the developments effects on the barrio Freida demonstrated a sense of social agency by writing:

If people don’t get together to fight this, they would all get overthrown. But I know we have a voice, we have spirit, we have a goal, and even if we suffer consequences, we will fight and get what we want. Will we let development bury our pride, our family and our liberty? NO! NO! NO! (p. 78)

Similarly, Adrian shared her feelings about how the *Analyzing Maps Project – What Do They Really Show?* affected her perception of reality:

…before that class…. I knew about certain historical moments and certain things, but I never really acted on any of them. I didn’t really share my ideas with anyone. This classroom really opened it up for me, and this is when I really started to get involved. I started talking to other people, and finding their opinions. (p. 88)

These projects seemed to evoke a range of emotions. In the gentrification project, of the twenty essays only seven did not mention fighting back in some way and of these seven only three expressed despair.

In both of these studies, mathematics and social justice issues were used to help marginalized students develop a sense of social agency. Although Gutstein achieves some
success in helping students develop a sense of agency, his findings raise some important questions. Firstly, as teachers, how do we address the realities of the world through the use of mathematics without the students developing a sense of hopelessness or powerlessness? Secondly, how can we build on students’ sense of justice and empower them to take action on social justice issues? Thirdly, what does teaching for social justice look like in a heterogeneous classroom? And finally, how does mathematics for social justice affect students of privilege? In order to improve student participation, achievement and critical analysis in mathematics, as well as to encourage students’ to develop social agency more research needs to be conducted to help achieve Gutierrez’s vision of equity.
Chapter 3: Research Methodology

Purpose of the Study

The aim of the study was to investigate the use social justice issues in mathematics to promote social agency in affluent, middle school students. I proposed the following research questions:

1) What does teaching mathematics for social justice (i.e. teaching strategies, resources, frequency, teacher-student interaction) look like in an affluent middle school classroom?

2) How does the incorporation of social justice issues in mathematics affect affluent, middle school students?

3) What factors affect development of social agency in affluent, middle school students?

Research Design

I chose to use qualitative research to study the effectiveness of integrating social justice issues in mathematics to promote social agency for several reasons. Firstly, qualitative research enabled me to explore and to understand teaching mathematics for social justice, an area with limited site-based research (Gutierrez, 2007; Gutstein, 2006). Qualitative research is commonly used to explore a phenomenon that has been addressed minimally in literature (Creswell, 2002). This type of research allowed me to learn more about this pedagogy and its effects on social agency from the students’ perspective.

Secondly, in order to understand how teaching mathematics for social justice can be used to promote social agency in affluent middle school students I explored the topic in its natural setting. This pedagogy is based around students’ cultural identities, which may be influenced by aspects of the school (i.e. teachers, friends) and community. By observing students in their
natural setting, I was also better able to assess other factors that may affect students’
development of social agency.

Finally, qualitative research allowed me to examine my research questions in-depth using
a number of methods. These included one-on-one interviews, participant observation and
documents to explore the effects of teaching mathematics for social justice. Using these
methods, I addressed the four research questions posed earlier. Qualitative research that explores
a phenomenon using a variety of data sources, “ensures that the issue is not explored through one
lens, but rather a variety of lenses which allows for multiple facets of the phenomenon to be
revealed and understood” (Baxter, 2008, p. 544).

I have chosen to use practitioner research (Anderson, Herr, & Nihlen, 1994). In
practitioner research, practitioners use their own sites as the focus of study. This type of research
acknowledges the role of the practitioner as more than an observer. Practitioner research is
similar to action research as it uses a systematic inquiry, but is different because it excludes other
stakeholders (Anderson, Herr, & Nihlen, 1994). Most practitioner research shares some common
elements: identifying an area of focus, collecting data, analyzing and interpreting the data, and
developing a plan of action, and then implementing the plan and reflecting (Creswell, 2003;
Creswell, 2005). Practitioner research allowed me to explore the effects of integrating social
justice issues into my mathematics class. It recognizes that I am not only an observer, but that I
am also an active participant in the research.

I conducted a study in which I collected data on teaching mathematics for social justice
during the Analytic Geometry and Quadratic Relations units in a grade 10 academic mathematics
classroom. Together the two units of study were 90 hours in length; thus allowing ample
opportunity to implement three cycles of practitioner research. The first cycle began with the
class discussion on defining social justice and having students come up with a list of social justice issues that were of interest to them. Using Freire (1970/2003) and Gutstein’s (2006, 2007) work to form my conceptual framework, I attempted to use social justice issues that were a part of the students’ reality. Therefore, it was important that I began my practitioner research by finding out about the issues that interested my students. During the discussion students came up with a range of issues including: poverty, sweat shops, racism, genocide, abuse, hunger, and human trafficking. Despite this range of topics, I felt that I was limited by the curriculum I needed to teach in grade 10 mathematics.

The activity that I designed for the first cycle dealt with the social justice issue of gender, education and income. Although the social justice issue did not directly address one of the student generated ideas, I thought that it dealt with the issue of power which is an underlying factor in many of the topics generated by the students. This activity was used to review the mathematical concept of linear equations and to introduce linear systems. During the cycle I recorded my observations in my personal journal and videotaped the class during the activities. After the social justice activity students were also asked to record their reflections using a video camera. These reflections and their written work on the social justice activities were used to determine their level of engagement, and for the development of classical mathematical knowledge, critical knowledge and social agency. I then used the analysis of the data to modify my teaching practices (i.e. how social justice issues are integrated, teaching strategies, topics discussed) for cycle two.

The second cycle which was informed by the first cycle compared resource distribution in affluent and impoverished areas in the Greater Toronto Area (see Appendix B). It was a culminating activity that assessed students’ ability to use their knowledge of properties of line
segments to answer the question, “How do the types and number of resources differ between communities of affluence and poverty?” Again, the results from this activity were used to inform the last and final cycle.

The last cycle integrated the concept of mathematical modeling, which included both linear and quadratic equations and the HIV/AIDS epidemic. A guest speaker from AIDS Committee of York Region was invited to speak to the students about the disease, focusing specifically on the prevalence of AIDS in Canada. Following this, students were given an assignment (see Appendix H) that gave them an opportunity to learn more about the AIDS epidemic in Canada and developing countries. Students also used their knowledge about modeling to determine whether linear and/or quadratic functions could be used to accurately reflect the trends in AIDS prevalence.

Data collection.

For my research I chose to use a number of methods including participant-observation, student video reflections, reviewing documents, and interviews. By using different types of data and methods of data collection, I was able to use triangulation to enhance the accuracy of my study (Creswell, 2003).

Firstly, through the use of a practitioner journal, I was able to conduct participant-observation. The practitioner journal helped me to record my reflections and observations on students’ engagement, their connections with the social issues presented, student-teacher and student-student interactions, and students’ development of social agency. Evidence of engagement included but was not limited to observations of students remaining on task, students talking about the issue in their groups or with me, and conversations that I had with the students about the social justice issue. In the practitioner journal, I also recorded new ideas, the process
of developing social justice activities, challenges and successes with activities, and possible improvements. Although I aimed to record reflections and observations during and after each mathematics class, and while working on the development of social justice activities I found it particularly difficult to make entries during the class. Many entries were made at the end of the day when I had an opportunity to reflect back on the class. Although I was unable to write entries during class time I still found that the process and the entries useful in the design and implementation of social justice issues in mathematics.

Secondly, practitioner-researchers have two sets of responsibilities, teacher and researcher. The use of a video camera in the classroom gave me the ability and flexibility to focus my attention on my teaching responsibilities; while ensuring that data was still being collected. It is “an extremely useful tool; it is fairly easy and less stressful to collect data this way, and one can find time later to index and analyze the footage”. (Anderson, Herr, & Nihlen, 1994, p. 150). Also the video data, unlike the practitioner journal, provided information on groups that I was not working with directly. This allowed me to assess students’ engagement during each lesson.

I also set up a camera to collect student feedback on the incorporation of social justice issues in mathematics. After each social justice activity, students, in pairs, were asked to videotape their responses to the following questions: (1) What did you learn from the social justice activity? (2) Were you affected in any way by the social justice activity? (3) What would make the activity better? (see Appendix C). For the last activity, students were also asked, (4) What questions do you still have? These open-ended questions gave students the opportunity to reflect and share their learning and feelings about the activity.
On most occasions, the camera was set up in a room adjoining the classroom. When the room was occupied, students videotaped their student reflections in the hallway. All students participating in the study had opportunities to record during class their feelings about the social justice mathematics activities and offer their feedback on its effectiveness. However, on several occasions some students were not able to videotape their reflections until 1-2 weeks after the activity because of time constraints. This delay may have compromised the reliability in the data as students may have forgotten many details about the activity.

Thirdly, I also collected students’ work to assess their level of engagement, connection with the issues, and understanding of classical mathematics. Student work included email responses, projects which included reflections, and tests. This mode of data collection gave me an opportunity to examine students’ understanding of classical mathematics and an in-depth look at students’ personal connection with the topic that may otherwise be overlooked when conducting participant-observation.

Finally, my thesis advisor conducted focus group interviews with some of the students to explore the effects of integrating social justice issues in the math class. It also provided an opportunity for students to discuss factors that prevented the development of social agency. The questions asked during the interviews explored how students’ perception of the purpose of mathematics has changed over the year, factors preventing students from taking action, and the effects of social justice issues in mathematics on students (see Appendix D). Initially, I had wanted to conduct two sets of focus group interviews, but because of the time constraints, the responses to some of the preliminary interview questions (see Appendix E) were collected via email.
Research context.

This study took place at an independent school in an affluent area in the Greater Toronto Area. According to Statistics Canada (2009), the median income in this area in 2005, including all census families, was $80,121. In addition, Caucasians, Chinese, South Asians and West Indians made up the highest percentage of the area’s population. The student population at the private school reflects this ethnic makeup and belongs to the middle and upper classes. Tuition for a grade 10 student is $17,000 annually. Scholarships are only given to grade 6 students entering grade 7 and grade 12 students. In the 2009-2010 school year, $4500 in scholarships were awarded in total to 5 students. Student bursaries are also available to families that demonstrate financial need. In this school year over $47,000 was divided among 6 students in the form of bursaries.

The school offers the Middle Years International Baccalaureate Program, which is a program recognized internationally. The program offers international education to a worldwide community of schools, with more than 745,000 students at 2,714 schools in 138 countries (IBO, 2009). There are three programs offered by the International Baccalaureate Organization and Program. The focus of this study is on the Middle Years Program, which is designed for students ages 11-16. The students in this study were completing their last of a four year program. The aim of the program is to help students develop the knowledge, understanding, attitudes and skills necessary to participate actively and responsibly to create a better, more peaceful world.

Description of research participants.

I observed, interviewed and collected documents from a grade 10 mathematics class. The class consists of 19 students ranging in age from 14 to 16. There were 8 Caucasian, 9 South
Asian, 1 Korean, and 1 Chinese student. Of these students, 16 of the 19 students have been at the school for at least 1 year, and 3 students were new to school. Of the 19 students in the class, only 2 students did not give consent to participate in the study. Therefore there were 17 participants in this study. During the course of the study one student left the province and did not complete the last cycle; while a new student joined the school in January and therefore only participated in the last cycle and focus group interviews.

**Analysis of data.**

Qualitative data analysis is an interactive and cyclical process (Miles & Huberman, 1984). Throughout my data collection, I was constantly reflecting on and interpreting data. As part of the process of practitioner research, I used my analysis to develop a plan of action for the next cycle of data collection. This cyclical process occurred for three cycles. At the end of each of the three cycles students were asked to record their responses on videotape. Their responses were viewed and used to inform the development of the next social justice activity in mathematics class. I also used my observations recorded in my practitioner research to inform my choices. Finally, these video reflections and the focus group interviews were transcribed and through the use of coding, themes were formulated from this data along with the students’ written work.

**Transcription of student video reflections and focus group interviews.**

Both the student video reflections and focus group interviews were transcribed following data collection. Not only do transcripts provide researchers with detailed and repeated examination (Heritage, 1984), but the process of transcribing itself, which requires close and repeated listening to recordings, was an essential part of analysis (Atkinson and Heritage, 1984).
I found that while I was transcribing the videos, I was also writing memos in the margins of transcripts and beginning to formulate codes.

**Coding the transcriptions and student work.**

Using Rogers’ (1998) levels of engagement as a framework, I began categorizing the text in the student video reflection transcripts. This “start list” (Miles & Huberman, 1984) contained 5 general categories: cognitive, affective, existential, empowerment and action. Even though I had a framework from which to work, I found that I also employed a grounded approach (Glaser, 1978) to some degree, by revising the codes to reflect the themes that were emerging from the text. Throughout the coding process, I found that I revised the codes several times. The code that I had the most difficulty with was cognitive. I wanted to reflect the different types of cognitive development that were occurring, but I found it very difficult to differentiate between the cognitive subcategories and therefore it became difficult to classify the text. After several revisions the final list of codes was used to categorize the text in the transcripts. Three themes emerged from the coding process: cognitive effects, affective effects and social agency. The final codes and themes are organized in Table 1.

The codes and a description of the text or a direct quote from the data sources were organized into an effects matrix (Huberman & Miles, 1984). The matrix was organized with participant names along the first column, while the activities and focus group interview were organized across the first row. This type of organization allowed for analysis of coded statements across time for each participant, as well as the opportunity to examine how each activity affected the participants as a group.
Table 1.

