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In Students' Words: The Development of Student Attitudes toward Mathematics - A Social Perspective

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IN STUDENTS' WORDS: THE DEVELOPMENT OF STUDENT ATTITUDES TOWARD MATHEMATICS – A SOCIAL PERSPECTIVE

A Dissertation Presented

by

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ABSTRACT

IN STUDENTS' WORDS: THE DEVELOPMENT OF STUDENT ATTITUDES TOWARD MATHEMATICS – A SOCIAL PERSPECTIVE

June 2011

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Student interest in pursuing advanced studies and careers in Science, Technology, Engineering, and Mathematics (STEM) has garnered much attention lately from government, business, and education leaders due to inadequate flow in the United States' STEM pipeline. Existing research points to mathematical self-efficacy and to mathematical self-concept beliefs as integral to the likelihood that a student will pursue a career in a STEM field. Students' identities, such as the "good-math-student" identity need to be verified in order for students to enact them. Both identity verification and attitude are influenced by self-efficacy and self-concept. Existing research also points to

teachers, parents, and peers as influencers of attitude. The current study seeks to add student voice, to this discussion – a feature that is largely absent from the literature.

Year-end mathematics grades from grade 4 on were analyzed for 588 juniors and seniors currently enrolled in Revere High School and used to assign each student to a researcher defined performance category. All students were then surveyed and forty-two subsequently participated in focus group discussions. SPSS and Weft QDA were used to analyze the quantitative and qualitative data respectively. Relationships among variables were identified using crosstab tables with Chi-Square tests. Qualitative data was coded and analyzed for trends.

Analysis shows that teachers have the strongest impact on student attitude toward mathematics. Attitudes are unstable and can vary with a change in teacher. Teachers who engage students in hands-on activities with real-world applications, who make students feel supported, who demonstrate passion for the subject, and who provide one-on-one attention have a positive effect on attitude toward math. Parents, especially fathers, impact attitude to a lesser degree and peers have very little influence on attitude. Surprisingly, students report older siblings as influencing their mathematics attitudes. Students in this study report higher self-concept beliefs than they do self-efficacy beliefs. Despite a generally positive attitude orientation among subjects, data show mathematics performance declines over the first three years of high school. Regarding mathematics, boys report more positive attitudes and have higher self-efficacy beliefs; special education students have decreased self-concept and decreased self-efficacy beliefs.

DEDICATION

To my parents

To my nieces and nephews: Jacklyn, Rachel, Jack, Sarah, Drew, Mary, Steven, Brendan, Danny, Tim, Matt, Maggy, Charlie, Tommy, and Mack – I love you all and you inspire me every day!

To my students – past, present, and future

To Mr. Stengel

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Finally, thank you to the students who participated in this study. Your words will make a difference; if not for your math class experiences, at least for those who come after you.

TABLE OF CONTENTS

CHAPTER Page

APPENDIX

APPENDIX

LIST OF TABLES

Table Page

Table Page

Table Page

Table Page

LIST OF FIGURES

CHAPTER 1

RATIONALE FOR STUDYING STUDENT ATTITUDES TOWARD MATHEMATICS

Context

Elected officials, policymakers, and business leaders in the United States have repeatedly voiced concern that our country is losing economic advantage over other countries, Germany, Japan, and China among them, because our students lag behind their international counterparts in math and science achievement. This is evidenced by the recent passage of federal legislation aimed at both recruiting more science and math teachers, and increasing the number of high school students participating in Science, Technology, Engineering, and Mathematics (STEM) Advanced Placement courses (Hoff & Cavenough, 2007). Further evidence comes in the founding of the National Math and Science Initiative (NMSI), a Texas based nonprofit group funded in part by Exxon Mobile, the Bill and Melinda Gates Foundation, and the Michael and Susan Dell Foundation (NMSI, 2007). The combined contributions by these three groups of 145 million dollars in financial support to NMSI demonstrates the urgency with which businesses are calling for a cadre of U.S. students who have the requisite academic skills

and the desire to pursue math- and science-related professions (Hoff & Cavenough, 2007).

In support of concerns expressed by these stake holders, the 2006 Program for International Student Assessment (PISA) results show that fifteen-year-old U.S. students average twenty-four points below the international mathematics average that included twenty-nine other industrialized nations (Cavenough, 2007).[1] Of greater concern is the fact that our *top scoring* mathematics students performed better than their counterparts in only four countries – Italy, Greece, Turkey, and Mexico (Cavenough, 2007).[2] Performance was only slightly better in science (Cavenough, 2007). These results are echoed in other international studies including the Trends in International Mathematics and Science Study (TIMSS) (US Department of education, 1999; 2003).

In its report *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, the National Academy of Sciences (2007) indicated that the United States lags behind the countries of the European Union in reference citations for physical science and engineering. They are about equal in mathematics (NAS, 2007). As other countries increase production in STEM areas, the United States is losing its footing as the solid leader in STEM research and development (NAS, 2007).

[1] Some argue that international testing programs are not valid because the United States chooses to educate all students while other participating countries employ selective enrollment protocols; resulting in imbalanced comparison groups.

[2] These data refute the argument cited in footnote 1 above.

Low student interest in pursuing careers in mathematics and science is a significant contributing factor to the United States' inability to recruit and retain students in STEM fields at the same rate as other countries such as China, Switzerland, Japan, and South Korea (NAS, 2007). Adding to the concern that the United States is not producing sufficient STEM professionals, data show as few as 53% of students who enter college with STEM majors actually complete the degree requirements in a STEM field (Chen, 2009).

Student selections of high school electives and college majors in the United States indicate they are choosing to study disciplines other than mathematics and science. The disparity between the number of high school students who take Advanced Placement (AP) courses in mathematics or science and the number who take AP courses in the humanities is staggering. In 2007, 693,915 AP exams were taken in math and science versus 1,303,022 AP exams in English language arts and social studies (College Board, 2007). The percentage of US students enrolled in bachelor's degrees programs in Mathematics, Statistics, Biology, Engineering, Physical Science or Science Technology compared to other majors is down from 21.7% in 1985 to 16.7% in 2006 (IES, 2008). Despite the percentage decline, the number of US students earning Bachelor's degrees in Biology/Biomedical Sciences, Engineering, and Computer/Information Sciences has increased significantly since 1970 (IES, 2008). This makes sense given the explosion of technological and biomedical advances over the last twenty-five years. However, the number of US students earning Bachelor's degrees in Mathematics or Statistics is down

from 24,801 in 1970 to just 14,954 in 2006 (IES, 2008). NMSI (2007) reports that the proportion of 24- year-olds who graduate with degrees in the natural sciences or engineering, as opposed to other majors, ranks the U.S. sixteenth of seventeen countries studied. National research on the demographic information related to students choosing STEM majors indicates they are more likely to be “male students, younger and dependent students, Asian/Pacific Islander students, foreign students or those who spoke a first language other than English as a child, and students with more advantaged family background characteristics and strong academic preparation…” (Chen, 2009).

At the state level, the Massachusetts Technology Collaborative has been collecting data on high school students’ intended college majors in the ten “Leading Technology States (LTS)” (Massachusetts Technology Collaborative, 2007). The LTS, California, Connecticut, Illinois, Massachusetts, Minnesota, New Jersey, New York, North Carolina, Pennsylvania, and Virginia, exceed the national average in employment within at least three of eleven STEM areas (Massachusetts Technology Collaborative, 2007). Information provided by students from these ten states on their college entrance exams (SATs and ACTs) shows Massachusetts has dropped in ranking among the ten states in percentage of students choosing STEM majors from seventh in 1999 with 26% to eighth in 2006 with 20%. This represents a drop in the number of Massachusetts students identifying STEM majors from 12,480 to 11,927 over that time period (Massachusetts Technology Collaborative, 2007).

The picture at the local level for Revere, Massachusetts where I have worked for the last fifteen years is even more bleak when these data are considered. Revere is a small urban district immediately north of Boston. The district meets the state's definition of *urban* due to a high percentage of students with low socio-economic status (73.3%) and a high percentage of students for whom English is not their first language and/or English proficiency is limited (57.5%). Of the 141 graduates in the Revere High School class of 2007 who declared college majors, only 22 (15%) identified science, technology, engineering or mathematics as their chosen field (Chamberlin, 2007). These data show Revere students choose STEM majors even less frequently than their counterparts across the state. This is not terribly surprising given the demographic characteristics of students who are more likely to choose STEM majors described above. In our urban district, many students have recently emigrated from other countries and do not speak English or had a primary language other than English; however, very few enjoy family characteristics associated with privilege. Rather than experiencing strong education preparation, many have had transient lives with frequent interruptions to their educational experiences.

There are those who dispute the existence of a STEM crisis. Robert J. Samuelson, for one, feels the U.S. is overreacting to the "crisis" in science and mathematics (Samuelson, 2005). He points out that only one third of scientists and engineers actually work in their fields and he argues that a need for scientists and engineers would drive up salaries and pull the professionals back into their fields

(Samuelson, 2005). The implication is that the failure of these things to happen indicates no crisis exists (NAS, 2007; Samuelson, 2005). Samuelson (2005) does acknowledge the poor performance of U.S. students compared to their international peers on international assessments and the fact that the U.S. relies heavily on immigrants to fill science and engineering positions. I interpret his argument as: there is demand in the U.S. for more scientists and engineers but not enough demand to entice such professionals with competitive salaries. This is a social issue framed by the people and professions that American people choose to value. It is not enough to refute the claims of others that the current STEM pipeline has inadequate flow volume.

Lowell, Salzman, and Bernstein (2009) analyzed several longitudinal data sets compiled over the last four decades by the U.S. Department of Education and the U.S. Department of Labor to compare the proportion of students entering the STEM pipeline and persisting along the STEM pipeline through midcareer for several cohorts of students. I find their research to be generally sound and their work evidences several interesting trends including: the retention of high school students within the STEM pipeline through college has been stable over the time period from 1972 through 2005 with roughly 10% of students entering college with STEM majors and graduating with STEM degrees (Lowell, Salzman, & Bernstein, 2009). Also, higher proportions of STEM graduates are entering STEM careers and staying in STEM careers than were in the 1970's (Lowell, Salzman, & Bernstein, 2009). However, these researches did not disaggregate data by particular STEM field: "the small sample available is why we

aggregate all STEM fields and occupations, as detailed breakdowns would not have enough sample size for reliable results" (Lowell, Salzman, & Bernstein, 2009, p.14). As data presented above from the National Center for Educational Statistics show, the number of US students earning Bachelor's degrees in Biology/Biomedical Sciences, Engineering, and Computer/Information Sciences has increased significantly since 1970 while the number of students earning degrees in other STEM fields, including Mathematics, has significantly declined over the same time period (IES, 2008). Such distinctions among particular fields are masked in the analysis of aggregate data. Thus, caution should be exercised in the development of generalized conclusions based on this research.

Problem Statement

My experiences as a high school mathematics teacher in Boston and Revere, Massachusetts and my experiences as the Director of Mathematics, Science, and Technology, in Revere have shaped my understanding that many school-aged children lose interest in mathematics at some point prior to entering high school. Many ninth grade students I speak to tell me they have "never been good at math" and they "never liked math" – their feelings reflecting over the long term of their short lives. Research shows that students' self-concept of mathematics ability declines as they matriculate through middle and high school (Wilkins & Ma, 2003). I feel that students' feelings about mathematics and students' self-concepts about mathematical ability impact their

engagement in mathematics classes and their interest in studying mathematics. This potential connection is particularly relevant as the NCTM *Principles and Standards for School Mathematics* document (2000) describes student disengagement in studying mathematics as a “serious problem” (p.371) and attributes disengagement, in part, to social influences that covey the message “not everyone is expected to be successful in math” (p.372). Disengagement is a more significant problem in the Revere Public Schools where a lower percentage of students, compared to state and national percentages, declare STEM majors as they apply to college.