Themes and Codes for the Effects of Incorporating Social Justice Issues in Mathematics

<table>
<thead>
<tr>
<th>Theme</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Effects</td>
<td>C-SJ</td>
<td>Student reports an awareness of social justice issue</td>
</tr>
<tr>
<td></td>
<td>C-ML</td>
<td>Student demonstrates evidence of applying mathematical concepts</td>
</tr>
<tr>
<td></td>
<td>C-NF</td>
<td>Student reports learning new facts unrelated to math and social justice issue</td>
</tr>
<tr>
<td></td>
<td>C-HL</td>
<td>Student demonstrates evidence of higher level thinking</td>
</tr>
<tr>
<td></td>
<td>C-PC</td>
<td>Student reports that his/her perception of mathematics has changed during the study</td>
</tr>
<tr>
<td></td>
<td>C-NO</td>
<td>Student reports that he/she did not learn anything from activity; already part of student’s prior knowledge</td>
</tr>
<tr>
<td>Affective Effects</td>
<td>A-PO</td>
<td>Student reports a personal connection with social justice issue</td>
</tr>
<tr>
<td></td>
<td>A-NE</td>
<td>Student reports negative feelings associated with social justice issue (i.e. helplessness)</td>
</tr>
<tr>
<td></td>
<td>A-NO</td>
<td>Student reports no development of feelings after exploring social justice issue</td>
</tr>
<tr>
<td>Social Agency Effects</td>
<td>EM</td>
<td>Student reports a sense of personal responsibility and commitment</td>
</tr>
<tr>
<td></td>
<td>AC-SJ</td>
<td>Student reports taking personal social and political action</td>
</tr>
<tr>
<td></td>
<td>AC-NO</td>
<td>Student reports that the activity did not result in social or political action</td>
</tr>
</tbody>
</table>

In order to improve reliability, different sources of data and methods were employed. When different sources of data conveyed the same information, it was noted on the matrix as triangulation. In addition to coding the transcripts, I also coded the coordinate geometry test and
all three of the assignments on social justice issues. By corroborating different sources of data, I was able to apply codes with more confidence. Information that contradicted a statement that a student made in another data source was also noted on the matrix and considered during analysis.

Finally, due to some of the information in the focus interviews dealing with factors relating to why students did or did not take action rather than the effects of incorporating social justice issues in mathematics, I used a separate group of codes for this data. I followed a similar process to the one used to determine the effects of integrating social justice issues in mathematics on students. After analyzing the data, three major themes emerged from the coding process and are shown in Table 2.

Table 2.

*Themes and Codes for Factors that May Affect the Development of Social Agency*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility</td>
<td>R-A</td>
<td>Students reported being too young to affect change</td>
</tr>
<tr>
<td></td>
<td>R-M</td>
<td>Students reported not having the money to affect change</td>
</tr>
<tr>
<td></td>
<td>R-N</td>
<td>Students reported that other people were responsible for taking social and political action</td>
</tr>
<tr>
<td></td>
<td>R-Y</td>
<td>Students reported that they had a responsibility to take social and political action</td>
</tr>
<tr>
<td>Personal connection</td>
<td>P-N</td>
<td>Students reported that the activity did not evoke a personal connection with the social justice issue</td>
</tr>
<tr>
<td></td>
<td>P-E</td>
<td>Students reported the need for experiences outside of the classroom</td>
</tr>
<tr>
<td>Teacher direction</td>
<td>T-D</td>
<td>Students reported the need for more teacher direction</td>
</tr>
</tbody>
</table>
The information in the table provides insight into factors that may affect whether students develop a sense of social agency. This can help teachers develop social justice activities that help move students from cognitive and affective domains towards taking action.
Chapter 4: Results

This chapter addresses the aim of the study, which is to investigate the use of social justice issues in mathematics to promote social agency in affluent, middle school students. Firstly, I will discuss my experience as a practitioner researcher by describing the three cycles of practitioner research. Specifically, I will describe the process and the challenges involved in designing and implementing activities that incorporated social justice issues in an affluent, middle school classroom. I will then summarize the differences between the three social justice activities and outcomes of each activity. Secondly, I will present my findings on how the incorporation of social justice issues into mathematics class affected affluent students’ cognitive and affective domains. I will also discuss how these activities empowered students and led some students to take action. Finally, I will discuss how the design and implementation of social justice issues in mathematics may have influenced students’ capacity to affect change. Factors such as age, students’ perception of responsibility, personal connection and teacher direction will be discussed.

Design and Implementation

Over the course of the year, I was able to conduct three cycles of practitioner research. The social justice issues were based on a discussion that I had with students on defining social justice and topics that interested them. This notion of starting with issues related to students’ personal experiences and histories are echoed by proponents of critical mathematics (Freire, 1970/2003; Gutierrez, 2007; Gutstein, 2007). During the discussion, students came up with a range of issues including: poverty, sweat shops, racism, genocide, abuse, hunger, and human trafficking.
I began by looking through teacher resources that were available (Stocker, 2006; Osler, 2007, www.radicalmath.org/). Unfortunately, I found no activities that directly covered the grade ten mathematics curriculum expectations and that also dealt with the social justice issues that the students presented. What makes the grade ten course so difficult and limiting is that it does not include a data management unit like the grades 7 to 9 mathematics courses. The grade ten mathematics course includes units on trigonometry, analytic geometry and quadratic relations. As a result, even though I had a range of social justice issues to use as a springboard, I felt that I was limited by the curriculum expectations in grade ten mathematics, as well as the lack of high school resources available.

Although I faced a number of limitations, I began my first cycle of practitioner research by developing the following unit question: How can I improve my community through what I have learned in mathematics? The purpose of the unit question was to provide a context for mathematics learning; a central theme. Specifically, I wanted to use mathematics to help students develop an understanding of inequities between males and females and discuss how they could use this information to improve the community. I had also wanted to look at learning preferences (i.e. who prefers to use technology, who performs better in groups) between males and females. However, after a discussion with my thesis advisor I removed this component from the unit. The rationale behind this decision is that it had the possibility of perpetuating stereotypes.

I began the cycle of practitioner research by introducing the unit question and describing the focus of the unit. As an introduction, I had students read an article written about the president of Harvard University, Lawrence H. Summers. During a conference, he said that innate differences between men and women might be one reason that fewer women succeed in
science and math careers. After reading the article, students were asked to express their own views on Summers’ statement. Hannah responded in her email:

I think that Summer’s is partly right in saying that a female’s lifestyle does not fit what commitment it would need to have a major field in Math and Sciences. I think that given the right opportunities of not only education but also our lifestyle, females can also succeed just as much as men in the field of science. I am unsure of the theory that genetics can contribute to the factor because math is a skill that is to be developed and only those with an interest can develop it further. Summers may be right in saying that there are less females studying Mathematics. He could be right to say that females gravitate towards the arts because of something to do with genetics but I do not think that genetics contributes to whether males or females have more of an aptitude for math. According to my observations in our current classroom and also in elementary school, the students that are more ahead in math tend to be females. I personally am not offended my Summer’s remarks, however, I do think that he might have pushed it a little during the meeting.

Alicia responded by trying to provide other reasons why the number of women might be lower than males in the field of mathematics. Similarly, Maaran also tried to provide an alternate reason:

My opinion on the article about men having a more innate talent for math and science than women is wrong. I think that both genders, male and female both have the ‘brains’ necessary for work in that field. Maybe more men than women have careers in math and science than women is because there is a more biased tilt towards men succeeding, like people with the same mind set as the man who wrote the article. If the professors believe
that men will do better than women, the way the mark the women, and encourage them will be not as good as how they are teaching the men.

The purpose of asking students to respond to the article was to elicit discussion about gender and mathematics. I felt that the students’ responses were a good springboard for the social justice issue of gender inequities.

Then students were asked to watch a video presenting the results found in a study conducted by Hyde and Mertz (2009). The study found that in the United States, the gap between girls’ and boys’ performance in mathematics has reached parity. Although the gap is narrowing when looking at the highest mathematics scores, boys still outnumber girls in this category.

Unfortunately, I found it difficult to address gender inequities while reviewing the concepts of a line (i.e. slope, midpoint). So I reviewed these concepts individually and then I presented the students with an assignment that dealt with gender, income and education. This required them to consolidate skills and knowledge that were covered over the previous couple of weeks. I created the activity by using data from the Internet (Appendix F). Students were given the assignment with minimal discussion about the social justice issues of gender inequity and were required to answer two questions: (1) Is there a relationship between the number of years you spend in school and your income? (2) Is there a difference in male and female earning power? Students seemed engaged in the activity. They seemed to stay on task and they asked questions relating to the activity. Based on the students’ work and their responses on the reflection videos, most students were able to apply their knowledge and skills to determine that there was a positive correlation between years of education and income. Also, most students concluded that the earning power of a male was higher than that of a female.
To follow-up the activity we discussed the findings of the assignment and briefly discussed factors that might lead to a difference in earning power between males and females. Students had a similar follow-up question on the assignment task sheet. Factors that were discussed included: priorities, family responsibilities, sexism, and low demand for female subject specializations. Sudhi suggested that a low demand for females’ subject specializations could result in a lower demand for them in the workplace when compared to males. She also wrote about willingness being a factor. Females may be more willing to choose jobs with a lower income so that they can fulfill family responsibilities, while males may take higher paying jobs to help financially support their family.

During the class discussion, I had also wanted to address a comment that Trevor had made during the class, when students were given time to work on the assignment. Students were given data that represented levels of education rather than years of education. In order to create a scatter plot, students were asked to change those categories into numbers of years. For example a bachelor degree could be changed to eight years of elementary and four years of secondary education, plus an additional three years of post secondary education, for a total of fifteen years. Trevor had difficulty changing the category “less than 9th grade” to a number. He could not believe that students in elementary school dropped out of school. After discussion, he felt that grade eight was the best choice because he felt that it was highly unlikely that younger students would drop out of school. Another student, Jennifer asked if it was illegal not to go to school. I responded with, “Do you think the police come to your house and take you to school?” In order to address this misconception, I had wanted to present statistics on dropout rate and age. More specifically I wanted to present the statistics and discuss why many elementary-aged students dropped out of school. I felt this would have been a springboard for more discussion on
inequity, especially dealing with who has access to education and the factors that would prevent a child from finishing elementary school. Unfortunately the Internet was not working that next class and did not work for over a week. In retrospect I could have printed the statistics for the students, given the unpredictable nature of our network connection. By the time the Internet was working, I felt that too much time had passed and it would be ineffective because we had moved to another topic.

After the assignment was collected and the class discussion was conducted, I watched the student reflection videos. Students were asked to answer and record their responses to: (1) What did you learn from the social justice activity? (2) Were you affected in any way by the social justice activity? (3) What would make the activity better? On the student video reflections, when students were asked, “What would make this activity better?” students replied with field trips and more discussion about the follow-up questions. Kaveri reflected:

   To make the activity better, I would go more into depth for the reasons more so than just the data like looking at the data was good and seeing the difference earning power and how long it affects their stay in school and that sort of stuff, but looking further into the actual issues and investigating why it is so.

Similarly, Catherine said, “I think before or after the activity that we should have a class discussion to help people absorb or be aware of what they just graphed and questions about. You could talk about the questions in the follow-up section; maybe talk about a couple of those”. So even though I had briefly addressed each of Catherine’s suggestions during the class discussion, I realized that I had to spend more time doing this in the next practitioner research cycle. In my practitioner journal I wrote:
I should have done a better job at setting the context; providing the students with historical and social contexts… I also should have done a better job with the discussion. Many students did not believe that students dropped out in elementary school, leading me to believe that they were unaware of others’ situations.

Also, other students suggested field trips or hands-on activities. In Nadya’s reflection, she said, “I would make some hands on activity in the project like a field trip or something like that”. Likewise, Jiya said:

Overall, I felt that the activity was quite educational and it taught me a lot I didn’t know, but I felt that there wasn’t enough interaction. So, maybe for more interaction we could have went to a field trip or had someone come to talk about this so like a guest or something. I think that would make it more fun.

At the end of this cycle of practitioner research, I felt I had several areas for improvement based on my observations and reflections and student video reflections. Firstly, I needed to do a better job at presenting and discussing the social justice issue. Secondly, I did not discuss actions students could take to reduce the difference in male and female earning power. I needed address how the students could affect change. Finally, I felt that needed to include a field trip or guest speaker in the next activity based on student feedback.

Using the feedback from the students and my personal reflections and observations, I began to develop an activity that dealt with the coordinate geometry. When looking through Real World Math: Engaging Students through Global Issues (Facing the Future, 2009), I found and modified an activity dealing with properties of a line (see Appendix B). I introduced the activity by having students read Poverty by Postal Code, a document developed by the United Way of Greater Toronto and The Canadian Council on Social Development (2004). While
reading the documents, the students were asked to draw emoticons indicating their feelings about information that was communicated through the document. As a class, we discussed how students felt about the information that they were reading. The purpose was to set the context for the activity. Then, as a class we defined the term community resource and came up with a list of community resources. Using that list students were asked to answer, “How do the types and number of resources differ between communities of affluence and poverty?” by comparing their community with a community identified in Poverty by Postal Code as having high poverty rates. Using the Internet, students were asked to plot and perform calculations relating to the community resources for both of these communities. Specifically, students were asked to use Google maps and the Internet to label and map community resources on graph paper. Then they were also asked to calculate the distances between their home and local resources in the community. Students were then asked to perform the same steps for their chosen community and compare resources using mathematics (i.e. graphs). They were also to answer other questions that required them to use their knowledge of equation of a circle, equation of a line, midpoint of a line segment and centroids.