Purpose

Attitude is an important predictor of achievement as students who have more positive attitudes toward school engage more in learning activities and persist longer in their effort to complete difficult tasks (Reyes, 1984; Wilkins, 2002). The purpose of this research is to attempt to understand, in part, the factors that students in the Revere Public schools identify as contributing to their own attitudes toward mathematics and the stability of their attitudes. By *attitude*, I mean specifically whether they like or dislike mathematics. I am particularly interested in social aspects of attitude development. This research will help educators understand whether students tend to associate the development of their attitudes toward mathematics with social, cognitive, or other factors, or some combination of factors. Discussions with students will reveal whose, if anyone’s, attitude toward mathematics students tend to emulate and why they select a

particular mathematics-attitude role-model. In addition, this research will identify whether students report the orientation of attitude toward mathematics as stable (infrequently changing) or unstable (changing frequently).

Conceptual Framework

As Director of Mathematics in Revere, Massachusetts, I frequently meet with students to help them select courses and plan their mathematics program. I also facilitate meetings between students, parents, and teachers when a parent or student has a grievance with a mathematics teacher (and vice versa). When I speak to students to mediate problems they report with teachers, students often make statements like: “S/he’s not a good teacher”, “S/he doesn’t explain anything”, and “I can’t learn the way s/he teaches”. I visit these classrooms about twice each month, and for the most part, do not observe what students report. With few exceptions and based on my experienced knowledge of effective instruction, the teachers demonstrate sound instructional techniques and provide detailed explanations of mathematical concepts. My experiences working with parents, teachers, and students in the ways described above have led me to wonder how a lesson that knowledgeable educators plan, observe, and interpret as effective is described by students to be ineffective teaching.

Theoretical Framework

The theoretical framework for my research includes Albert Bandura's social learning theory and identity theory. There are specific characteristics of each that are particularly relevant to student attitudes toward mathematics. I define each characteristic from the two theories just briefly here as they are discussed in depth in chapter 2.

Social learning theory teaches us that the individual and the environment interact to define each other (Bandura, 1977). I find this idea riveting in the context of mathematics classrooms and students' attitudes toward mathematics in the sense that the mathematics classroom environment can shape the student as an individual and therefore his or her attitude toward mathematics. Bandura (1977) also puts forth the concept of *model*: another person whose actions and the results of those actions inform the individual's behavioral decisions. Social learning theory presumes that individuals will only adopt the behavior of models they deem similar to themselves or whom they esteem (Bandura, 1977). A third key idea from social learning theory is *self-efficacy*: one's perception that s/he can successfully achieve a particular outcome (Bandura, 1977). The concept of self-efficacy is important in the classroom context because it determines the extent to which an individual will persist in any task (Bandura, 1977).

There are three concepts from identity theory that are particularly relevant to the current research. The first is the idea that at any point in time, an individual assumes *multiple identities* that are organized within the self by *prominence* (how important the individual deems the identity to be) and *salience* (the likelihood the individual will enact

the identity) (Burke & Stets, 2009). The multiple identities also undergo a continuous process of *self-verification* through which one attempts to correlate his/her meaning of the identity with the meanings s/he perceives from others (Burke & Stets, 2009).

Research Questions

The following questions guided this study:

1. In what direction are Revere Public School students' attitudes toward mathematics oriented?
2. What factors do Revere Public Schools students attribute to the development of their attitude toward mathematics?
    a. Who (if anyone) do students identify as influencing their attitude toward mathematics?
    b. What are the experiences that students identify as influencing their attitudes toward mathematics?
    c. In what ways does the mathematics classroom environment influence students' attitudes toward mathematics?
3. How stable are Revere Public Schools students' attitudes toward mathematics?
    a. If attitudes are unstable, to what do students attribute reversals of orientation?
    b. How long-lasting do students report reversals of orientation to be?

Methods

Looking at the transcripts of 11th and 12th grade students, I will identify those students whose grades indicate a change in mathematical achievement. This process should yield a list of students who have demonstrated at least one and a third letter grade increases or decreases in year-end grade over the span from 4th grade (or the earliest grade in the Revere Public Schools) to current grade. I anticipate that some of these students will have experienced changes in attitude toward mathematics as a result of or contributing to the change in performance. Responses of these students will be compared to those of students who have demonstrated gradual change in performance or consistent performance as described in Chapter 3.

Parent consent forms, accompanied by a cover letter describing the purpose, structure, and goals of my research, will be sent to student homes via US Postal Service. This letter will emphasize the fact that I hope to improve mathematics instruction for all currently enrolled and future students in the Revere Public Schools. Students who are allowed to participate by parents and who themselves agree to participate will be surveyed to identify, from the students' perspective, such attributes as student attitudes, trends in attitude by grade level, trends in causal factors to the development of attitudes, and stability of attitudes. After preliminary data analysis is complete, the researcher will identify smaller groups of students to participate in focus group discussions (seven or eight students at a time) to further explore attitudinal development from the students' perspectives.

Possible Benefits

This study could help all educators better understand what factors contribute to student attitudes toward mathematics, particularly those factors that contribute to the attitudes of students in the Revere Public Schools. Districts with similarly high levels of poverty and ethnic diversity could benefit from the findings of this research study as much as the Revere Public Schools. Teachers and administrators could better understand how the classroom environment impacts student attitudes over the long term. Depending upon student responses, the study could identify specific teacher behaviors that either promote or inhibit positive mathematics attitudes. Society as a whole could understand the role that significant others play in the development of students' attitudes toward mathematics. We are already seeing shifts in societal beliefs about studying mathematics (and science) through such pop-culture hits as the television shows *Numbers* and *Big Bang Theory,* and through the recent glamorization of being a "nerd". If we know who students say influence them and what they do to influence them, both positively and negatively, we can work to ensure more students develop positive attitudes toward mathematics. This could result in a larger number of students choosing to study mathematics and other STEM fields; providing the cadre of STEM professionals our government and our business leaders are working so arduously to develop.

CHAPTER 2

CONCEPTUAL AND THEORETICAL FRAMEWORKS WITH LITERATURE REVIEW

Rationale

Current research and recent reports clearly show that fewer and fewer American students are choosing to pursue science, technology, engineering, and mathematics (STEM) programs in high school and college (Hoff & Cavenough, 2007; NAS, 2007; Snyder, Dillow, & Hoffman, 2007). This is causing a dearth in STEM research and development in the United States and is contributing to the decline in the United States' economic stronghold (NAS, 2007). I seek to better understand how the students in Revere develop beliefs and feelings toward mathematics and who influences the development of these beliefs and feelings. Through extensive research throughout the 1980's and 1990's, Herbert Walberg and his colleagues developed their Educational Productivity Model which identifies nine factors that are the "chief psychological causes of academic achievement" (Walberg, 2003, p.7). Walberg, Fraser, and Welch (1986) identified six factors that influence attitude. They are "ability, motivation, attitude toward the teacher, amount of homework, class environment, and home environment"

(Walberg et al., 1986, p.5). This research is grounded in the analysis of large data sets and involves quantitative methods. It informs the current research by linking the home and the classroom to the development of student attitudes.

My review of existing research on the topic of student attitudes toward mathematics revealed the interchangeable use of several words related to or which describe, but are not necessarily the same as, *attitude*. These include orientation, belief, self-efficacy, and self-concept. All of these words emanate from the affective domain as described in Bloom's Taxonomy. In other words, these terms are based in feeling and emotion (Miller, 2005). Much of the existing research attempts to quantify these descriptors and then correlate values with levels of student achievement. Before moving on to the literature review and application of the theoretical framework, clarity demands that these terms be specifically defined. Throughout this work, I will apply the following definitions to these terms:

Belief: "acceptance of truth of something: acceptance by the mind that something is true or real, often underpinned by an emotional or spiritual sense of certainty" (http://encarta.msn.com/dictionary_1861589829/belief.html, 2010).

Attitude: "a mental state involving beliefs and feelings and values and dispositions toward something causing one to act in certain way." (http://wordnetweb.princeton.edu/perl/webwn?s=attitude, 2010).

Self-efficacy: the belief that one will be successful in achieving a particular outcome (Bandura, 1997).

Self-concept: **"**the totality of a complex, organized, and dynamic system of learned beliefs, attitudes and opinions that each person holds to be true about his or her personal existence" (as cited in Huitt, 2009).

Orientation: "a usually general or lasting direction of thought, inclination, or interest." (http://www.merriam-webster.com/dictionary/orientation, 2010).

The definitions above illustrate the close relationships among the words belief, attitude, self-efficacy and self-concept. I defined belief first because attitude, self-efficacy, and self-concept are defined by belief and contribute to beliefs in general. Self-efficacy and self-concept are so closely related I feel the need to discuss them further in the current context. Reyes (1984) defines mathematical self-concept as: "…how sure a person is of being able to learn new topics in mathematics, perform well in mathematics class, and do well on mathematics tests" (p.560). This definition can be reinterpreted as the personal belief that one will achieve positive outcomes on mathematics tasks – or mathematical self-efficacy. This is but one example of the conflation of self-efficacy and self-concept. While there will be unavoidable interchange of these two words as I discuss the research of others, my own use of self-efficacy and self-concept will be distinguished. In my usage, self-efficacy refers to one's perception that s/he will be able to accomplish something whereas self-concept refers to an opinion of self. For example, a student with

positive self-efficacy toward mathematics feels s/he can successfully complete mathematical tasks; a student with positive mathematical self-concept feels s/he is good at math. In the context of this work, orientation refers to the value of or direction (positive or negative) of an individual's attitude toward mathematics, self-efficacy beliefs about teaching and learning mathematics, and mathematical self-concept.

Literature Review

Student attitudes toward school in general and, in some cases, mathematics in particular and ideas closely related to student attitudes toward mathematics have been studied globally for over four decades. Independent research studies as well as analysis of PISA and TIMMS data have been used to assess and compare student achievement and student self-concept toward mathematics internationally with positive correlation (Karjalainan, 1989; Wilkins, 2004). Research also shows that confidence in mathematical ability, or mathematical-efficacy, is a predictor of achievement in mathematics (Ercikan, McCreith, & Lapointe, 2005; Flores, 2007; House, 2000). Attitude toward mathematics and past performance in mathematics classes are predictors of whether or not students will participate in advanced level mathematics courses (Ercikan, McCreith, & Lapointe, 2005; House, 2000). In addition to these school-based factors, home environmental factors, including socio-economic status, parents' education level and support for learning, impact student achievement and participation in advanced mathematics courses (Ercikan, McCreith, & Lapointe, 2005; Flores, 2007).

As indicated in chapter one, increasing student participation in STEM fields at both the secondary and post-secondary levels has received an incredible amount of attention lately. Vast financial investments from both government and private industry have been dedicated to increasing access to and achievement in advanced mathematics courses for all students at the high school level. This has resulted from the decline in the number of students entering STEM majors and professions over the last several decades. The spotlight on STEM education has caused a tremendous increase in research about STEM instruction, student attitudes toward STEM course work, and factors associated with student attitudes toward STEM course work.

It is intuitive that student attitudes, motivation, and self-concept impact student achievement. People generally prefer to engage in activities that they anticipate will result in reward and that they feel are doable (Schunk, 1987). In an international study of the relationship between mathematical self-concept and achievement, Wilkins (2004) analyzed TIMSS data and found a positive correlation for students around the world. Mathematical self-concept is positively correlated to student achievement which is positively correlated with student attitude toward mathematics (Reyes, 1984; Wilkins, 2004). Wilkins and Ma (2003) found that student attitudes toward mathematics and beliefs about the usefulness of learning mathematics decline as they matriculate through middle and high school. They further found that teachers' influence, parents' influence, and peers' influence all impact students' attitudes and perceived usefulness of learning mathematics, albeit in different ways. Wilkins and Ma (2003) write:

> To summarize the findings in relation to environmental variables, positive encouragement from teachers, peers, and parents was associated with the initial existence of positive beliefs about the social importance of mathematics and also to help diminish the development of negative beliefs and attitudes. However, attitude toward mathematics was related to teacher push and peer influence, whereas the influence of parents was related only to status and change in beliefs about mathematics (p. 61).

Considered along with Walberg's (and his colleagues) finding that the classroom and home environments impact student attitudes, Wilkins' and Ma's findings further guide the current study by identifying *who* other research identifies as influencing student attitudes. The influence of teachers, parents, and peers on student beliefs and attitudes will now be discussed consecutively in greater detail; I will then present a composite view of the concurrent influence of these three groups.

Teacher Influence

Existing research explores the impact that teaching style and teacher content knowledge have on student achievement (Trujillo, & Hadfield, 1999; Cornell, 1999). Researchers have found that American teachers use instructional methods that are less effective in developing critical thinking skills than the instructional methods used by teachers in many other countries. Furthermore, U.S. teachers' methods are less likely to require students to explore the depth of mathematical concepts that their foreign

counterparts explore (TIMMS, 2003; NAS, 2007). Lacking in-depth understanding of fundamental mathematical concepts, students struggle to make connections among concepts and fail to see the worth mathematics has in their lives (Crespo, 2003; NCTM, 1991). Mathematics is seen as a series of isolated, unnecessary skills to be memorized (Nardi & Steward, 2003). Students become disinterested and disengage. This problem is more pronounced in urban schools where fewer students enroll in advanced mathematics courses (Taylor, 2005) and where students are more likely to have inexperienced, un-credentialed teachers who are unable to convey mathematical ideas effectively (Darling-Hammond, 2001). Analysis of school and staffing data completed by The Education Trust, a non-profit student advocacy group based in Washington D.C., found that 17% of secondary classes nationwide are taught by "out-of-field" teachers who they define as teachers who have neither a degree nor certification in the field they teach (www.edtrust.org, 2009). However, the percentage jumps to 27% in high poverty schools and falls to 14% in low poverty schools when the data are disaggregated by this demographic (www.edtrust.org, 2009). The same report shows that 41% of mathematics classes in high poverty schools are taught by out-of-field teachers compared to just 17% in low poverty schools. In addition, 30% of mathematics classes in high minority schools are taught by out-of-field teachers compared to just 16% in low minority schools.

As indicated above, self-efficacy is the belief that one will be successful in achieving a particular outcome (Bandura, 1997). Teacher self-efficacy, more specifically, "is a teacher's expectation that he or she will be able to bring about student

learning.” (Ross, & Bruce, 2007, p.50). We can narrow this definition as it relates to teachers of mathematics by identifying that content in the learning. Thus, *teacher mathematics self-efficacy* is *the teacher’s expectation that he or she will be able to bring about student learning of mathematics*. This concept is important to the development of student attitudes toward mathematics as research shows a connection between teacher self-efficacy and student self-efficacy.

Researchers have found that teacher content knowledge directly impacts the teacher’s sense of self-efficacy which in turn predicts teaching style (Ross & Bruce, 2007; Cady & Rearden, 2007). According to Ross and Bruce (2007), “Teachers who believe that they will be successful set higher goals for themselves and their students, try harder to achieve those goals, and persist through obstacles more than do teachers who are not sure of their success” (p.50). Thus, a teacher who has a strong sense of self-efficacy is more inclined to try complex, experiential methods (loftier goals) and risk complete control of the learning environment (obstacles) – precisely the kinds of exercises that inspire student interest and help students take responsibility for their own learning and which are the primary instructional methods employed in higher achieving nations (NAS, 2007; Jarvis, Holford, & Griffin, 2003). The fortitude to persist among high self-efficacy teachers results from the teacher’s internal locus of control over learning – a common trait among high self-efficacy teachers that is not present in low self-efficacy teachers (Bandura, 1997; Ross, & Bruce, 2007). An orientation toward

internal locus of control means these teachers believe that they control the events that affect them and they believe that they can impact outcomes (Rotter, 1990).

In Cady's and Rearden's (2007) research of elementary pre-service teachers beliefs about mathematics and science, most teachers described the student's role in the classroom as passive while simultaneously indicating that teachers should engage students in hands-on activities with real-world applications. Despite their understanding of effective research-based instructional methods, teachers have difficulty stepping away from the traditional instructional methods they experienced as mathematics students themselves (Cady & Rearden, 2007). Their shallow depth of mathematical understanding and anxiety about mathematics inhibit many teachers from embracing alternative instructional methods (Ball, 1990). As described above, many mathematics teachers in urban schools do not have the requisite experience and content knowledge to earn certification in this content area. It follows that a greater proportion of these teachers will have a low sense of mathematical self-efficacy, and, therefore, will set lower achievement goals for their students.

Since teacher self-efficacy determines the types of activities in which teachers engage students, it also impacts student self-efficacy. For instance, the teacher determines whether or not students will be actively engaged in classroom discourse about mathematics. In their *Principals and Standards for School Mathematics* (2000), the National Counsel for Teachers of Mathematics called for teachers to engage students in rich tasks that require speculation, hard work, dialogue, and student interaction as a

means to actively engage students in their own learning. Classroom dialogue structured to fully engage students and incorporate their ideas develops student understanding of mathematical concepts and processes (Cornell, 1999). Such experiences also increase student achievement and student self-efficacy beliefs (Ross, & Bruce, 2007; Cornell, 1999).

The following visual summarizes this relationship:

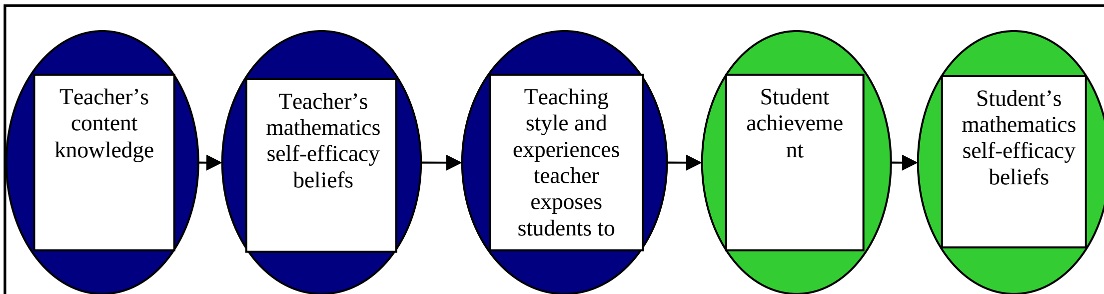

Figure 1: Teacher Influence on Student Attitudes and Beliefs

It is important to note that teachers with low mathematical self-efficacy will avoid the higher-level thinking tasks described above (Ross & Bruce, 2007). Thus, students with teachers who have high self-efficacy are at a distinct advantage to peers with teachers who have low self-efficacy in terms of engagement in activities that develop of their own self-efficacy. As indicated above, mathematics teachers in urban schools are less likely to be licensed in the content area. We can anticipate that urban schools have higher incidence of low self-efficacy teachers which has negative implications for student achievement.

Parent Influence

Parent beliefs about mathematical ability have a strong influence on their children's attitudes toward mathematics and their achievement (Eccles & Jacobs, 1986). Prior to age 18, students spend 85% of non-school time with parents (Shirvani, 2007). Research has long demonstrated the significant impact that parents have on the development of adolescents' school attitudes. Parents who value achievement model behaviors that impart to their children the belief that achievement is important (Hwang, 1995; McNair & Johnson, 2009). Virtually all of the research involving parental influence on adolescent attitudes toward school focuses on *parental involvement.* How researchers define parental involvement varies from simply providing encouragement, to discussing issues, to assisting in the completion of academic tasks, to participation in school activities – or some combination of these activities.

Gonzalez-DeHass, Willems, and Doan Holbein (2005) conducted a literature review of existing research on the relationship between parental involvement and student motivation. They found positive correlation between many aspects of parental involvement and student attitudes toward school including motivation, locus of control, and self-concept. As the authors indicate, their search of ERIC and PsychINFO online databases yielded hundreds of articles (Gonzalez-DeHass et al, 2005). However, when the scope was narrowed by various constructs including language, focus on students in US public schools, and valid research methods, only thirteen studies remained (Gonzalez-DeHass et al, 2005). The fact that only three of the thirteen articles focus on high school

students indicates the lack of research in this area. In addition, all three articles are grounded in psychology as opposed to education. I point this out not to imply diminished validity in these studies; rather to highlight the fact that these studies are not solely education based and do not specifically address mathematics. A major focus of all three articles is parenting *style* which informs but is not a primary concern in the current study. Still, these studies are relevant to the current study as they show parental involvement impacts student beliefs about school and self.

Steinberg Lamborn, Dornbusch, and Darling (1992) found that parental involvement, which they define as including helping kids with homework, attending academic and extracurricular school programs, helping kids with course selection, and monitoring progress, increases student achievement and student engagement in school. The correlation was significantly less pronounced among African-American students. The authors cite research that indicates peers have a stronger influence on the academic performance of African-American adolescents as a possible reason for the weak correlation between parental involvement and African-American students' achievement and engagement in school (Steinberg et al., 1992).

Trusty and Lampe (1997) also conducted research involving high school students and their parents. They extend the relationship between parental involvement and student achievement to include *locus of control*. Trusty's and Lampe's work cites the Steinberg, et al. (1992) study significantly and generalizes parental involvement to "how often parents did things with the student…discussed school, jobs, current events, and troubling

things with their adolescent." (p.377). The broad focus of this definition demonstrates the nature of the study which is less focused on educational constructs and more focused on adolescent development in general. However, it informs the current research in that locus of control is highly related to self-efficacy and academic success (Bandura, 1997; Ross & Bruce, 2007). Trusty and Lampe (1997) found that students who perceived higher levels of parental involvement also tended to be internal in their locus of control. That is, such students had a stronger sense that they control the events that affect them (Rotter, 1990).

In a 2002 study by Gonzalez, Doan Holbein, and Quilter, the relationship between high school students' goal orientation and parenting style is explored. The study positively correlates parental involvement to mastery goal orientation. Gonzalez et al (2002) define two types of goals: mastery goals "whereby students are interested in learning new skills and enhancing understanding" (p.451) and performance goals "in which students are concerned with proving their ability or avoiding negative judgments of their competence" (p.451). Students who are oriented toward mastery goals seek out difficult tasks, persist through them, and demonstrate inherent motivation while students who are oriented toward performance goals exhibit opposite behaviors (as cited in Gonzalez et al., 2002). Gonzalez et al. (2002) do not specifically define parental involvement, which is a limitation to their study; however, they cite both Steinberg et al (1992) and Trusty and Lampe (1997) in their discussion of parental involvement. I must be presumptuous and assume that Gonzalez et al. take some composite of the definitions of parental involvement described in the preceding paragraphs as theirs. Gonzalez et al.