I found that the vast amount of information on Google and the open-endedness of the assignment presented a challenge to many students. It was difficult for students to locate community resources, boundaries for the different communities were unclear, and depending on the number of community resources, the calculations became onerous. Many students expressed frustration with the activity and more time was given to students in order for them to complete the assignment. In my practitioner journal, I wrote, “Maaran asked if we could have an extra work period because it was difficult to locate and map out the resources. We talked about how real data is messy”. Like the students, I was also frustrated by a number of factors. Only a third
of the students had their maps printed and labeled for class, even though it was assigned for homework. The printer was also not working that day, so students who were not prepared were not able to use their time productively. This was an extremely difficult class, as I was trying to deal with printer issues, answer students’ questions relating to the assignment, and classroom management issues that resulted from students not being prepared.

An activity that I thought would take two eighty minute periods ended up taking four eighty minute periods to complete. Although the activity took longer than I intended and produced a lot of frustration, there was evidence of students using problem solving skills. During the class, some students noticed that a scale was given in Google maps and figured out how to convert the distances into actual distances. Other students noted that the areas were different between the two communities and wondered how that might affect the conclusion. Even though students were asking “good questions and understanding the realities of working with real data”, I wrote that “I hoped that in the end that I would achieve the purpose of the activity”, which was that impoverished neighbourhoods had fewer community resources than affluent neighbourhoods.

After completing the assignment, many students drew conclusions that were counterproductive to the development of social agency. My aim for this assignment was for students to see the lack of resources in areas of poverty when compared to their affluent neighbourhoods. However, this was not case. Many students found that there were more community resources in the area of poverty than in the area of affluence. During the discussion Paige responded:

For my project, I did Kensington Market, Chinatown. And so, in my personal community, I had a lot of resources, but not to the same degree as this other community
has. The other community had hospitals, one hospital, subsidized housing malls and in my community the most common was restaurants, we had three schools in one area. So, overall the areas were equal in resources, but I discovered the poorer area had more resources, so the idea that resources do they affect the wealth of the community, I'm starting to disagree with what I thought first, it no longer …[unclear]. This has so much available …[unclear].

Similarly, Catherine said:

The green spaces that there are. I saw that in my community and I did Scarborough Village as well. There are a lot of green spaces in both. I was just surprised because I didn't know that there were that many green spaces in the city, especially in Scarborough Village because it is really populated. In both there are equal amount of resources, there is a lot in Scarborough Village. I was surprised there are more schools than in my community and libraries there are more and there is lot of daycares in Scarborough Village. It possible that there are a lot of single parents and they need to leave their kids to go work, or both parents that need to go work.

Although Catherine was also surprised by her findings, the two students responded differently to their findings. While Paige wrote that she was considering changing her view that number of resources affected wealth of a community, Catherine tried to explain her findings based on her perception of poverty. Another student, Sudhi was also affected by the activity. When Sudhi was asked, “What did you learn from this social justice activity?” she responded:

I learned that many poor communities have the same number of resources as affluent communities; however, they are not used wisely and poor communities usually have
more transit and they expect people not to buy a car maybe because they are poor and can't afford it.

Because I was taken aback by the number of students who responded that they found more community resources in the impoverished area, I found it difficult to address how students could take action. Even though I had a list of actions we could take to affect change (i.e. creating videos to educate others, writing to or speaking with mayoral candidates, collaborating or having discussions with inner city schools), I felt that introducing an action component would be ineffective. So, we briefly discussed actions we could take. If most students found that their affluent communities had fewer resources, why would they want to take action to aid an area of poverty? After the discussion, I wrote about my disappointment with the outcome of the activity:

Findings were all over the place; from more resources in the high poverty community to more churches. I think my problem with the assignment was losing sight of the purpose. What was I trying to do? Perhaps, I need to follow through with, “What can we do with this (be specific) information?” Also, I noticed that the weaker students did not hand in their work or if they did, they did not answer the math-based questions. If I were to do this activity again, I would not have had the students compare the two communities. I would have had them look at one of the communities listed in the United Way report; look at how the resources were distributed, the accessibility of the resources and what resources were needed.

In my third cycle of practitioner research, I decided to use a less open-ended activity based on students’ responses, my observations, and dialogue with students. I felt the openness of the resource distribution activity, led to students forming conclusions that were unexpected and
counterproductive to their development of social agency. Also, because I did not expect them to conclude that affluent neighbourhoods had fewer resources than areas of poverty, I was not prepared and lacked the expertise to change what I felt was a negative outcome into a positive outcome. In my third and final practitioner research cycle, I felt that I needed to use an activity that was already developed to reduce any unexpected results. Although I started from an existing document in the second cycle, I had modified it to such a degree that it no longer resembled the initial activity. Also, I realized that I did not have to be the expert on the topic and for the next activity I would bring one in to the classroom. Finally, although I had intended to include an action component in this activity, I did not even address action because of the unexpected results. For the final cycle, I decided to address how students could take social or political action.

For the third social justice activity, I used an activity developed by a teacher at another school (see Appendix G). Originally, the activity dealt with HIV/AIDS prevalence in Canada, focusing specifically on First Nations. The activity explored the use of mathematical modeling to approximate the real-life situations, in the case HIV/AIDS prevalence. Specifically, students were also asked to use the developed model using their knowledge of quadratic and linear functions. Using this activity as a starting point, I made minor changes and additions to the pre-existing activity (see Appendix H). Because I had limited knowledge of Native Indian issues in Canada, I eliminated that section and replaced it with students exploring HIV/AIDS prevalence in Asia or Africa. I chose Asia and Africa continents because there was data available on Gapminder (www.gapminder.org/), a website that provides data on a number of issues that is easily accessible to students and teachers.

To set the context for this social justice activity, I introduced the issue of HIV/AIDS by having students watch a YouTube video called the *Hidden Faces of AIDS*.
I had hoped that the video would evoke emotions that may ultimately provoke students to take action. Students were then asked how they felt about what they had watched. The students who shared their feelings reported feeling: sad, helpless, and pretty bad. After discussion about the video, students were asked to complete a quiz found on *AVERT, AVERTing HIV and AIDS* ([www.avert.org/quizzes.htm](http://www.avert.org/quizzes.htm)). They were asked to share information that they already knew, as well as information that they learned from doing the quiz. Finally, students were briefed about the assignment and were given the rest of the period to begin working on the assignment.

For the next class, I had arranged for a guest speaker from the Aids Committee of York Region to discuss the issue of HIV/AIDS in Canada. I felt that in the previous two cycles, I lacked the knowledge to address the complexity of gender and poverty, so for this cycle, I decided to bring in an expert from the community. The guest speaker discussed HIV/AIDS in Canada and the stigma associated with this disease. I felt that the speaker tried to make it relevant to the grade ten students by appealing to their affective domains.

Afterwards, students were given three more eighty minute periods to complete the assignment. Because most of the data was given to the students, I found there were fewer frustrations with this activity when compared to the resource distribution assignment. Although I provided the students with one set of the data, they were also asked to look at the HIV/AIDS prevalence in another country using Gapminder. Even though students were given the freedom to choose a country to research, they still were restricted by having to use the website that was provided.

Then at the end of the activity, students were asked to form small groups. In each group, each person was asked to: (1) describe the HIV prevalence trend in their chosen country, (2)
provide some reasons to explain the trend based on research, (3) provide an example of one thing they could do to help reduce the prevalence of HIV locally or globally. Lastly, they were asked to discuss the following excerpt from an article found on www.toronto.ctv.ca:

Mayoral candidate George Smitherman tore into his rival Rob Ford on Wednesday over comments he made four years ago, when Ford said only gay people and drug users were at risk for contracting AIDS. "I'd like you to explain to people how your character, and especially these comments, is justifiable now that you present yourself as someone who wishes to be mayor of Toronto, one of the most diverse places to be found anywhere in the world," said Smitherman, during a debate in front of Toronto Real Estate Board members. In 2006, Ford argued against a $1.5-million AIDS prevention strategy, telling council: "It is very preventable. If you are not doing needles and you are not gay, you wouldn't get AIDS probably, that's the bottom line."

After completing the activity, I felt that this activity was more successful than the other two activities. Although students were given some choice, there were fewer problems because their choices were limited. Unlike the resource distribution activity, I observed that students asked fewer technical questions (i.e. about websites) and more mathematics-related questions. In addition, by bring in a guest speaker there was less pressure for me to be the expert on the topic. Finally, I felt that students were presented with some ways that they could help to reduce HIV/AIDS prevalence. The differences among the three cycles of practitioner research are summarized in Table 3.
Table 3.

Summary of findings from the three cycles of practitioner research

<table>
<thead>
<tr>
<th>Social justice activity</th>
<th>Social justice issue</th>
<th>Setting the context</th>
<th>Informal observation of student engagement</th>
<th>Class discussion after the activity</th>
<th>Action component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, income and education</td>
<td>Gender inequities and poverty</td>
<td>Video and article</td>
<td>Students stayed on task and asked questions relating to the activity</td>
<td>Limited</td>
<td>None</td>
</tr>
<tr>
<td>Resource distribution</td>
<td>Poverty</td>
<td>Poverty by Postal Code report</td>
<td>Students were frustrated and asked technical questions</td>
<td>Class discussion led to unexpected conclusions</td>
<td>None</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>Poverty and stereotypes</td>
<td>Video, quiz and guest speaker</td>
<td>Students stayed on task and asked questions relating to the activity</td>
<td>In small groups, students shared their findings and researched actions they could take</td>
<td>Presented opportunities</td>
</tr>
</tbody>
</table>

In the next section, I will describe the effects of incorporating these social justice activities in mathematics on students.

Effects of Incorporating Social Justice Issues on Students

Upon a closer analysis of the texts from the focus group interviews, student reflection videos, student work, and practitioner journal after the three cycles of action research, I found that the incorporation of social justice issues into my grade ten mathematics class had a range of effects on the students. These effects ranged from the cognitive, affective, empowerment to action. Within some of these categories, the outcomes ranged from positive to negative to no effect.
Cognitive effects of incorporating social justice issues in mathematics on students.

One of the main concerns that teachers face when incorporating critical mathematics into their classroom is the potential for it to negatively affect students’ acquisition of classical mathematical knowledge, especially with those students already having difficulties acquiring classical mathematical knowledge. During the three cycles I found evidence of both classical and critical mathematical knowledge acquisition. After completing the three cycles of practitioner research, there was evidence indicating that all students’ cognitive domains were affected. These effects included students: developing an awareness of the social justice issue, applying their knowledge of classical mathematics and changing their perception of mathematics.

In the first cycle, students were given a set of data and were asked to plot lines of best fit of income versus education for males and females (see Appendix F). By determining the equation of the lines, students were able to determine the difference in earning power between males and females and the relationship between years of education and income. When students were asked what they learned from the social justice activity there was a range of responses.

Many students indicated in the student reflection videos that they learned something about the social justice issue. When Jennifer was asked, “What did you learn from this social justice activity?” She responded, “I learned that men make more than women, even though they may have the same degree. Umm, which isn’t fair”. Similarly, Hannah responded that she “learned that women have a disadvantage over men when it comes to earning, whether their education is the same”. Likewise, Trevor responded, “I learned about the different wages between men and women and how long they stay in school; and even when the men and women
stayed in school the same amount of time, the men still made more”. These types of responses are indicative of how their peers responded when posed with the same question.

Although students indicated that they learned something about the social justice issue, no students explicitly indicated learning any classical mathematical knowledge. Only two out of eleven students demonstrated any evidence of applying mathematical concepts. Catherine mentions mathematical concepts in her response: “Just seeing the raw data and then putting it on the scatter plot made me more aware of women do make less money than men do.” Another student Hannah noted that an exponential growth curve might be a better model of the data, which was one of their follow-up questions.

Unlike the student reflection videos, there was more evidence of mathematical learning in students’ written responses. In the gender, income and education activity, students were asked the following questions: (1) Explain what the slope of the line of best fit represents. (2) Explain what the y-intercept means. (3) Using the information that you have found, is there a relationship between the number of years you spend in school and your income? Support your answer. (4) Using the equations of the line of best fit, is there is a difference in male and female earning power? Support your answer. If there is a difference between earning power, what real-life factors might contribute to this? Although students’ responses demonstrated a range of classical mathematics knowledge, most students were able to answer these questions by applying mathematical concepts acquired in previous lessons. Jeff, a student who had limited knowledge and skills in mathematics, wrote:

The slope represents the amount of income. It shows how much money can be made for each year of education for males and females. The y-int means how much money a person can make without an education. Its where the point where the line intersects with
y axis. Yes, there is a relationship because the better education, the better income you get. There is a difference between male and female earning power. Males get paid more than the females.

Although Jeff did not provide evidence to support his conclusions, he was able to make conclusion. He was also able to correctly describe the slope and y-intercept in this context. Similarly, when asked the same questions Jiya, an average mathematics student, replied:

The slope of the line of best fit represents the progression or steepness of the data, in other words, how much education is needed to produce a certain amount of income. In this data the income is the rise and the number of years educated is the run. The y-intercept in this data for men is -14068 and for women the y-intercept is 8783. The y-intercept is the point on the graph which touches the y-axis. Algebraically it would be the “b” is the equation y=mx+b. According to this graph the y-intercept represents the amount of income a person receives without any years of education. According to this data there is a relationship between the number of years you spend in school and you income. The more education you have, the more amount of income you will receive…

According to my graph men make more income than women. There could be many factors that this data hasn’t stated withier this data is from a developed or developing country or on average how many people have been surveyed. These factors affect the accuracy of what is being graphed because if this information is from a developing country there are strong possibilities of gender bias since men are traditionally seen as the money makers…Similarly another factor is the amount of people surveyed. It is possible that the amount of people surveyed were a group of uneducated people or people with lower-status jobs and it didn’t speak for the majority of the population.
Although Jiya’s responses were more descriptive than Jeff’s and contained some minor errors, she formed the same conclusions. Similar to Jeff, she did not support her conclusions with evidence from the assignment. For example she doesn’t state how she knows there is a relationship between the number of years you spend in school and your income. Also, she does not explain how she knows that men make more income than women. On the other hand, she does describe factors that might result in males earning more than females when they have the same amount of education. Finally, Jiya stated that -14068 is the y-intercept and that it is the amount of income a person receives without any years of education. However, she did not discuss why this value was negative.

Unlike Jeff and Jiya, Nadya, a student with a strong knowledge-base, did support her conclusions. She wrote:

The slope of the line of best fit represents the earning power of one gender. So, since the male line is steeper it means that they are able to earn more for a certain amount of time spent on education compared with a female. The y-intercept in this situation represents the average income without any education. It means that without any education a person wouldn’t be able to even earn a dollar, male or female. This is the point where everyone starts off and then slowly raised their average income the more education they get. Based on the information that I found there is a relationship between the number of years spent in school and the average income. This is shown through the positive slope on my graph, showing the increased values. This is also true because many of the high-paying jobs require a lot of knowledge and understanding in order to do well. So, the more education you have the more likely you are to have a higher income. Using the equations of the line of best fit I can tell that there is a difference in earning power between males and
females. This is because the slope for males is higher, so any amount in years will be multiplied by a larger number. This would give the males a larger income, for the same amount of years. One real-life factor that might contribute to this is the impression, that some of society has, that women are better at staying home and taking care of the family. Also, in a high-paying profession that used to be dominated by men, it is very hard for a female to join. This may also be due to more pressure while working.

Similar to Jiya and Jeff, she reached the same conclusions. However, Nadya did support her conclusions by referring to the slope. Finally, the last example comes from Sudhi, a student, who achieved the highest on the assignment. She gave both the slopes for males and females, 2625.5 and 1015.5, respectively. And then wrote “Slope usually represents the steepness of a line. In this scenario, it means the average income for each year of education when an x-value is substituted in the equation.” When asked about the y-intercept, Sudhi state the y-intercept for males and females, 0.213 and 0.8783, respectively. Then she wrote:

Y-intercept is the numerical value when x=0. For this scenario, the y-intercept represents income with no education. This is because the x-axis shows the years of education, so if it is set to 0 meaning no education then it will show the income at that level. It is interesting to see by the y-int values that women earn higher with no education than male.

Although Sudhi presented two y-intercept values, she calculated these incorrectly on the assignment. Instead of choosing two points from the line of best fit, she picked two data points directly from the table. What is worthy of note is that she stated that it was interesting that the female had a higher y-intercept, but she did not elaborate on this further.
When asked if there was a relationship between number of years you spend in school and income, she wrote that there was and that this could be seen through various means such as: r-value, line of best fit and percentages. She then went on to discuss each of these indicators in context. For example, she wrote, “R-value is a quantitative method of describing relationships in a set of data. When r = +1 then it means a positive correlation. For this scenario, since both r-values are very close to 1 we can say that there is a positive correlation between education and income.” Similarly, when asked about earning power, she replied that there was a difference between males and females and that this could be supported by two means: slope and the line of best fit. More specifically, she said:

Through the slope values we can see that the males slope is higher than the females slope. This means that the average salary expected per year for males is higher than females showing clear differences in earning power between gender… From the graph, we can see the females’ line of best fit is positioned lower than the male’s trend line meaning incomes for females are plotted lower.

These students’ responses reflect a range of abilities. Some students were able to draw correct conclusions, but they were not supported with evidence. Other students who reached similar conclusions were able to provide numerical evidence. Regardless, most students were able to formulate the same, correct conclusions based on data given.

In the second activity, which looked at the distribution of resources between areas of poverty and affluence, students reported learning about resource distribution in impoverished and affluent communities and its effects. Unlike the gender, income and education activity, where many of the students demonstrated the application of classical knowledge, only some students applied their mathematical knowledge in this assignment.
In the student reflection videos, a small number of students reported learning about resource distribution in areas of poverty compared to areas of affluence. Vlad learned that, “resource distribution is like important and resource distribution affects poverty rates in communities”. Likewise, Nadya said that, “from this social justice activity I learned about some of the causes and effects of affluent neighbourhoods compared to poor neighbourhoods, such as the lack of resources or the distribution of them and how it affects the community and stuff like that”.

Although some students indicated learning something about resource distribution and its affect on poverty, most students said that they learned that there were more community resources in the areas of poverty compared to their own affluent neighbourhoods. Paige responded, when asked what she learned from the activity, “I discovered the poorer area had more resources, so the idea that resources do they affect the wealth of the community, I’m starting to disagree with what I thought first…” Other students made similar conclusions. Jiya said that what she “learned was that even though some communities are more affluent than others they still might have less resources. And also that just because a community is considered poor it doesn’t mean that they don’t have resources nearby”. Like Jiya, Kaveri also learned that “communities that are not wealthy don’t necessarily have fewer resources than communities that are wealthy”, but what is interesting about her response is that she also reported learning about wealth and power, and formulating reasons why affluent communities have fewer resources. In her reflection video, Kaveri said:

In a more wealthier or affluent community if they have a car and they have access to better public transportation they don’t have as many resources because now they can get to wherever they need to go. Whereas in the smaller community,
they might need better public transportation and then they have their resources that are more closely packed together, so it can be walking distance for people. And I didn’t know that before…I also learned that wealth is also associated with power, so maybe that communities that don’t have as much wealth…they feel that they don’t have the power to ask the municipality to do something about their lack of resources.

Although some students reported learning about relationship between poverty and resource distribution, one student reported, “I really didn’t learn that much because I already knew about the poverty and what people were facing, so I didn’t really learn much” and many more students reported learning that affluent communities have fewer community resources than areas of poverty. Even though the latter conclusion was not the intended outcome for the activity, we discussed factors that may have led to these drawing conclusions (i.e. population density). Some students suggested that we should have considered population per area, the quality of these resources, and car ownership.

Similarly to the gender, income and education activity, most students demonstrated some ability to apply their mathematical knowledge. Many of the “average” and higher-achieving students were able to calculate the distance between locations on a coordinate grid. However, most of the lower-achieving students did not submit any calculations. In addition, only the higher-achieving students were able to correctly solve the extension question where they were asked to calculate the centroid. Based on these observations, I wanted to see if lower-achieving students also performed poorly on similar questions found on the unit test. When I compared the students’ performance on the social justice activity and the unit test, I found that some students who performed poorly on the social justice activity, performed better in test situations. While
some students who performed well on the social justice activity received lower marks on written tests. Finally, some students received similar marks on both assessment tasks. These findings did not present patterns between higher and lower achieving students. This was only a rough comparison, as there were only 3 questions on the test that covered the same concepts covered on the resource distribution activity. Although comparisons of students’ performance on the social justice activity and the test did not produce any noticeable patterns, I found that students’ video reflections and responses to focus group interviews tend to suggest that presenting social justices issues in mathematics contributed to their classical knowledge acquisition. Sudhi said that she “learned mathematical modeling skills and thinking, application skills that (she) could apply elsewhere. From the assignments, it strengthened (her) concepts of linear and quadratic regression.”

In the last activity, all students indicated that they learned something about HIV/AIDS and demonstrated the ability to apply their mathematical knowledge. There were a number of video reflections where students stated that they learned something about the stigma associated with HIV/AIDS. Other students learned about the number of people affected with HIV/AIDS in Canada and around the world.

Catherine said, “I didn't know there was all this stigma towards homosexuality and AIDS and I didn't know so many children were affected by AIDS as well”. Similarly, Jiya also noted that she learned about discrimination. She said, “I learned that HIV prevalence and the discrimination of HIV is still alive and that a lot of people are being more educated about safer sex and just the prevention of HIV”. Though, some students reported learning about discrimination associated with HIV/AIDS, many more of the students reported learning about the number of people affected by HIV/AIDS. Kaveri reported
I learned a lot about like the prevalence of HIV/AIDS, like it is always every year we learn about it. Someone is always telling us like HIV/AIDS is a really big thing and we should learn to prevent it and spread awareness, but this year we specifically learned the statistics, which makes it more real.

Likewise, Hannah responded:

I learned that different statistics and different results depending on what they can afford and what kind of treatments and awareness is for HIV, so, all the number of people diagnosed depends on the countries' awareness and supportiveness of different issues.

In the same manner, Nadya said:

From this activity, I learned the prevalence of HIV in several world countries, countries around the world, I was unaware of. I knew there was a lot in Africa, but I didn't know specific amounts and rates. I also learned some of the causes of HIV, what can lead to it, as well as the effects of it… I think, I just learned a little more about HIV and AIDS in Canada, before I guess I didn't really think about it before that it existed here, to a certain extent. So, I guess I learned how much, how many cases there are.

These responses are reflective of other students’ responses when asked what they learned from the social justice activity. Students were also asked in the activity to go to leading together: Canada Takes Action on HIV/AIDS (2005-2010) (http://www.leadingtogether.ca/602_act.html) and read about the social factors and issues of inequity that are driving the epidemic. They were asked to identify and explain how these factors would increase the prevalence of HIV/AIDS.

Nadya wrote:

There are several factors that contribute to the trend. One of them is lack of social support. This is when the community is not willing to accept or help people who are
suffering from this virus. An understanding community would set up programs, such as the needle exchange, in order to help prevent the spread of HIV/AIDS. When there is a lack of social support, people are afraid to become public about their infection in fear of discrimination or stigmatisms. Another important factor would be the public policies in the area. This can include taxation, housing, immigration and social services. The policy decisions can either limit or increase access to preventative measures. For example, if the policy is not to fund affordable housing many people will be out on the street because they cannot afford a home. This could lead to drug use or prostitution. On the other hand, there could be policies that offer free condoms and clean needles to help prevent the transfer of the virus. The laws of the country are also a factor in this case. They can help to prevent and lead to an increase in the prevalence of HIV. For example, the fact that most drug use is illegal forces drug users to operate underground and in bad conditions, meaning the sharing of needles which spreads the virus. People who are HIV positive may be afraid to say so in fear of losing their job as well, due to rigid workplace policies. Once the employer is notified the person may not be allowed to return.

In Kaveri’s response she indicates that “poverty, homelessness, stigma, addiction, violence, untreated mental health problems, lack of employment opportunities, powerlessness, lack of choice, lack of legal status and lack of social support” all contribute to the HIV/AIDS epidemic. Similarly, Paige wrote:

Some of the factors that lead to the growth of HIV are poverty, homelessness, stigma, addiction, violence, untreated mental illness, little job opportunities, lack of choice and lack of legal status. When dealing with poverty and homelessness, many people, especially teenagers in some cases, will try to make money through the use of their body,
leading to a spread of HIV. Also violence and addiction can contribute to HIV because a person may be a drug addict trying to deal with violence and HIV may be spread through the use of the same needles. When a person has no job, is discriminated or treated with disrespect due to a mental illness, they may also again turn to other methods of income. When a person must deal with no money, a mental illness or the need to feed a family, other options such as prostitution are considered for basically, survival. When these individuals are not looked after by the government or society, HIV can be spread and contracted through the whole community.

These student responses are indicative of the types of responses other students made on their assignment. In addition to learning about the issues associated with HIV/AIDS, all students demonstrated the ability to apply their mathematical knowledge to answer questions related to quadratic and linear functions and mathematical modeling.

Hannah, a high-achieving student, was able to correctly identify basic components of a parabola in relation to the context presented, some of the times. When asked, “Specific to this data set, what does q represent?” she responded, “In context, q represents the number of people reported in the year with the most reports”. Also when asked, “In this data set, is the value of a positive or negative? How can you tell?” she correctly responded, “The value of a is negative because the parabola opens down”. She was also able to transform a quadratic regression in the form of \( y = ax^2 + bx + c \) to find values of p and q, algebraically, and discuss the accuracy of mathematical models. When she was asked whether the quadratic regression accurately modeled the data set, she responded:

I do not think that the model accurately represents this data set because the r-value is not as close to 1 to make it as accurate. The r-value is 0.799 which means that if you made
predictions they would not be completely right in terms of the plotted points. Also, when looking at the parabola, it only passes through a few points, some of the values that it shows do not correspond with the data.

When she was asked whether a linear regression more accurately reflects the data set, she replied:

I think that a linear regression would be better for this data set because the r-value is 0.826 which is closer to 1 than the quadratic regression. Since the r-value is 0.826, it means that any predictions we make will be approximately close to the real data set.