(2002) found that parental involvement was positively related to mastery goal orientation. This is significant in that students with mastery goal orientation exhibit behaviors that are associated with positive self-efficacy and positive self-concept. Thus, parental involvement is positively correlated to student self-efficacy and self-concept beliefs.

Hosiin Shirvani (2007) conducted a study involving ninth grade Algebra students and their parents. Shirvani's research is of particular interest because the subjects are high school students and their parents and because the study is situated in the mathematics classroom. The researcher administered surveys to parents and students in treatment and control groups (Shirvani, 2007). The surveys were administered prior to and after parents in the treatment group received increased communication from the Algebra teacher about their child's performance (Shirvani, 2007). Results showed that "students in the experimental group had significantly higher self-confidence in their abilities of doing mathematics work" and "had significantly improved their conduct and engagement in the classroom" (p.42). These findings support the extension of the generalized findings about parental involvement in children's education described above to the specific context of parental involvement in mathematics education.

Overall, this body of research demonstrates that parental involvement impacts student attitudes. Parental involvement increases achievement and student engagement in school (Steinberg et al., 1992); it develops in students an orientation toward internal locus of control (Trusty & Lampe, 1997); and it fosters mastery goal orientation (Gonzalez et al., 2002). Internal locus of control and mastery goal orientation foster positive self-

efficacy beliefs and positive self-concept which increase student engagement and achievement (Karjalainan, 1989; Wilkins, 2004). The findings of Trusty and Lampe (1997) and Gonzalez et al. (2002) support and lend causal reasoning to the findings of Steinberg et al. (1992).

The following visual summarizes this relationship:

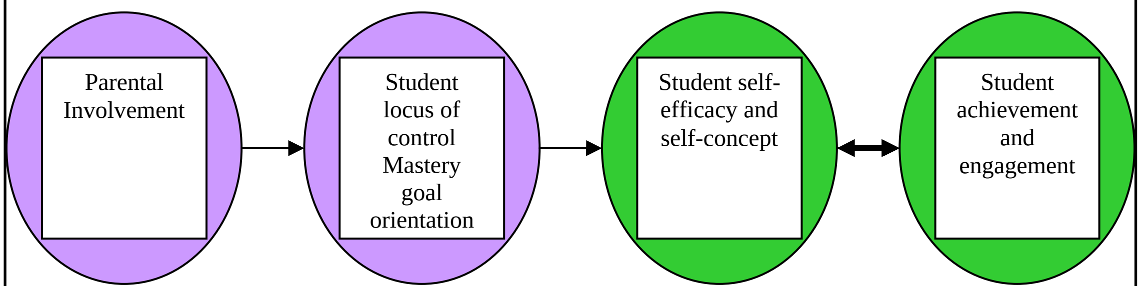

Figure 2: Parent Influence on Student Attitudes and Beliefs

Because any degree of parental involvement requires a commitment of time, the importance of parental involvement has implications in urban contexts where many parents do not have the time to give. Often, the parents of urban school students work multiple jobs in an effort to support their families financially. In addition, many urban school students are living in one parent homes where the single parent must meet the financial and time demands typically distributed between two parents. The financial constraints faced by the parents of students living in poverty inhibit parental involvement (Gutman, & Eccles, 1999).

Peer Influence

Much of the research on adolescent peer influence focuses on how and when kids engage in negative behaviors such as smoking, alcohol use, and sexual activity. There is, nonetheless, a substantial body of research that focuses on how peers influence academic achievement and attitudes toward school, a small portion of which focuses particularly on mathematics achievement and attitudes. In their literature review of studies involving academic achievement and motivation, Urdan and Maehr (1995) cite "considerable research that has shown a link between students' social relationships and their beliefs and behaviors in school" (p.218). A major criticism of earlier research about mathematics education has been the failure of researchers to incorporate a socio-cultural perspective in favor of a focus on how individuals develop mathematical understanding (as cited in Stinson, 2006). While peer influence on attitudes toward school and academic achievement in general has been studied for some time, such socio-cultural studies with emphasis on mathematics have emerged, with few earlier exceptions, only in the last decade (Hickey, 2003; Stinson, 2006; Elliot, Hufton, Illushin, & Lauchlan, 2001). Unlike the literature on teacher and parent influence, the body of research on peer influence incorporates student voice far more frequently through interviews and focus groups. The increased use of qualitative and mixed research methods with adolescent subjects highlight the socio-cultural nature of these studies which I will now discuss in further depth.

In the academic context, an individual student can be influenced by peers in a variety of ways. Some peer influence results in increased academic achievement and more positive beliefs about school and learning while other forms of peer influence can have the exact opposite effects. Central to the orientation of peer influence is the individual student's associations:

> In particular, peers can either encourage adolescents to view their school experiences positively, or encourage them to see school as an uninteresting or hostile place. The outcomes for any specific adolescent depend on the characteristics of the peers with whom the adolescent spends most of his time (Berndt, & Keefe, 1992, p.51).

Peer influence on student attitudes toward school is mediated by the closely related concepts of social-efficacy and self-regulation. Social-efficacy involves an individual's belief that s/he can successfully establish social relationships including those with peers (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). Self-regulation is one's ability to resist engaging in risk-laden behaviors espoused by peers and his/her inclination to adopt any higher academic aspirations articulated by peers (Bandura, et al., 1996). Both concepts are integral to the discussion of peer influence as the former influences the student's peer group associations and the latter influences behavioral decision making.

Negative aspects of peer influence emerge in the form of pressure to mask academic ability in an effort to avoid negative peer responses (Sullivan, Tobias, & McDonough, 2006). This type of peer influence is particularly prevalent among African

American males (Steinberg et al., 1992; Stinson, 2006). Hufton, Elliott, and Illushin (2002) conducted extensive interviews with 154 fifteen year-olds to determine, among other things, the impact that peers have on mathematics classroom behavior and work rates. Among the subjects were students from three high schools in Kentucky who reported that students who were perceived by peers to work *too* hard were assigned negative labels such as “nerd” (Hufton, et al., 2002). The uncomplimentary depictions carried across the classroom borders to general in-school and out-of-school domains (Hufton, et al., 2002). As a result, “It was normative for pupils to adopt the role of unwilling learners and to try to undermine the efforts of teachers to set and maintain the direction and pace of learning” (Hufton, et al., 2002, p.277). Interestingly, these same students esteemed what appeared to be effortless academic achievement among peers (Hufton, et al., 2002). Evidently, adolescent students feel it is socially acceptable to achieve in school provided one does not overly exert him/herself to do so. As Sullivan, et al. (2006) describe, this attitude is endemic to society as a whole but also to particular classroom cultures. Student interviews indicate that, in the classroom environment, adolescents feel teachers should mediate the attempts by peers to debase effort and achievement (Sullivan, et al., 2006).

Peer influence also manifests itself negatively when students are unable to align themselves with any peer group and when students align themselves with “dissocial” peer groups (Bandura, et al., 1996). Dissocial peer groups are inclined toward deviant behavior (as cited in Bandura, et al., 1996). Students who participate in peer groups that

devalue achievement (as many dissocial peer groups do) may purposely disengage from learning as a means to maintain association (Urdan & Maehr, 1995; Bandura, et al., 1996). In addition, association with dissocial peer groups results in rejection from academically inclined peers which is also correlated to lower academic achievement (Bandura, et al., 1996). Students who have low social-efficacy have trouble making friends. This decreases the student's inclination to seek academic help from peers and results in lower academic achievement (Bandura, et al., 1996).

Assuming an individual student is able to associate with *some* peer group, the discussion in the preceding paragraphs can be oriented in a positive direction. Nardi's and Steward's (2003) research involving interviews with seventy high school students found that students report working with peers in their mathematics class to be helpful in developing conceptual understanding. The students describe asking peers for help to be less intimidating than asking teachers for help (Nardi, & Steward, 2003). This research relates to teacher influence in the context of the types of activities in which the teacher chooses to engage students. Working with peers can enhance self-efficacy beliefs as students feel more positive about their ability to complete a task when they observe a similar peer's success (Bandura, 1997; Schunk, 1987). As indicated above, some level of positive social-efficacy is a pre-requisite to seeking help from peers (Bandura, et al., 1996). Students who identify their school environment, including peer relationships, as positive indicate more positive attitudes toward school in general and demonstrate greater academic achievement (McNair & Johnson, 2009). This supports the findings by

Bandura, et al., (1996) that higher levels of social-efficacy promote positive school attitudes. Even association with dissocial peer groups is better than no association at all in terms of attitude orientation as acceptance from *some* peers results in more positive attitudes toward school than does utter rejection (Bandura, et al., 1996). Thus, individual adolescent attitudes toward school are influenced by peers simply through the individual's social-efficacy – his/her ability (or inability) to *cause* inclusion in peer groups. Further, the *type* of peer group(s) with which one associates will impact access to peer help, inclination to seek peer help, and academic achievement.

The following visual summarizes this relationship:

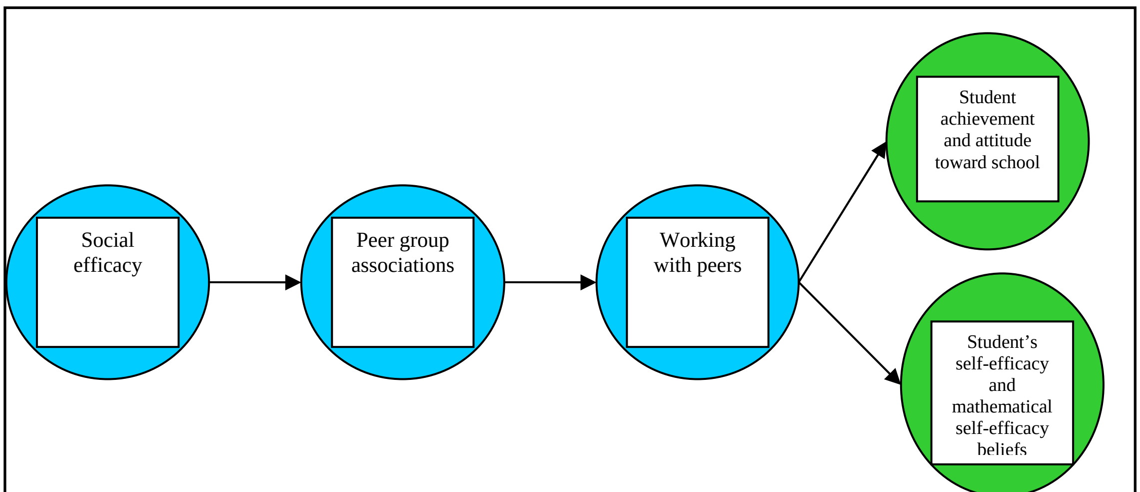

Figure 3: Peer Influence on Student Attitudes and Beliefs

The literature on peer influence informs practice in urban schools. Urban educators who are aware of the importance that peer group associations have on student achievement can take steps to help students form positive alliances with peers. Because so many students transfer into urban schools during the school year, these schools contain

far more students without peer group associations at any given point in time. Urban educators should consider programs, both at the classroom level and at the school level, that facilitate peer group association when new students arrive.

The three bodies of research outlined above have several overlapping aspects. The relationship between student self-efficacy beliefs and achievement and attitude toward school is evident in all three areas. In fact, research outlined in the parent influence section demonstrates this to be a reciprocal relationship. The research on teacher influence and peer influence highlights the importance of student interaction which is determined by the teacher's instructional style. The following composite visualization of the three bodies of research illustrates these relationships and provides a holistic view of the influence that others have on student attitudes toward mathematics:

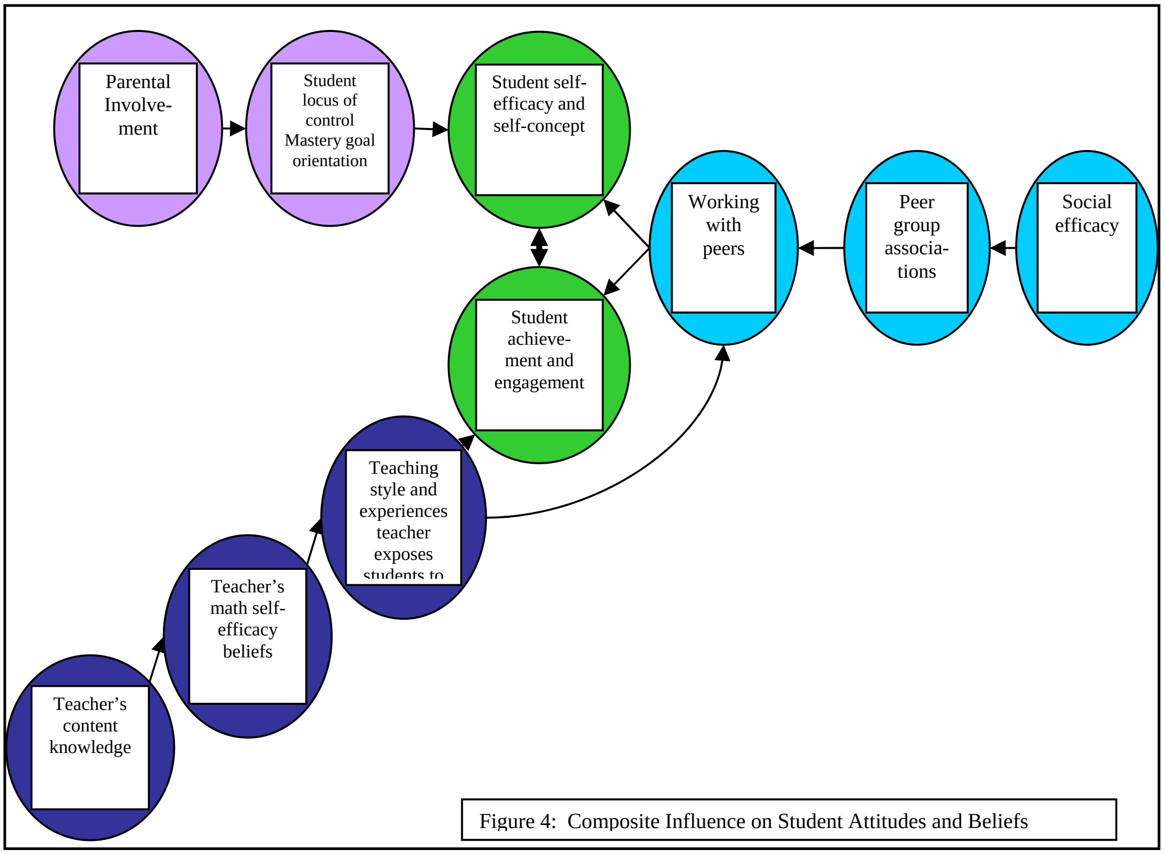

Figure 4: Composite Influence on Student Attitudes and Beliefs

Limitations

The research discussed here is helpful to our understanding of factors and people that influence student attitudes toward mathematics as they focus directly or indirectly on this topic. However, very few of the studies involve discussion with current secondary mathematics students. Cady's and Rearden's (2007) qualitative study focused on Pre-service K-8 teachers' epistemic beliefs about math and science teaching and learning and Cornell's (1999) qualitative study focused on factors pre-service elementary teachers attribute to the development of their own attitudes toward math and how they define

effective instruction. Similarly, Casa's, McGivney-Burelle's, & DeFranco's (2007) research involved pre-service teachers and the development of an instrument to measure their attitudes toward discourse in the mathematics classroom; Trujillo & Hadfield (1999) interviewed mathematically anxious pre-service teachers. These studies involve subjects who are similar to the subjects intended for the current study as they are recent (relatively) high school graduates; however, life experience in the years since graduating high school may have influenced responses to research questions. In addition, the subjects of these studies elected college enrolment which leaves the research lacking in terms of the experiences of students who choose paths other than post secondary education. Ross' and Bruce's (2007) research focused on the impact that professional development programs have on the self-efficacy of practicing teachers. Thus, their subjects are even further removed from those of the current study.

The research on parental influence involved analysis of large data sets and/or surveys. None of these studies included interviews or focus groups. Thus, results assume the subjects and the researchers had shared understanding of survey questions and interpretation errors are not evident. Shirvani's (2007) study most closely relates to the current study because it includes high school students and is directly related to the learning of mathematics. However, the methods were strictly quantitative in nature. The quantitative and meta-analytical natures of these studies fail to adequately incorporate the student voice.

Although the literature on peer influence shows more frequent employment of qualitative methods involving students, only three of the studies focused on high school mathematics students (Hufton, et al., 2002; Nardi & Steward, 2003; Stinson, 2006). The need for qualitative research on adolescent attitudes toward mathematics that incorporates student voice within the socio-cultural framework is evident.

Theoretical Framework

Albert Bandura's Social Learning Theory as well as Burke's and Stets' Identity Theory form the basis of the theoretical framework for my research. I will begin with a brief discussion of other theories that inform my study but have been excluded from this theoretical framework and provide rational for these decisions. I will then discuss Bandura's theory, followed by identity theory, and finally show how they interact to influence attitude development.

Development of the Theoretical Lens

There is no doubt that cognitive ability influences student attitudes toward mathematics and several theories of cognition, including Piaget's cognitive development theory, were considered as my research progressed. In Piaget's definition of intelligence, there is a specific set of criteria that must be met and mastered at each stage of cognitive development. In order to move from one stage to the next, the child must master that specific set of criteria (Child Development Institute, 2007; Glatthorn, Boschee, &

Whitehead, 2006). This can be problematic in our age-based educational system where students are primarily assigned to classes based on chronological age. In this dynamic, students who are behind their same age peers developmentally and persist in the concrete operational stage might struggle with the formal operational concepts that are part of their mathematical curricula in upper elementary and middle school, thereby negatively impacting the child's attitude toward mathematics.

While I acknowledge the importance of cognitive influence on adolescent attitudes toward mathematics, I have elected to focus on the social and environmental aspects of the dynamic. Thus, theories of cognition that focus on the social aspects of cognitive development (such as social learning theory and Identity Theory) are better suited to this study. My focus is on students who generally have the requisite cognitive ability for the math classes they are taking. I anticipate some subjects in my study may struggle from time to time, may struggle regularly, or may have struggled historically in their mathematics classes. However, all subjects will be developmentally ready to learn high school level mathematics. Some of my subjects may currently have or may have had Individual Education Plans (IEPs) in the past. IEPs are designed to ensure students with various forms of cognitive or developmental delay – evidenced and documented through testing – have access to the curriculum through, as Massachusetts state law mandates, the *least restrictive environment*. This means that, as much as possible, the student engages in the same learning activities as his/her classmates who do not have an

IEP. Children with IEPs indicating full inclusion in the “regular” mathematics class are considered developmentally ready to learn high school level mathematics.

During the research process, I also considered Vygotsky’s Social Development Theory and Activity Theory as lenses through which to approach the data. Both social development theory and activity theory focus on the social aspects of learning and inform the impact that learning environment has on student attitudes (see Engestrom & Miettinen, 1999; Roth, 2005; Tobin, 2005; Vygotsky, 1978). Both theories have also been widely used to study ways in which individuals and environments influence each other and ways in which power, or agency, influences culture, behavior, and attitudes (see Cole, 1999; Engestrom, 1996; Hayrynen, 1999; Leiman, 1999; Ryle, 1999; Seiler, 2005). Activity theory and social development theory both help us understand how an individual student can come to interpret the learning environment as positive or negative which subsequently impacts his/her attitude toward mathematics. However, both theories are better suited to research conducted in situ. Because the current study is not framed within the classroom learning environment, activity theory and social development theory do not provide adequate lenses through which to explore the social aspects of the development of student attitudes toward mathematics from the students’ perspectives.

Bandura’s social learning theory and identity theory incorporate the ideas described by social development theory and activity theory but are grounded in the study of individuals. Social Learning Theory’s emphasis on *self-efficacy* and how it both shapes and is shaped by the learning environment is framed by the individual’s

perception of self and the environment. Identity Theory focuses on how individuals come to define themselves and develop associations. I seek to understand the students' opinions of what impact various experiences and various individuals have on the students' attitudes toward mathematics. I further seek to understand students' opinions of the extent to which these experiences have a *lasting* impact on students' attitudes toward mathematics. Social Learning Theory and Identity Theory enable me to explore these opinions from the perspectives of students and I now discuss these theories in greater depth.

Social Learning Theory

Bandura's theory, as cited in Jarvis et al. (2003) is focused on social interaction as the primary conduit of learning. Bandura asserts that "all learning phenomena resulting from direct experience occur on a vicarious basis by observing other people's behavior and its consequences for them" (1977, p.12). Thus, individuals determine which behaviors to adopt and which behaviors to reject without necessarily engaging in the behavior him/herself, based on whether or not they observe a self-assumed positive result for others. His behaviorist approach posits that individuals shape their environment and the environment shapes the individual: "Both people and their environments are reciprocal determinants of each other" (Bandura, 1977, p. vii). Thus, the teacher is shaped and each student is shaped by the classroom environment, and the classroom environment is shaped by the teacher and students in it. Similarly, students are shaped by

their home environments which are in turn greatly influenced by parents, siblings, friends, and others.

Social learning theory places emphasis on the immediate social context and on individual development through the individual's interpretation of the social interaction (Bandura, 1977, Tudge & Winterhoff). Individuals select *models* (those people whose behaviors the individual chooses to emulate) based on who the model is and the individual's perception of the model. Bandura theorizes that individuals will only adopt the behavior of models they deem similar to themselves and models they esteem (Bandura, 1977). Bandura (1977, p.127) states: "Some of the behavioral changes accompanying observed outcomes may be mediated through modification of the model's status itself. Individuals who possess high status are generally modeled more than those of subordinate standing." He goes on to say: "Ordinarily, people favor reference models similar to their own ability over highly divergent ones whose behavior they can match only though great effort" (p.134). The outcome of the modeled behavior is also important in determining the impact that the modeled behavior will have on the individual's behavior.

Mediating an individual's decision to accept or reject modeled behavior is another key concept from social learning theory – *self-efficacy*. Bandura (1977) defines one's sense of self-efficacy as "the conviction that one can successfully execute the behavior required to produce the outcomes" (p.79). This is necessarily precipitated by an *outcome expectancy* which Bandura (1977) defines as "a person's estimate that a given behavior

will lead to certain outcomes" (p.79). In order for an individual to attempt a modeled behavior, the individual must value the outcome observed and perceive the outcome to be successful (Schunk & Zimmerman, 2007).

The concept of self-efficacy is important in the classroom context because it determines the extent to which an individual will persist in any task (Bandura, 1977). Students and teachers who lack self-efficacy are reluctant to engage in cognitively-advanced learning activities and are more likely to cease working prior to achieving learning goals (Bandura, 1977; Ross & Bruce, 2007). It is important to point out that Bandura (1977) identifies self-efficacy to be highly situational. Thus, an individual can experience a low sense of self-efficacy on one task but a high sense of self-efficacy on another. Repeated successes mediate intermittent failures to produce an overall increase in self-efficacy whereas repeated failures with intermittent successes produce an overall decrease in self-efficacy (Bandura, 1977). Thus, students who demonstrate generally high levels of self-efficacy could have low levels of self-efficacy specifically related to mathematics. Also, students who may have demonstrated mathematical self-efficacy oriented in one direction *could* have new experiences that cause the reversal of orientation.