Although she used r and \( r^2 \) values to support her answers, she does not address that using a quadratic regression would eventually lead to zero cases of HIV/AIDS and using a linear regression would show that the number of cases of HIV/AIDS would continue to increase over time.

Lower-achieving students were also able to answer the two questions, but did not always provide numerical evidence. Jeff wrote:

This quad reg does not model this data set because the curve of best fit does not accurately math up with the points. The lin reg is 0.826319419. It is more accurate because the “r” value is closer to 1 meaning the line of best fit goes with the points on the graph.

Similarly, Maalika compared the shape of the parabola with where the data points were located:
The quadratic regression fits the data set more accurately. This is because the data set is more of a curve and so is the quadratic regression. The linear regression will not accurately reflect the data set. This is because the data is more of a curve rather than a line.
Like the other two social justice activities, this activity affected students’ cognitive domain.

Students learned new information about HIV/AIDS and the social issues that perpetuate the epidemic and demonstrated the ability to apply classical mathematical knowledge.

Finally, students also noted a change in their perception of the purpose of mathematics. Many stating that there were other uses for mathematics and that it was more meaningful when mathematical concepts are applied through a social justice lens. During the focus group interview, students were asked whether their perception of the purpose of mathematics changed over the past year and Hannah responded:

I think generally when you do math, it's like oh it's equations or numbers or you have a graph. You don’t know what it's for or you analyze it or you say the trends, but you don't exactly know the story behind it. I guess when like especially for this assignment when we added in different kinds of issues [unclear] kind of help explain what's going on it made the data make more sense. But it also kind of, I don't want to say fun, it made more interesting. Instead of having a question here's a bunch of numbers, tell me the trend and make up a story. It was kind of more meaningful.

During another focus group interview, Trevor replied, “I feel that it has. I am able to see where mathematics fits into everyday living”. Unlike Trevor’s response, Sudhi’s response extends beyond how mathematics is used in our daily lives, but links it directly with social justice issues. She wrote:

Yes, my perception towards mathematics has changed. Prior to this course, I always thought that math is solely for engineering or architecture – real life career applications. However, this year’s assignments have shown me that math can be used to model many

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1 When a section of a student’s response was unclear in the video it was noted by writing “[unclear]” directly in the quote.
scenarios such as poverty, stopping distances, correlation between income and education and HIV comparison locally and globally. I think that the purpose of mathematics education has been extended to include using mathematics to educate others about social justice issues.

Like these students, many other students in the class noted that their perception of mathematics had changed over the course of the year. Therefore, the incorporation of social justice issues seems to affect students’ cognitive domain in a number of ways. It appears to result in learning about social justice issues, the application of classical mathematical knowledge and a change in students’ perception of the usefulness of mathematics.

**Affective domain.**

After analyzing the text from the student video reflections and focus group interviews, I found that some students reported changes in their affective domains, while other students explicitly said that they were not affected by the social justice activity. The reported changes ranged from forming a personal connection with the issue to developing a sense of helplessness. Female students seemed more affected by the gender, income and education. Both females and males did not seem to be particularly affected the resource distribution activity; while both were affected by the HIV/AIDS activity.

In the gender, income and years of education activity, some females reported a personal connection with the social justice issue than males. Many of the female students used the word “we” and indicated that they were affected by the issue because they were women. Hannah said, “I was kind of affected to know that even when we [emphasis] do the same amount of work or more we [emphasis] will still get a lower income…” Similarly, Kaveri also made the female connection. In her reflection video she said, “…I think that affected me because it’s something
to consider, considering I’m a female”. On the other hand, Vlad and Trevor, the two males that recorded videos, both explicitly indicated that they were not affected by the activity.

On the other end of the spectrum, two female students developed a sense of helplessness as a result of exploring the issue. What is even more interesting is that in her video response, she starts out with a sense of empowerment that changes to a sense of helplessness. Sudhi said:

Yeah, it did affect me because it taught me that maybe if I go to university and I work hard and take more degrees than I might have a chance of earning more and despite the fact that I may have the same degree as any boy or man out there, I will still earn less, so that is pretty sad for me and disappointing for me to know.

Similarly, Catherine also expressed a sense of helplessness. She said, “They can’t afford it and not everyone can get a scholarship and work up. That’s something that you can’t really change”.

Unlike this activity, fewer students reported an emotional effect after completing the resource distribution activity.

In the resource distribution activity, six students explicitly said that they were not affected after doing this social justice activity, compared to three in the first activity. No students indicated negative effects on their affective domains. And only one student, Kaveri, indicated any sense of injustice. In her video response she said:

I was affected by the social justice activity because I realized how unfair it is like Poverty by Postal Code and coming from a neighbourhood that is better off than other neighbourhoods. It’s not fair that just because they live in that area that they have worse conditions.

Therefore, the majority of the students explicitly stated that they were not affected in any way by this activity.
The last activity dealing with HIV/AIDS seemed to evoke the most emotion from the students. In Catherine’s response during the focus interview, she compared the emotional effects of all three activities. She said:

I think all of them affected me emotionally, like all to different degrees. The AIDS was definitely the top one. And all of them affected me. It made me feel like wow this is still happening, this is happening and I didn’t know it…The resource distribution one affected me the least. I would say out of the three.

Unlike the other two activities, this is the only activity where males reported any emotional effects. Jeff said “…it really struck us because we had a guest speaker come in and tell us deep information about it…I feel very bad because these people can barely get any help and I feel like I need to help them”. Similarly, Tom, who reported that the resource distribution had no effect on him, said in his reflection video that “Now I am aware of this serious issue of HIV and I kind of feel sympathy for people who have them and I want to prevent it…” After completing the activity, one student developed a sense of helplessness. Hannah reflects:

It kind of made me feel a little more helpless, instead of being able to help because you find all these statistics and the number shock or you look at the trends and you think what else can we do because there isn’t really anything left to do. The government is in turmoil … and all the other organizations have tried, but there isn’t really anything … [unclear].

Finally, there were a number of students, who explicitly said they were not affected by this activity, but reported feeling shocked by the statistics.
Social agency.

Developing a sense of social agency is defined as “seeing oneself capable of making change” (Gutstein, 2006, p. 27). Based on the student reflection videos and the focus group interviews, some students progressed from the affective domain to developing a sense of a social agency. However, not all students who indicated a change in their affective domain progressed to developing a sense of social agency. Also, some students reported empowerment or the desire to take action without reporting a change in the affective domain. Finally, most students who explicitly said that the social justice activity had no affect on them, did not report any development of social agency.

Almost half the class reported the desire to affect change. For many of these students, there was evidence of change in the affective domain and of those students developing a sense of social agency. Kaveri said:

I was affected because as an instruction to the activity we did a quiz and we watched a video and we got to learn exactly how many people had HIV/AIDS. It’s like the number of people is really staggering and it’s really bad, and it really makes you want to help.

Paige shared her feelings about the gender, income and education activity on her video reflection. She said, “It made me think about what I could do so that I am not put down like other women in our society”. Then she described what we could do to address the differences in earning power:

Find out the real reasons why. We reach a mutual reason and discuss them in class on what can be done to help them and then you know and try to solve the issues. And we could look to our student council or Students for Social Justice Club and we could give our suggestions and hope that something is done.
Both, Jeff and Tom indicated that they felt sympathy for victims of HIV/AIDS, and also indicated that they wanted to help. Jeff said, “I feel like I need to help them”. Similarly, Tom said, “I want to prevent it somehow”. Even though a number of students progressed from the affective domain to developing a sense of social agency, a small number of students who indicated explicitly that they were emotionally affected did not necessarily develop a sense of social agency. There were also a number of students who reported wanting to affect change, but did not report any emotional connection with the activity. Sudhi indicated that she wanted to take action after completing the HIV/AIDS activity. When asked if she was affected in any way after doing the social justice activity she responded, “No, not really, but I did learn more information and it has like now more likely to volunteer in any HIV special events of anything or organizations”. So, even though Sudhi did not report being emotionally affected, she did want to affect change based the activity’s affect on her cognitive domain.

Finally, almost all of the students who explicitly indicated that they were not affected by the social justice issue did not mention feeling empowered or a desire to take action. Eleven out of twelve students responded in their student videos that they were not affected by the social justice activity. These students did not have any evidence of developing a sense of social agency.

After conducting three cycles of practitioner research, less than half of the students reported the desire to take action. Most of those students also reported a personal or emotional connection with what they had learned. Although there seems to be some progression from the affective domain to developing a sense of social agency, this progression was not reflected in all students.
Factors that May Affect the Development of Social Agency

Although the three cycles led some students to take action, the design, implementation and other factors may have affected students’ development of social agency. Firstly, in the student reflection videos and the focus group interviews, students often reported the need for personal connection and experiences outside of the classroom. Secondly, during focus group interviews students often said that they wanted more teacher direction in terms of how they could help. Thirdly, when students asked who was responsible for resolving the social justice issues, many of the students felt that it was not their responsibility but that of adults. The only exception was the HIV/AIDS activity. Finally, other factors that prevented action, which were discussed by students are age, lack of financial resources and other responsibilities.

Personal connection and experiences outside of the classroom.

It was a difficult task to find social justice issues that connected with the grade ten mathematics curriculum. In addition, it was even more difficult to find topics that linked to a group of heterogeneous, affluent students. Although some students connected in a broad sense, such as being a woman or a teenager, more than half of the students did not report taking action as a result of the social justice activities. This disconnect between the student and the topics were evident through their focus group interview responses and their use of language.

Some female students felt a personal connection with the gender, income and education activity. This activity tended to appeal to their female identity. Many female students noted that they were affected because they were women or used the word “we” in their responses. Alicia said, “…when we [emphasis added] do the same amount of work or more we [emphasis added] will still get a lower income…” Similarly, Tarika stated that she was affected because she was a woman. Although some students indicated that they were affected by the HIV/AIDS activity, it
affected them in a different way. In the HIV/AIDS activity, students felt empathy towards the
victims of AIDS rather than a connection with their own personal identity. In his student video
reflection, Jeff said “I have been affected because I feel [emphasis added] very bad because these
people can barely get any help and I feel [emphasis added] like I need to help them.” Even
though these students were affected by the activities, students did not indicate that these
activities caused them to take action. During the focus group interview, Kaveri talked about the
effects of the social justice issues:

It affected me. I think it would have affected everyone on some level. You can't not feel
anything…[unclear] after looking at, you know how these people…[unclear]. Oh, my
gosh, it's such a big number. I don't think it was effective in the sense that it would make
me want to go out and really start fundraising or something.

During the focus group interviews, Kim recalls a story about her experience in Russia:

So, when you do it you actually worry about the numbers. Not, you don't see it in real
life. I think what we could have do is, again is, I do my school in Russia, when we were
raising money for a, we had, next, across the street, we had like a, what it called again
like a school for homeless kids, so we actually would raise money or collect clothes or
anything and go there and give it to little kids, and we actually see those kids, and when
you stand, I don't know, when see it, when you feel it, it affects you than when you just
work with numbers.

During the same interview, Trevor echoed Kim’s thoughts about connection:

In the assignment, it was like you took it more like something you just had to get done,
like yeah. Like Kim said like you, you look at the numbers and you don't realize where
they belong too much. Like you understand, ok those are kind of big numbers sometime,
but like, it doesn't have as much as an affect when like the guy came in from the, from, the guy that like deals with AIDS and when he educated us and stuff like that, because then you like, you really like focus on that subject, and you're not really worrying about math and yeah you're focused on the subject really learning about it.

Based on student responses, it seems that experiences need to be integrated into the social justice activities to help students develop a personal connection with the issues. Interestingly, a number of students mentioned during their student reflection videos, the need for more experiences outside of the classroom when asked, “How would you make the activity better?” Therefore, bringing community resources (i.e. guest speakers) into the classroom or taking the students into the community may help students to develop a deeper personal connection with the issue, which may lead to more students taking action. This will be further discussed in the next section.

**Teacher-direction.**

During the focus group interview, a few students indicated that more teacher-direction was needed for action to take place. Students expressed the need for specific ways, rather than general ideas, of how they could affect change, and actions that they could do immediately. Throughout the cycles, students were given only given general ideas of how they could help.

At the end of the gender, income and education activity we did not discuss actions that could result in change. In the second activity that dealt with resource distribution, we briefly discussed how we could affect change. Actions included buying from local stores, and writing letters and talking to government officials. In the last activity, during the last class, I asked the students to come up with a list of things they could do to help the HIV/AIDS problem. These ranged from asking their sexual partners to get tested and wearing condoms, to volunteering at organizations. Even though this activity gave students some ideas as to how they could help,
when asked during the focus group interviews why students did not take action, a number of respondents that they needed more teacher-direction. Catherine said:

She could have made it more straight-forward; this is what you could do. You should get started on that. I'm not saying it's her responsibility to do that, but it would have made it easier for all of us to sit down and to come with ways to help cause we all have other things to worry about as well. I'm not saying that they are more important these, but to us sometimes. It would be easier if we had the answer right in front of us and we didn't have to think about it.