The three key ideas attributed to social learning theory and presented above, *the reciprocal determination of environment and individual,* the descript concept of *model*, and *self-efficacy*, have implications for classroom practice. Teachers must be cognizant of how they assign student partners and groups. They must ensure models are

appropriately matched to prevent reduction in individual self-efficacy. Administrators must hire qualified teachers to ensure students regard the teacher as a high status model. Furthermore, teachers must monitor their own self-efficacy and take steps to remediate isolated instances of decreased self-efficacy so that students regard the teacher as a high status model. Teacher self-efficacy, student self-efficacy, and the appropriateness of models will impact motivation, in turn defining the learning environment which will, in the sphere of reciprocal determination, either foster or impede the development of positive attitudes toward mathematics for all participants.

Critics of social learning theory argue that Bandura does not adequately address the power dynamics inherent in all social environments (Jarvis et al., 2003). Because his theory is so focused on the individual, Bandura fails to adequately account for mediation of environmental aspects such as social inequality in behavioral decisions (Jarvis et al., 2003). In the urban classroom environment, social inequality is manifest in the teacher's formal authority (versus the lack thereof for students) and in the racial, gender-based, and socio-economically based biases of some school administrators, teachers, students, and other key players in education (MacLeod, 2004; Tobin, Elmesky, & Seiler, 2005; Swartz, 1997). Thus, the criticism of social learning theory is relevant.

Identity Theory

Identity Theory grew out of the earlier structural symbolic interaction perspective (Burke & Stets, 2009). Structural symbolic interaction (SSI) addresses individual nature

and the ways in which an individual and society relate to each other (Burke & Stets, 2009). It focuses on actors' meanings and maintains that societal structure is stable and organized (Burke & Stets, 2009). Identity Theory takes as its subject SSI's "agent of action" which is the identity (Burke & Stets, 2009, p.61). Unlike many other theories (such as Activity Theory) Identity Theory distinguishes between persons and agents. In Identity Theory, each identity an individual holds is itself an agent (Burke & Stets, 2009).

Before describing identity theory more fully, I must mention social identity theory which is closely related to identity theory. These two traditions have different names for very similar constructs and focus on different units of study. Identity theory focuses on *roles* (what the individual does) whereas social identity theory focuses on the *group* (who the individual is) (Stets & Burke, 2000). Due to the idiosyncratic nature of the differences that separate identity theory and social identity theory, leading researchers in both areas (Sheldon Stryker for social identity theory and Peter Burke for identity theory) have called for the integration of these two strands as a means to create a more robust analytical frame (Stryker & Burke, 2000). Stryker and Burke (2000) argue that "such a merger would prevent redundancies in separate theories and would be a basis for establishing a general theory of the self" (p.233). They further argue that the relationship between who one is and what one does are intertwined to the extent that analysis should occur in conjunction rather than in parallel (2000, p.234):

> We suggest that being and doing are both central features to one's identity. A complete theory of the self would consider both the role and the group bases of

identity as well as identities based in the person that provide stability across groups, roles, and situations.

Their point is well taken. In typical constructs, the role one plays (say as a profession) determines the groups with which one associates. For example, a teacher associates with her class and with her colleagues (among other groups) *as a teacher*. Were she not a teacher, she would not associate with these groups – at least not in the same capacity. However, her interactions in each of these groups determine the role she plays. With her class, the teacher identity may engage in authoritarian and superior behaviors whereas interactions with her colleagues may elicit more collaborative and egalitarian behaviors. The behaviors manifested by the teacher identity are situational and are influenced by the particular group with which the identity is engaged. Thus, we can not fully discuss her role without considering the immediate group.

I now move on to more specific discussion of identity theory. Like its relationship to social identity theory, identity theory is itself split into nuanced strands in its application by various researchers based on which aspect of identity is emphasized. The three major emphases are interactional, structural, and perceptual control (Burke & Stets, 2009). The interactional emphasis focuses on the idiosyncratic dimension of identity (how different individuals interpret their roles differently) while structural identity theory focuses on conventional dimensions of identity (the socially-based shared meanings of roles) and perceptual control identity theory highlights the meaning dimension of identity (the internal processing through which individuals maintain the

roles they claim) (Burke & Stets, 2009). While all three strands share the umbrella title of identity theory, existing research is typically focused along just one of these three lines. Again, leading researchers are calling for a melding of these three traditions in order to establish a more holistic theory of self and identity. Burke and Stets (2009) write "The development of identity theory can be enhanced by merging Stryker's ideas about identities at the social structural level with McCall and Simmons's views at the interactive level and Burke's conceptualization at the individual level" (p.55).

The identity portion of the theoretical framework for the current study is best described by Burke and colleagues' perceptual control emphasis of identity because it highlights the meaning that individuals make of their identities which, I contend, will most closely inform the study of student self-described attitudes toward mathematics. Nonetheless, I agree with Burke, Stryker and Stets that an identity is determined not only by the internally defined meaning of a role but also through the group dimension of the identity, through discrepancies in role definition, and through the normative definitions of roles. Necessarily, the closely related traditions of social identity theory, the interactional emphasis of identity theory, and the structural emphasis of identity theory will be engaged. As I refer to identity theory in the remainder of this work I will combine aspects of all four traditions with appropriate reference.

While other researchers define identity differently, the definition adopted and used in the current research is attributed to Stryker and Burke who describe identity as "parts of the self composed of the meaning that persons attach to the multiple roles they

typically play in highly differentiated contemporary societies" (2000, p.284). Three key concepts in identity theory and relevant to the current research are the idea that all individuals, at any point in time, have *multiple* identities that interact with each other and compete for continual validation; the *prominence* and *salience* of a particular identity which impacts whether or not the individual will activate a particular identity over another in a particular situation; and behaviors enacted to reaffirm conceptions of the identity or *self verification* (Burke & Stets, 2009; Stets & Burke, 2000). These three ideas will be discussed in detail below.

Identities are formed through a process called *identification* (Stets & Burke, 2000). Identification occurs as the individual categorizes him/herself in a particular *role* in relation to others within a structured society (Stets & Burke, 2000). Each role is associated with related counter-roles that inform the identity. Examples of counter-roles include parent and child, teacher and student, and husband and wife. Counter-roles inform identities through interaction between the two (or more) individuals assuming the roles. This dynamic will be discussed in greater depth below. Stets and Burke define role as "symbols that are used to designate positions – the relatively stable, morphological components of social structure" (2000, p.225). Upon identification, the individual's behavior is determined by the expectations and meanings associated with that particular role (Stets & Burke, 2000). The role refers to externalized expectations related to the position one holds while the identity is the internalized expectations related to the position defined by the role (Stryker & Burke, 2000). Individuals identify with

many roles but enact only some of them (or one of them) in particular instances (Burke & Stets, 2009).

The multiple identities to which one ascribes are organized by the self in relation to each other in what McCall and Simmons call the *prominence hierarchy* which constitutes the ideal self (as cited in Burke and Stets, 2009). Placement of a particular identity within the prominence hierarchy is determined by the amount of self support and support from others perceived by the individual for the identity, how committed the individual is to the identity, and the rewards the individual attributes to the identity (as cited in Stryker & Serpe, 1994). Extrinsic rewards take the form of resources such as money and prestige while intrinsic rewards include feelings of gratification and self-efficacy (Burke & Stets, 2009). The situational self is defined by the *salience hierarchy*. Identity *salience* is integral to an individual's decision of which identity (or identities) to enact in a particular situation. Stryker and Burke (2000) define identity salience as "the probability than an identity will be invoked across a variety of situations, or alternatively across persons in a given situation" (p.286). While identity prominence describes the importance one ascribes to a particular identity and identity salience describes the likelihood that a particular identity will be enacted, the two are very closely related and impact each other (Burke & Stets, 2009; Stets & Burke, 2000). For example, one of my most prominent identities is that of school administrator. I enact this identity every day through my job and it is integral to my study as a doctoral candidate. I take great pride in this identity and the role I play through it. Family members and friends often ask me

about school policy issues at parties and social gatherings. In responding to their questions, I enact my school administrator identity in situations where my sibling, daughter, or friend identities would seem more appropriate. The prominence of my school administrator identity is increased as I experience the intrinsic reward of helping others understand something that they previously didn't. At the same time, this identity becomes more salient as the likelihood I will invoke it across situations increases.

While the prominence and salience hierarchies are considered stable, they can and do change as individuals encounter new experiences and different situations. Changes occur through failures in the process of self verification (Burke & Stets, 2009). Self verification is ongoing and occurs as an individual activates a particular identity. Upon activation, the individual behaves according to the norm and expectations s/he associates with that role. These norms and expectations, the meaning of the identity held by the individual, are called the *identity standard* (Burke & Stets, 2009; Stets & Burke, 2000). As individuals act in social settings, they perceive the verbal and non-verbal actions and reactions of others; they seek feedback through these perceptions that conform to the meaning of the identity standard (Burke & Stets, 2009). Individuals continuously compare their perceptions to the identity standard and act based on the degree of correlation. When perceptions match the identity standard, the individual will continue to act in accordance with the identity standard (Stets & Burke, 2009). Such situations are appropriately framed in structural identity theory. Discrepancies, best framed in interactional identity theory, result in behaviors targeted to bring the perceptions in line

with the identity standard (Stets & Burke, 2009). Thus, it is perception – not behavior – that individuals seek to control (Stets & Burke, 2009).

As indicated above, the process of self-verification (action, perception, comparison, consistent or altered action) is ongoing and continuous and may or may not be conscious (Stets & Burke, 2009). Stets and Burke refer to this as the identity process and the cyclical organization of the four components as the control system (Stets & Burke, 2009). It is here that counter-roles impact identity. Often, perception is based on behaviors, verbal and non-verbal, of individuals acting through counter-role identities. The control system acts to either modify the individual's identity standard or change the environment to force alignment with the identity standard. Here, social identity theory is emphasized.

Other than the limitations inherent in research that focuses on just one of the main strands of identity theory that I described above, criticisms of identity theory include the impression that it focuses too heavily on self perception and does not adequately address ways in which identities of different individuals, enacted together, influence each other (Hogg, Terry, & White, 1995). This criticism is somewhat addressed by social learning theory. Hogg, Terry, and White (1995) further argue that identity theory fails to address the socio-cognitive development of identity – how one comes to assume a particular identity and how socially developed identity standards reflect social norms. These criticisms, which are the only ones I could find documented, pre-date later work by Stryker, Stets, and Burke wherein they call for integration of stands of identity theory as

described above (Stryker & Burke, 2000; Stets & Burke, 2000, Burke & Stets, 2009). Such a meta-theory that incorporates the three primary strands of identity theory with social identity theory, might answer these criticisms. In the meantime, combining Bandura's social learning theory with identity theory will provide the socio-cognitive lenses needed to complement identity theory.

The Two Theories Considered Together

Bandura's concepts of *model*, *self-efficacy*, and *reciprocal determination of environment and individual* form a well developed schematic of how interactions occur and are interpreted as either a positive or a negative experience by the subject. Considered within the paradigm of identity theory, we can understand how experiences and interactions with others shape attitude through the identity (or identities) the student assumes.

As Bandura (1977) reminds us, all ***individuals have been shaped by their environment*** (i.e. the home and past math classes). Consider the first time a student enters her ninth grade math class. S/he holds some sort of definition for what a good math student is and how a good math student behaves. She holds some picture of what others expect a good math student to be and to do. She holds a perspective on whether, according to the norms, she is a good math student or not. Students who arrive with the requisite signs to understand and/or engage in mathematical discussions will likely experience more *self-verification* of the good math student identity than those students

who do not. Whether or not a particular student has internalized the requisite signs is largely determined by the *models* s/he has encountered en route to the current class – including parents, past teachers, and peers. This will impact the student's identity standard for "good math student" as well as her sense of *self-efficacy*; hence her behavior, and her attitude toward mathematics. Also impacting behavior, environment, and attitude will be the *prominence* and *salience* of the good math student identity. Perhaps this individual favors her jock identity or her class clown identity or her BAD math student identity. Which ever identity receives the strongest degree of verification is likely to dominate. This, of course, is largely regulated by the feedback the student perceives from peers and the teacher, as well as parents.

Whether or not the teacher has acquired the requisite signs is largely determined by the *models* and experiences s/he has encountered en route to the current class. Like the student, this will impact the teacher's sense of *self-efficacy*; hence his/her behavior. His teacher identity standard will influence the activities and structure of the mathematics classroom and each student's sense of mathematical *self-efficacy*. His formal authority will determine the extent to which students are able to self-verify the good math student identities (and other identities) held by the members of his class.   Thus, <u>***the environment is shaped by the individual even as the individual shapes the environment.***</u>

Application of Theoretical Framework

The ideas described above guided the development of survey questions and focus group questions intended to elicit factors that students self identify as influencing the development of their attitudes toward mathematics. They narrowed the scope of my research to focus on student perceptions of social/environmental factors such as classroom environment, self-efficacy, and self-verification. This theoretical framework is well suited to the current topic as evidenced by the correlation between the theoretical components and the literature review discussed above. Overlaying the concepts of *model, self-efficacy, reciprocal determination of environment and self, multiple identities, prominence and salience, and self-verification* onto the composite model of influence on student attitudes, the diagram in figure 5 below emerges. Note that different colors are used to represent each of the theories only as a means to help readers visualize the applications of each theory (orange for Bandura's social learning theory, and yellow for identity theory). The letter in each box corresponds to the first letter of the concept the box represents. Exceptions are *prominence and salience* for which "PS" is used to reinforce the idea that both can be influenced simultaneously and *multiple identities* for which "Is" is used to distinguish from "M" for model. The lower case "s" is a reminder of plurality.

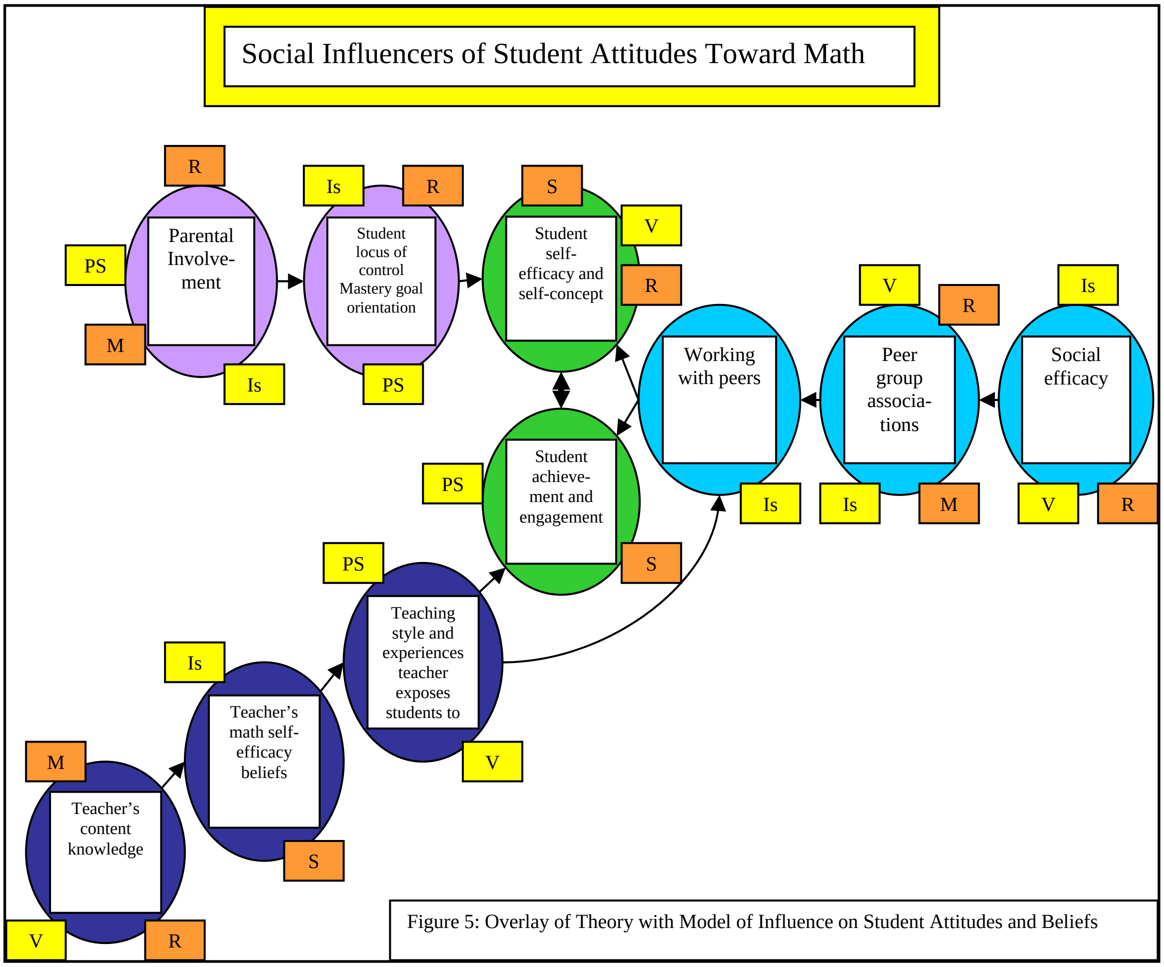

Figure 5: Overlay of Theory with Model of Influence on Student Attitudes and Beliefs

This lens will obscure the impact that other factors such as cognitive ability have on the development of student attitudes toward mathematics. As indicated above, the existing research on the development of student attitudes toward and beliefs about mathematics lack student voice and socio-cultural perspective. The next chapter describes the methodology intended for this study and will more explicitly demonstrate the socio-cultural character of this research.

CHAPTER 3

METHODS

Introduction to Methods

The purpose of the current study was to determine how students in Revere felt about mathematics, to what and to whom students attributed the development of their feelings about mathematics, and how stable their mathematics feelings were. I wanted to know whether or not Revere students liked math and why they thought they felt the way they did. In Chapter 4, I describe (generally and demographically) attitudes toward mathematics among Revere students in the fall of 2010. I was also interested in learning whether or not students felt their feelings had taken root over time or if they felt their attitude toward mathematics had fluctuated over the years. If attitudes fluctuate, how often does this occur? I wanted to understand the student's socio-cultural view of attitude development. My own impression, which is supported by the research outlined in Chapter 2, is that student attitudes about mathematics are influenced by teachers, parents, and peers. However, there is very little research that actually focuses on student perception of attitude development based on conversations with students.

I also wanted to understand the role that students felt their parents, teachers, and peers play in the development of their own attitudes toward mathematics. With such understanding, I would be able to infer which group(s) of individuals has the strongest impact on attitude from the students' perspectives. I anticipate this will vary by individual and will be influenced by the strength of association the individual has with the other actors but we need to know what students think. By understanding levels of stability, we can learn whether or not interventions (ie – a good teacher, peer group facilitation) can, from the students' perspectives, have a lasting positive impact.

Some of the questions that informed the development of survey and focus group questions include: How do students self-report their attitudes toward mathematics? Do students feel their attitude has always been the same or has it changed? If it changed, when did this happen? How often do student report their attitude changes? Which identities do students say they enact in the mathematics classroom? Do those students who have "good math student" identities achieve self-verification? To what extent do students think they influence what happens in mathematics class? To what extant do students think what happens in mathematics class shapes their attitudes toward mathematics? Are there some tasks in mathematics class that afford students self-efficacy? How do students describe such tasks? Does the description involve peer work? How much of a student's attitude toward school does s/he feel is based on his/her belief that s/he can (or not) do well in math? How do these things relate to the student's attitude toward the teacher? How do these things determine the classroom environment? Do

students attribute their attitude toward mathematics to signs their teachers gave them or to signs their parents gave them or to signs their peers gave them or to some combination of the three? If students describe a combination influence, whose signs have the most influence? Who do students say their models are? How do students recognize the signs from models? Are the signs inferred by students or made explicit? Some of these questions are appropriate to ask explicitly; others need to be *approached* through questions students will understand.

Survey and Focus Group Questions

To operationalize the ideas above, I developed the specific survey and focus group questions presented in Appendices A and B. Tables 1 and 2 below will guide the reader in understanding the associations between each question on the survey and each question in the focus groups and the current research questions through the theoretical lens. Statements of questions within the tables are abbreviated for efficient format. The focus group questions vary slightly for each of the “attitudes”. The questions in table 2 were specifically asked of students who said they like math. Differences for other groups are generally in the orientation of the question. For example, question 3 for students who said they do not like math is “was there ever a time you liked math”. As indicated above, the actual survey/focus group questions are available in the appendices and the actual research questions are available on page 11 of chapter 1.

Table 1

Guide to Survey Questions and How They Address Research Questions Using Theory

Survey question	Research question	Theoretical lens
1. What grade are you in?	N/A	N/A
2. What is your gender?	N/A	N/A
3. Which describes your attitude toward math right now	1. In what direction are RPS students attitudes toward math oriented?	Identity
4. Which best describes how you have felt about math over time?	3. How stable are RPS students' attitudes…	Identity, self-verification
5. Why do you think you feel this way about math?	3a. To what do students attribute reversals	Reciprocal det. of envi. and self., self-verification, self-efficacy
6. If you picked b, c, or d in #4, what grade(s) were you in when the change(s) happened?	3b. How long lasting do students report reversals to be	Self-verification
7. Does your mother/female guardian like math?	2a/b. Who/what experiences influences attitude	Models, identity
8. If you said YES or NO for #7, how do you know this?	2b. What experiences influence attitude	Reciprocal det. of envi. and self, salience, prominence
9. Does your father/male guardian like math?	2a/b. Who/what experiences influences attitude	Models, identity
10. If you said YES or NO for #9, how do you know this?	2b. What experiences influence attitude	Reciprocal det. of envi. and self, salience, prominence
11. Do most of your friends like math?	2a/b. Who/what experiences influences attitude	Models, identity
12. If you said YES or NO for #11, how do you know this?	2b/c. What experiences/classroom environment influence attitude	Reciprocal det. of envi. and self, salience, prominence
13. Do you think you are good at math?	1. In what direction are math attitudes oriented?	Self-concept, identity, self-verification
14. If you said YES or NO for #13, how do you know this?	2b. What experiences influence attitude	Self-efficacy
15. When you solve math problems, how sure are you that you got the right answer?	1. In what direction are RPS students attitudes toward math oriented?	Self-concept, identity, self-verification, self-efficacy
16. Are there any people in your life who you think have shaped your attitude toward math?	2a. Who influences student attitudes toward math	Models, identity
17. How do you know each of these people you listed in #16?	2a. Who influences student attitudes toward math	Models, identity
18. Is there anything else to help me understand how students come to like or dislike math?	2a/b. Who/what experiences influences attitude	To be determined
19. Will you be in a focus group?	N/A	N/A