This opinion was shared by a number of her peers, who said that if they were given more specific direction as to how they could help, they would have been more likely to take action. Likewise, Kaveri said, “…If she gave like a specific way you could go do this and this and this and do this like right now. OK, I would get involved in this organization like tomorrow, but it was kind of general.” Similarly, Catherine said, “…I feel like I don’t know what I can do about city resources…There’s not much I can do about it until I’m old enough to get to a country and help out, and I can’t really give money.” This notion of being too young to affect change comes up again in another students’ response, Trevor said:

It's kind of harder when you are younger and like you have exams and stuff to worry about, projects. So, a lot of people are active with like sports and stuff like that. So, it just like it's hard to really get that, of course there's like Craig Kielberger and stuff like that, who did it young, but it's a rare situation like and like it harder to like, it seems to be harder to contribute when you're young than when you're older.

In addition to age being a factor, Trevor also mentioned that other responsibilities and interests that prevented him from taking action.
After analyzing the data, my intentions of giving students different ideas about how they could help seemed counterproductive. While students indicated in their responses that they wanted to help, the data seems to indicate that students lacked the knowledge and time to initiate action, and that more teacher-direction was necessary to facilitate action.

**Responsibility.**

Finally, when students were asked what should be done about each of the social justice issues and who was responsible, they generally replied that it was someone else’s responsibility. The HIV/AIDS issue was the only activity to which they replied it was partially their responsibility. With this issue, they felt they could do something to cause change, whereas, they felt there was nothing they could do to affect the other injustices.

Specifically, during the focus group interviews, students said that employers and employees were responsible for resolving the gender and income issues. Catherine responded when asked who is responsible, she responded:

For the gender and income. I think that it's not just up to employers, like heads of companies. It is also up to the men and women working as well. The women need to stand up for themselves and men need to stand up for the women. If it's really apparent. Both working in the same company and the one guy is making thousands more than the woman. They should both be doing something about it. They shouldn't just be saying that sucks.

Students also felt that one person could not make a difference and that people needed to join together to cause change or eliminate these inequities.

In the resource distribution activity, students felt that the government, community and city planners, and people living in those communities were responsible for ensuring that
community resources are distributed equitably among communities. Kano responded to Trevor’s response that the government was responsible for distributing resource equitably by saying:

No, I think it’s the town. That town. Maybe provinces as well, wherever that province is the issue in lies [unclear] the towns and cities that has least resources. It's not the government's responsibility. The government's responsibility is of the country. Province's responsibility is of their area.

To this, Trevor added, “It’s also kind of like the people’s problems too, because it’s not like the province opens up stores. It’s more like the people that build companies and businesses, and stuff like that”. Again, they attributed the responsibility to groups of people that did not include themselves.

What was interesting is when asked the same question about the HIV/AIDS epidemic students responded by saying everyone, people, the government, and students were responsible. Jiya noted a difference between this activity and the other two:

I think the previous these assignments that we had, they didn't really, there was nothing we could do to, we could do specifically to affect them. That's more like government and like bigger people. But, like HIV and stuff, there's something we could do because even if we spread the word or kept an open mind towards it and help to reduce the discrimination that happens to people that HIV and AIDS, it would make a bigger difference than to …[unclear]

And unlike his response to the resource distribution activity, Trevor included that all people were responsible for resolving the HIV/AIDS issue. He said that:

once you have that knowledge you have to use it and spread awareness, and maybe you want to, maybe you want to learn something, and maybe you want to
take it to like another level and want to educate yourself more, so then you
research more about it and like yeah.

The data suggests that students felt that they had a responsibility and the power to positively
affect the HIV/AIDS epidemic. Students felt that talking about the issue with others and not
discriminating against people with HIV/AIDS could affect change.

Many students felt that adults were responsible for resolving the inequities presented in
the activities. Students felt that they lacked the power and resources to affect change in the
gender, income and education and the resource distribution activities; whereas, most students felt
that they were able to positively affect the prevalence of HIV/AIDS. The main difference
between the three activities was that in the final activity, a guest speaker and the wrap-up activity
provided examples of actions that students could do to reduce the prevalence of HIV/AIDS.
Although some students recognized that the HIV/AIDS epidemic was a complex problem and
developed a sense of hopelessness, many students developed a sense of social agency.
Chapter 5: Discussion

In this final chapter, I will begin by presenting a brief summary of the findings from the research. I will then use cultural-historical activity theory to discuss how teachers can help students to develop a sense of social agency. Then, I will discuss the limitations and implications of the research. And finally, I will conclude with questions that were generated from the research, which could lead to further research in the field.

Summary

This research aimed to investigate the use of social justice issues in mathematics to promote social agency in affluent, middle school students. Specifically, I wanted to explore: (1) What does teaching mathematics for social justice look like in an affluent middle school classroom?  (2) How does the incorporation of social justice issues in mathematics affect affluent, middle school students? (3) What factors contribute to or prevent the development of social agency in affluent, middle school students? Each of these will be summarized briefly in this section.

Firstly, because much of the research has been conducted on homogeneous students of low SES (Brantlinger, 2007; Gutstein, 2006; Frankenstein, 1995; Tate, 1995) studying adult college mathematics or grades seven and eight curricula (Brantlinger, 2007; Gutstein, 2006; Frankenstein, 1995), I wanted to explore what teaching mathematics for social justice would look like in an affluent, middle school classroom. I found there were limited social justice resources available for the grade ten high school mathematics curriculum (Facing the Future, 2009; Stocker, 2006; Osler, 2007). I used data and documents I found on the Internet as a springboard for two of the three activities, while the HIV/AIDS activity was modified from an
activity developed by another teacher. Like Brantlinger (2007) and Gutstein (2006), I found that
the social justice resources available were limited and that the resources needed to be adapted to
meet the expectations of the grade ten mathematics curriculum. I also found that the curriculum
restricted the social justice issues that could be incorporated. As a result, I was unable to use
many of the issues presented from the students at the beginning of the year. Freire (1970/2003)
wrote:

We must never merely discourse on the present situation, must never provide the people
with programs which have little or nothing to do with their own preoccupations, doubts,
hopes, and fears - programs which at times in fact increase the fears of the oppressed
consciousness. It is not our role to speak to the people about our view of the world, nor
to attempt to impose that view on them, but rather to dialogue with the people about their
view and ours. We must realize that their view of the world, manifested variously in their
action, reflects their situation in the world. Educational and political action which is not
critically aware of this situation runs the risk either of "banking" or of preaching in the
desert. (p. 96)

The tension that I experienced when designing the activities, between critical and classical
mathematics resulted in the imposition of my views and needs in place of the students’ interests
based on their life experiences and culture. This disconnect between the topic and the student,
may have resulted in the activities being less likely to evoke emotion, which in turn may have
affected whether students developed a sense of social agency.

Secondly, I wanted to explore how the incorporation of social justice issues in
mathematics affected affluent, middle school students. The studies conducted on homogeneous
classrooms of low SES found a number of outcomes that ranged from students: feeling a sense
of helplessness, developing an awareness of social justice issues, changing their perception of the usefulness of mathematics, feeling empowered, to taking social and political action (Gutstein, 2006; Frankenstein, 1995; Tate, 1995). Similarly, I found that some students in my mathematics class exhibited similar outcomes. In addition to these outcomes, some students also noted that the incorporation of social justice issues in mathematics had no effect on their affective domains. There was more evidence of an effect on females’ affective domains than that of males.

My findings indicated that students’ acquisition of classical mathematical knowledge was not hindered by the incorporation of social justice issues into mathematics. Both low and high achieving students were able to complete the gender, income and education activity, as well as HIV/AIDS activity. Even though four students did not demonstrate classical mathematical knowledge on the resource distribution activity, it seemed that the technical issues and not the lack of mathematical knowledge were the issue. Some students even reported that the incorporation of social justice issues helped them to understand the mathematical concepts presented in class. Like Gutstein, I agree that classical knowledge acquisition needs to be achieved in order for students to achieve equity through critical mathematics; “both sets of goals – social justice and mathematics – are dialectically interrelated. In the larger framework of teaching mathematics for social justice, each set is necessary, and neither is sufficient by itself” (Gutstein, 2006, p. 29). To ensure that social justice activities do not further create inequity between different groups of students in the classroom, further and more thorough comparisons should be done; as Lubenski (2007) suggests “the goal is to understand and address the complexities of implementing meaningful instructional methods equitably” (p.22).

Lastly, I wanted to determine the factors that may affect affluent, middle school students’ development of social agency. I found that a lack of personal connection with the social justice
issue and teacher-direction, as well as students’ perception of who was responsible for erasing the injustices all have an effect on whether students take action. Other factors that seemed to affect students were age, lack of resources and other responsibilities. In the next section, I will use cultural-history activity theory (CHAT) (Engeström, 2005) to explain how teachers can address these factors; in order to help promote social and political action.

**Motivating and Enabling Students to Take Action**

In this section, I will explain how activities designed according to the principles of CHAT can facilitate the development of social agency in students. CHAT is “an evolving theoretical framework” (Roth & Lee, 2007, p. 186) used to explain human learning and development. It is based on the notion that there is a dialectical relationship between the individual and his/her activity with the environment; where the individual and the context both influence each other and cannot be separated from each other (Roth & Lee, 2007), and that “activity is characterized by its social, historical, and cultural features” (Elhammoumi, 2001, p. 2007). Engeström (2005) describes these features as tools and signs, rules and norms that govern society, communities of practice and division of labour. The interaction between each element can be illustrated using the activity triangle shown in Figure 1 (Roth, 2004).

*Figure 1. Activity triangle depicting an activity system.*
There are three versions of CHAT and what differentiates Engeström’s version of CHAT from the others is:

Activities… do not exist in isolation; they are part of broader systems of relations in which they have meaning. These systems of relations arise out of and are reproduced and developed with social communities which are in part systems of relations among people. (Lave & Wenger, 1991, p. 53)

In other words, Engeström’s theory recognizes that activities are culturally and historically mediated and provides a framework that enables researchers to look at the dynamic and interconnected nature of human behavior and its context (Roth & Lee, 2007). Engeström also “endorses the fact that all activity systems are part of a network of activity systems that in its totality constitutes human society” (Roth & Lee, 2007, p. 200).

Informed by Engeström’s work, I have developed an activity triangle for this study, which is depicted in Figure 2, to explore how teachers can facilitate the development of social agency.

![Activity Triangle](image)

Figure 2. Activity triangle for factors affecting the development of social agency.
In this model, the students are the subject, the object is the development of social agency and social and political action is the outcome. Using this model, I will explain how mathematics teachers can apply the principles of CHAT to develop social justice activities that develop personal connections with the issues, independence, and a sense of responsibility.

Firstly, in my study, students were given limited choice and worked within the confines of the classroom when exploring gender, income and education, and when comparing resource distribution in two neighbourhoods. Even though students learned about the HIV/AIDS epidemic within the classroom, they seemed to develop more of a personal connection with the social justice issue because a member of the AIDS community spoke to them. According to CHAT, students may develop a personal connection with the social justice issue by being given the freedom to choose the object of their activity and becoming part of the community of practice. Communities of practice are groups of people who share a similar concern or an interest for something they do and learn through interaction with each other (Wenger, 1998). Participation in these communities has also been shown to affect students’ identities (Roth & Lee, 2007).

In an article written by Roth and Lee (2007), they describe how an environmental unit designed using the CHAT principles can lead to personal connection and a change in identity. During this unit, students were given the freedom to choose the aspect of the creek they wanted to explore and what tools they were going to use to implement their plans, within the limits of the collective goal; to generate scientific knowledge to rescue Henderson Creek. During this activity, the authors noted that “even students who often do not ‘succeed’ in school science became core participants in the activity, including girls, aboriginal children, and students marginalized because of a ‘learning disabled’ classification” (p. 193). Often students are
motivated when given control over their own learning (Lompscher, 1999). Allowing students to identify their object can motivate them, leading to effects on students’ affective domain.

Increasing one’s possibilities in the world and control over one’s life conditions – learning in the broad sense – are associated with positive emotional valence. The subject receives successes and failures with respect to the chosen motive positively or negatively, but the possibility of success shapes the way in which the subject engages in activity…but actions also feed back and mediate emotional states. (Roth & Lee, 2007, p. 215)

This dialectical relationship between emotion and action can result in students developing the personal connection that they deemed necessary to promote action.

In addition to choice, working within a community of practice can also lead to the development of personal connection. By participating in practical activity, students participating in the environmental unit saw themselves as “active participants and learners within the environmental movement” (Roth & Lee, 2007, p. 216); in other words, they saw themselves as being part of a community of practice, working towards a collective goal through meaningful work. Thus, if mathematics teachers developed social justice activities where students were given the opportunity to work with and be contributing members of a community of practice, they may begin to see themselves as agents of change rather than individuals merely learning about social justice issues in mathematics class. By being part of a community of practice, students may develop a personal connection with social justice issues and the people within that community, and ultimately see that their individual actions contribute to a larger collective goal, equity.
Secondly, students in my study expressed the need for teacher-direction to help them understand how to take social and political action. The application of CHAT principles can help to reduce the need for teacher-direction by providing opportunities for students to engage in practical activity, while utilizing the skills and knowledge of a community.

Teachers, parents, elders, and other villagers, who contribute to making this environmental unit possible, all play different roles; without their participation, the outcomes would not exist…That is, these other people mediate the activity and many actions that realize it, expanding the range of possibilities, and therefore contributing to constituting the activity as a more enriched form than if one teacher is to take the unit on his or her own. (Roth & Lee, 2007, pp. 194-195)

Thus, if teachers create an environment where students participate in practical activities, they will learn how they can affect change by doing ‘real’ work with members of the community.

Finally, CHAT enables us to understand why in many cases students in my study did not see themselves as responsible for addressing the inequities concerning gender and resource distribution. Not only does CHAT give us insight into students’ perception of their role in society, but it also allows students to change their perception of self. Figure 2, shows how students are affected by the rules and norms that govern human activity and by division of labour. In society, students are often seen to have limited power and their behavior is governed by classroom norms, parental expectations, and personal beliefs and values. Sometimes these rules and norms contradict the way that students see themselves in society. Often students conform to the norms of a traditional classroom, where they are seen merely as "'receptacles’ to be ‘filled’ by the teacher…The more meekly the receptacles permit themselves to be filled, the better students they are” (Freire, 1970/2003, p. 72). If this is the norm for students, then they
have limited experience with questioning authority, and forming and stating their opinions about social justice issues. Because of this students don’t see themselves as agents of change. Even though students’ actions are often limited because they have less autonomy than adults, they can still affect change if given opportunities, support, knowledge and skills to do so. By designing social justice activities that incorporate practical activity, tools (i.e. community resources, language, knowledge) and the opportunity to work with members of the community who are role models and provide expertise, students can begin to overcome some of the obstacles that prevent them from taking action. Like the students at Henderson Creek, students may begin to see themselves as active participants in eliciting change.

Therefore, teachers can use the principles of CHAT to design activities that facilitate the development of social agency in students. The principles of CHAT can be used to help students develop a personal connection with the social justice issues and a sense of responsibility to eliminate inequities. Finally, CHAT can be used to design activities that foster a relationship with a community of practice and thus eliminating the need for teacher direction.

**Limitations**

The study was limited by a number of factors: one class and small sample size, disproportionate ratio of boys to girls, and methods used. First, the study group was one mathematics class with seventeen students. When trying to investigate the effects of incorporating social justice issues in mathematics on affluent, middle school students’ development of social agency, this is only a small sample of a much larger population of students. Research on a larger sample of this population needs to be conducted to gain a better understanding of the effects of incorporating social justice in mathematics. More research is needed on this population of students to refute or support my findings.
Also, there were a disproportionate number of boys to girls, six to eleven respectively. Although it seemed that females’ affective domains were affected more often than males, this may have been skewed based on the ratio of boys to girls. Another factor that may have affected the number of male students who responded as having no affect is the gender of the person videotaping. In the future, I would have students videotape themselves, to eliminate this factor. Also, the person videotaping the reflections may have caused students to respond differently to the reflection questions.

Finally, one of the aims of the study was to investigate the effects of incorporating social justice issues into mathematics. However, the design of the activities and the student reflection video questions may have affected students’ ability to communicate cognitive and affective effects. In the resource distribution activity, the technical difficulties that some students experienced may have prevented them from applying mathematical knowledge and skills. In other words, the incorporation of the social justice issue may have affected students cognitively, if it were not for these technical difficulties. Also, in an attempt to not to direct students’ responses, the student reflection video questions were open-ended. Students were asked “What did you learn from the social justice activity?” and “Were you affected in anyway by the social justice activity?” However, in doing this, I may have missed an opportunity to learn more about the effects of incorporating social justice issues on students’ cognitive and affective domains.

**Implications and Further Study**

I hope that my research will be useful to teachers interested in critical mathematics and contribute literature in this field. Critical mathematics is fairly new idea that stems from Paulo Freire’s critical pedagogy from the 1970s. Even after 40 years, only a small number of researchers have implemented some form of critical mathematics.
The research mostly looks at the effects of developing social agency through the use of critical mathematics in marginalized groups of students in the United States. My research offers new information on how critical mathematics affects affluent, middle school students. This is a population of students that has not been studied.

In addition, I hope that my findings will help to improve the practice of critical mathematics. Because I have used practitioner research, I hope that it will be accessible to other teachers and that my findings will help them to move towards the integration of critical mathematics into their instruction. This study led to new questions and areas to be explored that may contribute to the critical mathematics instruction.

- How can teachers develop the knowledge-base necessary to teach social justice issues in mathematics?
- Within the restrictions of the Ontario Ministry of Education, how can high school teachers develop meaningful social justice activities that facilitate the development of both critical and classical mathematics knowledge?
- Does the incorporation of social justice issues affect males differently than females? Does this cause inequity?
- Does the incorporation of social justice issues in mathematics to facilitate equity on a global level actually create inequity in the classroom?
- When addressing social justice issues through mathematics in affluent students, how do we prevent students from developing a superiority complex? In other words, how do we eliminate the notion that the affluent people are the ones with power?
- What are the long-term effects of integrating social justice issues in mathematics on students?
Does the incorporation of social justice issues negatively affect students’ acquisition of classical knowledge?

There is still much work to be done in this field. It is clear from my study on affluent, middle school students that there are many questions that still need to be answered and further investigations need to be conducted on other classrooms where critical mathematics is being taught, in order to assess the scope of the effects on students.
References


Turner, E. E, & Font Strawhun, B. T. (2006). “With math, it’s like you have more defense”: Students investigate overcrowding at their school. In E. Gutstein, & B. Peterson (Eds.), *Rethinking mathematics: Teaching social justice by the numbers* (pp. 81-87). Milwaukee, WI: Rethinking Schools.


**Appendix A**

Rogers’ (1998) Levels of Engagement

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Learning new facts and concepts</td>
</tr>
<tr>
<td>Affective</td>
<td>Feelings associated with the new facts and concepts</td>
</tr>
<tr>
<td>Existential</td>
<td>Feelings may prompt consideration of deeper issues such as the meaning of life</td>
</tr>
<tr>
<td>Empowerment</td>
<td>If resolved, existential feelings can lead to a sense of personal responsibility and commitment</td>
</tr>
<tr>
<td>Action</td>
<td>Informed personal social and political action</td>
</tr>
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</table>
Appendix B

Resource Distribution

Exploring the distribution of community resources between different communities

Pre-activity Questions
1. What are “resources”? 
2. Define “resource distribution” and explain why it is important? 
3. What resources are beneficial to communities and why? 
4. What businesses are harmful to communities and why?

Task
How do the types and number of resources differ between communities of affluence and poverty?

We will be addressing this question by comparing our community with another community, which has been identified as a neighbourhood with very high poverty rates by the United Way’s report, Poverty by Postal Code: The Geography of Neighbourhood Poverty.

Skills
- Midpoint of a line segment
- Length of a line segment
- Distance from a point to a line
- Equation of a line
- Graphing

Steps
1. Choose a community, which has been identified by the United Way as a neighbourhood with very high poverty rates in 2001, on page 29 of the report.
2. Using Google maps and the Internet, label, map and calculate the distances between your home and local resources in the community. Overlay the information on a grid, with your house being the origin.
3. Choose a specific address in your other location and label, map and calculate the distances between its location and the local resources within the community. Overlay the information on a grid.
4. Explore the implications of where these resources are located. Support with calculations. What assumptions have you made and how do these assumptions affect your calculations?
5. Using mathematics, describe the types and number of resources in each of the communities. Are there any major differences between the two communities? Elaborate.
6. Are the communities designed for people with cars or is it easy to live without a car?
   a. Are they accessible by foot? State the radius used for the boundary and justify your choice. Write the equation of the boundary.
   b. How accessible are these resources by other modes of transportation?
7. Discuss other factors you need to consider when answering the question.

Extension Questions
1. The city of Toronto is planning on building a new community centre. They plan to place the community centre in the middle of 3 schools. On one of the maps, connect 3 schools in the area by forming a triangle. Mathematically, determine the coordinates of the centroid of the triangle. Show all work. Is this the best location of the new community centre? Explain.
2. How do you think people in a community can actively work together to become resource rich?
3. How can you use the information that you learned from this assignment? What other things can we look to compare different communities?

Assessment Rubrics

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<tr>
<th>Achievement Level</th>
<th>Knowledge and Understanding Criterion A Descriptors</th>
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<td>Application</td>
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<td>Ministry</td>
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<td>0</td>
</tr>
<tr>
<td>1 – 2</td>
<td>1- 1 1+</td>
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<td>3 – 4</td>
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<td>5 – 6</td>
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<td>7 – 8</td>
<td>4- 4 4+</td>
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<td>1- 1 1+</td>
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<td>2- 2 2+</td>
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<td>4- 4 4+</td>
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</tr>
<tr>
<td>5 – 6</td>
<td>4- 4 4+</td>
</tr>
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</table>
Appendix C

Student-Video Reflection Instructions and Prompts

The purpose of the video reflection is to collect student feedback about the social justice activity. Your reflections should be 1-3 minutes in length. Turn on the video camera and hit record. I would like you to begin the video reflection by stating today’s date, and the title of the social justice activity. Then I would like you to answer the following questions:

What did you learn from the social justice activity?

Were you affected in any way by the social justice activity?

What would make the activity better?

What questions do you still have?
Appendix D

Interview Protocol for Focus Group Interview

Name of Interviewer: ____________________________
Name of Interviewee: ____________________________
Date: ____________________________

To facilitate my note-taking, I would to video tape our conversation today. For your information, only the researchers on the project are privy to the tapes, which will be eventually destroyed after they are transcribed. All information obtained during the interview will be confidential, your participation is voluntary and you may stop at any time if you feel uncomfortable, and at any time after our interview you may ask to withdraw parts or this entire interview.

This interview should not last longer than 30 minutes. During this interview I will ask you several questions relating to our mathematics class and social justice issues.

Introduction

You have been selected for this interview because you have been a part of a research project examining the effects of integrating social justice issues into mathematics. This research project looks at how the integration of social justice issues affect student learning and the development

A. The Purpose of Mathematics
   1. Has your perception of the purpose of mathematics education changed?
      Probe: How so?

B. Teaching Mathematics for Social Justice
   1. Do you feel that social justice issues have a place in mathematics?
   2. What did you learn from the social justice activities presented in mathematics class?
      Probes: What mathematics concepts and/or skills, and information about social justice issues do you learn from the activity?
   3. Were you affected in any way by any of the social justice activities presented in mathematics class?
   4. What do you think we should do about these social justice issues? Who is responsible and why?
   5. Did anyone take action as a result of the social justice issues discussed in math class?
      Probe: Why or why not?
Appendix E

Interview Protocol for Initial Interview

Name of Interviewer: __________________________________________
Name of Interviewee: _________________________________________
Date: ________________________________________________________

To facilitate my note-taking, I would to video tape our conservation today. For your information, only the researchers on the project are privy to the tapes, which will be eventually destroyed after they are transcribed. All information obtained during the interview will be confidential, your participation is voluntary and you may stop at any time if you feel uncomfortable, and at any time after our interview you may ask to withdraw parts or this entire interview.

This interview should not last longer than 30 minutes. During this interview I will ask you several questions relating to our mathematics class and social justice issues.

Introduction

You have been selected for this interview because you will be part of a research project examining the effects of integrating social justice issues into mathematics. This research project looks at how the integration of social justice issues affect student learning and the development of social agency.

A. Interviewee Background
1. How long have you been at TMS?
2. Briefly, describe your involvement in the school and local community?
   Probes: Do you participate in sports teams?
   Do you do volunteer work?
   Can you tell me more about the volunteer work that you do?
   Why do you volunteer?

B. The Purpose of Mathematics
1. What do you think is the purpose of mathematics education?
   Probe: Why should we learn mathematics?
2. What do you think should be the purpose of mathematics education?

1. Do you think social justices issues should be taught through mathematics?
Appendix F

Is there a relationship between the number of years you spend in school and your income?

The following data was retrieved from http://www.infoplease.com/ipa/A0883617.html

Using the data below:
• Determine whether there is the relationship between the number of years you spend in school and your income.
• Determine whether there is a difference in male and female earning power.

You will need to complete steps 1-5 by hand and #6 using your graphing calculator. To determine whether there is a relationship:

1. Write a hypothesis.
2. Determine which columns you are going to include in your graph. Do you need to graph all columns or can you leave some out?
3. Make one scatter plot for both male and female data.
4. Draw 2 lines of line of best fit, one for males and another for females.
5. Determine the equation of the line of best fit for both males and females.
6. Determine the r-value for both lines.

### Median Annual Income, by Level of Education, 2003

<table>
<thead>
<tr>
<th>Sex &amp; Year</th>
<th>Elementary/Secondary</th>
<th>Less than 9th grade</th>
<th>9th to 12th grade, no completion</th>
<th>High school completion (includes equivalency)</th>
<th>Some college, no degree</th>
<th>Bachelor's Degree</th>
<th>Master's Degree</th>
<th>Doctorate</th>
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<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td>21,217</td>
<td>26,468</td>
<td>35,412</td>
<td>41,348</td>
<td>56,502</td>
<td>70,640</td>
<td>87,131</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td>16,907</td>
<td>18,938</td>
<td>26,074</td>
<td>30,142</td>
<td>41,327</td>
<td>50,163</td>
<td>67,214</td>
</tr>
</tbody>
</table>

NOTE: Year-round, full-time workers 25 years and older. (—) = not available.
1. Includes 1 to 3 years high school for 1990.
2. Includes 4 years of high school for 1990, and equivalency certificates for the other years.
3. Includes 1 to 3 years of college and associate degrees for 1990.
5. Includes 4 years of college for 1990.
* Data not available

Follow-up Questions
1. What is the calculated r-value? What does the r-value tell you?
2. Explain what the slope of the line of best fit represents.
3. Explain what the y-intercept means.
4. Using the information that you have found, is there a relationship between the number of years you spend in school and your income? Support your answer.
5. Using the equations of the line of best fit, is there a difference in male and female earning power? Support your answer. If there is a difference between earning power, what real-life factors might contribute to this?
6. What assumptions did you make? How would these assumptions affect the accuracy of your answers?
7. How could the findings from this assignment be applied to real-life? Why are these findings important?
8. Is there another model that would be a better fit for this data?

Assessment Rubrics:

### Communication in Mathematics

<table>
<thead>
<tr>
<th>Achievement Level</th>
<th>MYP</th>
<th>Ministry</th>
<th>Communication in Mathematics</th>
<th>Criterion C Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>The student does not reach a standard described by any of the descriptors given below.</td>
<td></td>
</tr>
<tr>
<td>1 – 2</td>
<td>1-</td>
<td>1+</td>
<td>The student shows basic use of mathematical language and/or forms of mathematical representation. The lines of reasoning are difficult to follow.</td>
<td></td>
</tr>
<tr>
<td>3 – 4</td>
<td>2-</td>
<td>2+</td>
<td>The student shows sufficient use of mathematical language and forms of mathematical representation. The lines of reasoning are clear though not always logical or complete. The student moves between different forms of representation with some success.</td>
<td></td>
</tr>
<tr>
<td>5 - 6</td>
<td>4-</td>
<td>4+</td>
<td>The student shows good use of mathematical language and forms of mathematical representation. The lines of reasoning are concise, logical and complete. The student moves effectively between different forms of representation.</td>
<td></td>
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</tbody>
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### Reflections in Mathematics

<table>
<thead>
<tr>
<th>Achievement Level</th>
<th>MYP</th>
<th>Ministry</th>
<th>Reflections in Mathematics</th>
<th>Criterion D Descriptors</th>
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<tr>
<td>1 – 2</td>
<td>1-</td>
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<td>The student attempts to explain whether his or her results make sense in the context of the problem. The student attempts to describe the importance of his or her findings in connection to real life.</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td></td>
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### Knowledge and Understanding

<table>
<thead>
<tr>
<th>Achievement Level</th>
<th>Ministry</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>The student does not reach a standard described by any of the descriptors given below.</td>
</tr>
<tr>
<td>1- 1+</td>
<td>The student demonstrates limited knowledge and understanding of linear functions.</td>
</tr>
<tr>
<td>2- 2+</td>
<td>The student demonstrates some knowledge and understanding of linear functions.</td>
</tr>
<tr>
<td>3- 3+</td>
<td>The student demonstrates considerable knowledge and understanding of linear functions.</td>
</tr>
<tr>
<td>4- 4+</td>
<td>The student demonstrates thorough knowledge and understanding of linear functions.</td>
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</table>
Appendix G

Quadratic modelling: HIV/AIDS in Canada

<table>
<thead>
<tr>
<th>10 K/U</th>
<th>22 T/I</th>
<th>Total:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 C</td>
<td>17 A</td>
<td>54 %</td>
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</table>

**Background information**

The Human Immunodeficiency Virus (HIV) is the virus that causes Acquired Immunodeficiency Syndrome (AIDS). HIV attacks the immune system, resulting in a chronic, progressive illness and leaving infected people vulnerable to opportunistic infections and cancers. The median time from infection to AIDS diagnosis now exceeds 10 years. AIDS is fatal. There is no cure. (from Health Canada).

There are over 15,000 people living with HIV/AIDS (PHAs) in Toronto. They represent different socio-economic and ethnic backgrounds, sexual orientations, age groups, and they belong to many different cultural communities within the city.

PHAs may face social and physical challenges that affect their health and well-being. These challenges take many forms: HIV-related stigma and discrimination, for example, tends to isolate PHAs from their communities, while periods of ill-health can make it difficult for them to maintain steady, full-time employment.

The needs of PHAs are increasingly complex. As people live longer with HIV/AIDS, the social and physical challenges they face can become increasingly complicated and difficult to overcome. Social isolation, due not just to the stigma attached to HIV/AIDS but to the gradual passing away of their peers, the side-effects of long-term medication use, and difficult-to-meet nutritional requirements — all of these things can have a negative impact on their well-being. Factors such as gender, sexual orientation, socio-economic status, and cultural background can further complicate the situation. (from the AIDS Committee of Toronto.)

**Mathematical Modelling**

One important reason for learning mathematical concepts is that sometimes, mathematics can help us to understand and address issues we face in society. For example, studies have shown that the demand for oil is increasing around the world, but the amount of oil available is finite. We can use mathematical concepts to make predictions using the data that we have, in order to determine how the supply and demand will interact and what the broader consequences of this situation will be. This process is called *mathematical modelling*. We use mathematical ideas to approximate the situations we observe, and then we extend the concept to make predictions about the future. We also need to recognize the limits of this process, and to remember that there are always many factors that influence any particular situation.

In this assignment, you will collect data about AIDS in Canada, and use it to make predictions about the future of HIV/AIDS in Canada.
**Data Retrieval instructions**
1. Go to the Public Health Agency of Canada website (http://www.phac-aspc.gc.ca/) and select “English”.
3. Select “HIV/AIDS” from the list.
5. Select “Surveillance Report to December 2006.”
6. Open the PDF document and find the table containing data on the “Number of Cases Reported to PHAC.”
7. Copy and paste this table into a spreadsheet or statistical software programme (see below), or input the data into your graphing calculator.
8. Graph the data from 1979 until 1997.

**Questions**
1. In general, what does \( h \) represent?
2. Specific to this dataset, what does \( h \) represent?
3. By inspection of your scatter graph, what is a reasonable approximation of \( h \)?
4. In general, what does \( k \) represent?
5. Specific to this dataset, what does \( k \) represent?
6. By inspection of your scatter graph, what is a reasonable approximation of \( k \)?
7. What is the difference in the parabola between a quadratic equation with a positive \( a \) value and a quadratic equation with a negative \( a \) value?
8. What happens if \( a \) is zero? Discuss in terms of both the equation and the resulting graph.
9. If a quadratic equation has a positive \( a \) value, will the vertex of the parabola be a maximum or a minimum? Why?
10. How does changing the value of \( a \) affect the shape of a parabola?
11. What is your best value for \(a\)? 

12. What is your best value for \(h\)? 

13. What is your best value for \(k\)? 

14. Write your equation here in the form \(y = a(x-h)^2 + k\).

15. How are \(h\) and \(k\) related?

16. What is the vertex of your graph? What does this mean in terms of this dataset?

17. Print your graph and include it with your assignment.

**Analysis (5 Communication marks overall)**

1. Describe the trend(s) you observe in the data.

2. Why do you think the data forms a parabola? What factors contribute to this shape?

3. According to your equation for a curve of good fit, how many AIDS cases would there have been in 2000? in 2008?

4. According to your equation, when will there be no more AIDS cases in Canada? Do you think that this is a realistic prediction? Why or why not?

5. Based on the data, can we conclude that the AIDS epidemic in Canada is coming to an end? Explain.

6. Do you think that a parabola is a good model for the situation of AIDS in Canada? Why or why not?
7. Add the data for 1998-2006 to your graph. How does the data after 1998 compare to the trends you observed for 1979-1997? How does this new data affect your opinion of the accuracy of this mathematical model? Why do you think this later trend is occurring?

8. Write at least two questions you have based on this data (e.g. questions for further research).

9. Look at the bar and line graphs titled “Reported AIDS Cases in the Aboriginal Community in Canada” (Note that the scale for the bar graph is on the left, and the scale for the line graph is on the right). What trends do you observe in these graphs? Note: according to the 2006 census, about 3.8% of Canadians were Aboriginal, and this number has stayed fairly consistent since 1991.

![Reported AIDS Cases in the Aboriginal Community in Canada](image)

10. Compare the bar graph above to the graph that you created from the Public Health Agency of Canada publication on the number of AIDS cases in Canada. In what ways are the two graphs similar? In what ways are they different? Why do you think these differences exist?
11. What information would help you to understand the situation of AIDS among Aboriginal Canadians better?
Appendix H

Quadratic modelling: HIV/AIDS in Canada
(Adapted from an activity developed by Michelle Munk)

Background information
The Human Immunodeficiency Virus (HIV) is the virus that causes Acquired Immunodeficiency Syndrome (AIDS). HIV attacks the immune system, resulting in a chronic, progressive illness and leaving infected people vulnerable to opportunistic infections and cancers. The median time from infection to AIDS diagnosis now exceeds 10 years. AIDS is fatal. There is no cure. (from Health Canada).

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Mathematical Modelling
One important reason for learning mathematical concepts is that sometimes, mathematics can help us to understand and address issues we face in society. For example, studies have shown that the demand for oil is increasing around the world, but the amount of oil available is finite. We can use mathematical concepts to make predictions using the data that we have, in order to determine how the supply and demand will interact and what the broader consequences of this situation will be. This process is called mathematical modelling. We use mathematical ideas to approximate the situations we observe, and then we extend the concept to make predictions about the future. We also need to recognize the limits of this process, and to remember that there are always many factors that influence any particular situation.

In this assignment, you will collect data about AIDS in Canada, and use it to make predictions about the future of HIV/AIDS in Canada.

Data Retrieval instructions I
1. Go to the Public Health Agency of Canada website (http://www.phac-aspc.gc.ca/) and select “English”.

116
3. Select “HIV/AIDS” from the list.
5. Select “Surveillance Report to December 2006.”
6. Open the PDF document and find the table containing data on the “Number of Cases Reported to PHAC.”
7. Copy the data from this table into your graphing calculator.
8. Graph the data from 1979 until 1997.
10. Sketch the graph below and label the axes.

About the graph
1. In general, what does p represent? [1K]
2. Specific to this dataset, what does p represent? [1A]
3. Using the trace function, what is a reasonable approximation of p? [1A]
4. In general, what does q represent? [1K]
5. Specific to this dataset, what does q represent? [1A]
6. Using the trace function, what is a reasonable approximation of q? [1A]
7. In this data set, is the value of a positive or negative? How can you tell? [2A]
8. What does the vertex represent in this data set? [1A]
9. Using the a, b, and c from your quadratic regression in the form of \( y = ax^2 + bx + c \), find values for p and q algebraically. [4A]
10. Which of the two methods (graphically or algebraically) used to determine p and q is more accurate? Explain. [5T]
11. What is the vertex of your graph? What does this mean in terms of this dataset? [1A]

What does the graph tell us?
12. Describe the trend(s) you observe in the data. [3A]
13. Does the quadratic regression accurately model this dataset? Provide evidence. [5T]
14. Would a linear regression more accurately reflect the dataset? Provide evidence. [5T]
15. According to your equation for a curve of good fit, how many AIDS cases would there have been in 2000? in 2008? Compare your values with those found in the 2008 dataset at
16. According to your equation, when will there be a time where there are no more AIDS cases in Canada? Comment on the validity of the model. [5T]

17. Add the data for 1998-2006 to your graph. How does the data after 1998 compare to the trends you observed for 1979-1997? How does this new data affect your opinion of the accuracy of this mathematical model? Why do you think this later trend is occurring? [5T]

Data Retrieval instructions II

1. Go to ManageBAC and find the HIV prevalence excel sheet.
2. Open the document.
3. Choose a country located in Asia, India or Africa.
4. Graph the data on your graphing calculator.

What is happening in other countries?
1. Which country did you choose and why?

2. Describe the trend in HIV prevalence over time. [3A]

3. Would a linear or quadratic regression accurately model this dataset? Explain. [5T]

4. How does this trend compare to the trend of HIV prevalence over time in Canada? What are some reasons you can think of that would account for these differences? [3A, 3T]

5. Go to http://www.avert.org/ and use the information to help explain the pattern in the graph; tell me a story about the graph. [5A]

6. Go to http://www.leadingtogether.ca/602_act.html and read the social factors/inequities issues driving the epidemic. What are some of the social factors/inequities that contribute to this trend? Explain how these factors would increase the prevalence of HIV. [5A]

7. Go to http://www.avert.org/aids-hiv-epidemic.htm and read about initiatives to help reduce the prevalence of HIV/AIDS. Is there anything that can be done to reduce the prevalence of HIV? Is there anything you can do?
### Knowledge and Understanding Criterion A Descriptors

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>The student does not reach a standard described by any of the descriptors given below.</td>
</tr>
<tr>
<td>1 - 2</td>
<td>The student attempts to make deductions when solving simple problems in familiar contexts.</td>
</tr>
<tr>
<td>3 - 4</td>
<td>The student sometimes makes appropriate deductions when solving simple and more-complex problems in familiar contexts.</td>
</tr>
<tr>
<td>5 - 6</td>
<td>The student generally makes appropriate deductions when solving challenging problems in a variety of familiar contexts.</td>
</tr>
<tr>
<td>7 - 8</td>
<td>The student consistently makes appropriate deductions when solving challenging problems in a variety of contexts including unfamiliar situations.</td>
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### Reflections in Mathematics Criterion D Descriptors

<table>
<thead>
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<th>Score</th>
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### Communication in Mathematics Criterion C Descriptors

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<tr>
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<tr>
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