Table 2

Guide to Focus Group Questions and How They Address Research Questions Using Theory

Focus group question	Research question	Theoretical lens
1. Students who said they like math on the survey said they like math because…What do you think about that?	2b. What experiences influence attitude	Self-concept, identity, self-verification
2. Was there any big event or experience that made you think "Gee, I really like math"? If so, what was it? [a]	2b. What experiences influence attitude	Self-concept, identity, self-verification
3. Was there ever a time that you didn't like math? If so, When?, What made it change?, Does it change often? If so, why?	3. How stable are attitudes/what causes reversals/how frequent	Self-concept, identity, self-verification
4. Tell me about the math classes you've been in. How were classes structured? (a lot of independent work, lecture, group work, projects, etc.), What kinds of class structures do you like the most? Why?,	2b/c. What experiences influence attitude/How does the classroom environment influence attitude	Reciprocal det. of envi. and self, salience, prominence
What role do you play in your math class? How do you influence what happens in class?, How does life outside of class impact action in class?, What role do teachers play in classes? , How does this vary with different teachers?		Identity, self-verification, Reciprocal det. of envi. and self
How does what happens in math class make you either like math more or like math less?, What happens if the work in math class is too hard/easy? How does this make you like math more/less?, What do you do if you're not sure how to solve a math problem? How important is the structure of the math class to making you either like or dislike math?		Identity, self-verification, self-efficacy, Reciprocal det. of envi. and self
5. Friends: Why do you think your friends like/dislike math? , What do your friends say/do that tells you this?, Does that impact how you feel about math at all?, Do you think how you feel about math influences your friends?	2a/b. Who/what experiences influences attitude	Models, identity
6. Parents/guardians: Why do you think your P/G like/dislike math?, What do your P/G say or do that let's you know this?, Does that impact how you feel about math?, Do you think how you feel about math influences your P/G?	2a/b. Who/what experiences influences attitude	Models, identity
7. Is there anyone else in your life who has influenced how you feel about math? If so, what did they say or do that influenced you?	2a/b. Who/what experiences influences attitude	Models, identity
8. Is there anything else you think you should explain that will help people understand how you came to like math and what/who influences your attitudes?	2a/b. Who/what experiences influences attitude	To be determined

[a]Students who have "no strong feelings" toward math were not asked question #2

These questions can be organized into three broad categories: Student attitudes toward mathematics and their self-efficacy beliefs about mathematics or ***Attitude and Self-Efficacy*** (survey questions 3,4,5,6,13,14,15 and focus group questions 1,2,3,4), students' perceptions of others' attitudes toward mathematics and how students perceive these people to influence their own attitudes toward math or ***People of Influence*** (survey questions 7,8,9,10,11,12,16,17 and focus group questions 5,6,7), and other information that students feel is relevant to the current study or ***Other Information*** (survey question 18 and focus group question 8).

Methodology

I used a sequential mixed methods approach in my study (Creswell, 2009). This methodology is well suited for two-phase studies, like the current study, in which a qualitative phase follows a quantitative phase (Creswell, 2009). My methodology included three phases of data collection. The first was completed without subject interaction as I reviewed student transcripts. This data was analyzed using the SPSS statistical software package. The two phases involving students followed in the form of a survey, then focus group discussions. Likert-type survey responses were analyzed using SPSS while responses to open-ended survey questions and focus group questions were analyzed using Weft QDA software program. The focus groups enabled me to probe deeper into how students feel their attitudes toward mathematics are influenced by others. They also enabled me to explore student belief systems about mathematics, the types of

learning environments the students feel foster positive attitudes toward mathematics, and any other factors that students feel foster positive attitudes toward mathematics. The latter emerged from students in the course of conversation. The focus group discussions lent clarity to and provide insight to the findings from the survey.

I used this methodology because neither the survey nor the focus groups alone would generate a clear picture of the students' attitudes and perspectives. The survey provided a large volume of data, which is necessary for effective analysis, but did not capture student voice. The focus groups captured small samples of student voice that alone would not be representative of the population of Revere High School juniors and seniors.

Participants

The participants for my study were students enrolled as juniors and seniors at Revere High School during the 2010-2011 school year. This included students in special populations including English Language Learners and special education students. Students who do not speak English as their first language were provided translational dictionaries in their own language to use during survey completion and focus group discussions. In addition, students who speak Spanish as their first language were provided surveys written in Spanish and invited to respond in Spanish. I excluded severe special needs students who do not participate in traditional mathematics classes as they would be unable to complete the survey and would not have had representative

mathematics learning experiences. I chose to work with students of this age because I feel their levels of maturity and experience compared to early high school or middle school students would mediate inhibitions that students may have about discussing their mathematics experiences.

Study Parameters and Time Line

The University of Massachusetts, Boston Institutional Review Board approved this study in September 2010. Both the Superintendent of Revere Public School and the Revere High School Principal granted permission for my research. The study began in October, 2010 with the mailing of consent forms to the parents/guardians of all juniors and seniors. My interactions with participants came in three forms. First, I looked at existing student performance data. This initial form of data collection did not involve direct contact with participants, but was used to group participants by performance category as will be described below. I also used these data to determine evidence of a particular grade(s) at which achievement changes. This numerical data analysis occurred during November and December of 2010.

Surveys were administered during the junior and senior English Language Arts study period between November 17, 2010 and November 24, 2010. Analysis of the survey data was completed in December 2010 and January 2011.

Focus group discussions were conducted on December 15, 2010. All conversations were videotaped and the videotapes were transcribed by an independent

contractor. Transcripts were coded and analyzed, as were responses to open-ended questions from the survey, using Weft QDA software. This qualitative analysis with quasi-statistical methods was completed in January and February of 2011.

The risk to participants in this study was minimal. Survey and focus group questions were vetted by the University of Massachusetts, Boston Institutional Review Board prior to my interaction with students.

Data Collection

My data collection began with extraction of demographic information and the historical mathematics grades of all juniors and seniors from our student information system, PowerSchool. I exported student names, addresses, mathematics grades, current school grade level (junior of senior), gender, English language learner status, and special education status into an Excel spreadsheet.

The student information system provided 750 names along with addresses to which I sent the consent forms. Consent forms for most students were sent in English; for limited or former limited English proficient students with Spanish as their first language, consent forms were sent in Spanish. The return of some mailed consent forms identifying wrong addresses and comparison to current enrollment numbers (381 juniors and 300 seniors) revealed I had un-enrolled students listed in my database. Investigation showed the extraction process included all students who had *ever* been enrolled in these

two classes, not just those students currently enrolled. When former students were removed, I was left with 683 subjects.

Between the start of this process and the organization of survey materials, 6 students withdrew from Revere High School and 4 students transferred into the junior or senior classes. Thus, the number of subjects was 681 – matching our current enrollment. Confident that my database accurately listed all possible subjects, I further refined the data by removing the records of students who would not be available or able to complete the surveys. These included severe special needs students who do not participate in traditional mathematics classes, students who are members of the senior class but not currently taking classes (these are typically kids who should have graduated the previous June but needed to return just for one last semester to make up credits), and students who were enrolled but had not been reporting to school (these are typically kids who transferred schools (often to their countries of origin) without completing the transfer process, or who dropped out). In this process, my number of subjects was further reduced by eighteen to 663. Of the 663 students, consent was denied for seventeen, thirty-five denied assent, twenty-one were absent when the surveys were administered, and two students withdrew from school on the day the surveys were administered. The final number of subjects thus became 588.

I used the random number generator in Microsoft Excel to assign a random code number to each student. While surveys were being administered, I created a second database in which I removed student names and addresses leaving just the randomly

generated code, historical grades, and demographic data (socio-economic status, grade level, ELL status and special education status). This new database would be augmented with any additional data collected and would be used for analysis. In this way, I could not link data to student names. I maintained the first database only to identify the names of focus group participants and deleted it once that task was completed. In the de-identified database I assigned each student to a performance category using the methods I describe in the next section.

Assignment to Performance Categories

In Revere, student grades are assigned as A+, A, A-, B+, B, B-, C+, C, C-, D+, D, D-, or F. Letter grades were converted to their numerical counterparts according to Table 3 below. Grade differences in consecutive school years were calculated by subtracting the more recent numerical equivalent from that of the previous school year for each pair of consecutive years. This process yielded the direction and magnitude of any grade change for each participant.

Table 3

Letter Grade to Numerical Conversions

Letter Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
Numerical equivalent	12	11	10	9	8	7	6	5	4	3	2	1	0

Using this data, students were assigned to one of ten performance categories based on the historical trend in their year-end mathematics grades while enrolled in the Revere Public Schools from fourth grade on. I chose to start with fourth grade because research shows student attitudes toward mathematics decline through the middle school years (Wilkins & Ma, 2003) and attitude impacts achievement (Reyes, 1984; Wilkins, 2004). By looking at grades from upper-elementary years through high school, I hope to capture any fluctuation in attitude through achievement.

The first three of ten performance categories are characterized by ***significant*** changes in grades. ***Significant-change-positive*** and ***significant-change-negative*** categories include students who have demonstrated at least a four grade increase or decrease in consecutive year-end mathematics grades at any point from fourth grade on. An example of ***significant-change-negative*** step is going from an A at one year end to a B- at the next year end (since this means the student's consecutive year-end grades jumped down four steps in consecutive years, with the steps being those from A to A-, from A- to B+, from B+ to B, and from B to B-). An example of a ***significant-change-positive*** is going from a D- to a C in consecutive years since this means moving through the four steps from D- to D, D to D+, D+ to C-, and C- to C. Students assigned to these performance categories would have traversed five letter grades, including the + and – increments, from one end of year grade to the next end of year grade.

I selected the width of this grade change interval because the drastic change was likely to resonate with students and their parents. I anticipated that these students would

be acutely aware of what was happening at the time of the grade change. This awareness would assist in the student's ability to articulate self-perceptions of the learning environment and the influence others may have had on their achievement. Students in this group may have had just one significant grade change or could have multiple significant grade changes. Students whose grades fluctuated significantly over the years were assigned to a third category that I called ***significant-fluctuating***.

The fourth, fifth, and sixth performance categories were populated by students I call ***gradual*** change students. These are students who demonstrated more gradual increases (***gradual-change-positive***) or decreases (***gradual-change-negative***) in final grade or whose grades fluctuated by small margins over the years (***gradual-fluctuating***). Such students might have demonstrated a four grade change over a number of years or they may have stayed within a narrower band of grade range. These students may not have been as aware of the factors that influenced grade fluctuations/changes because of the gradual nature of the change.

I named the seventh, eighth, and ninth performance categories ***consistently-high***, which I define as grades always at or above a B-, ***consistently-average***, which I define as grades always between a C- and a B-, and ***consistently-low***, which I define as grades always at or below a C-. I have intentionally overlapped the end points of these performance ranges as my experience shows students with typically consistent grades might have one or two aberrant grades that straddle the typical definitions of high (A/B range), average (C range), and low (D/F range). I was somewhat skeptical about finding

a body of students who performed at the consistently low level. This is because of historically subjective assignment of grades (typically C or above) at the elementary level and because of the non-standards based grading systems common in our schools (Wiggins, 1994). This data will be discussed in more depth below results show only five students fell into the consistently-low performance category.

The final performance category was created for students for whom I had too few grades to determine a performance trend. These students were assigned to a category I called ***fewer-than-four-grades.***

Survey

Although on-line survey systems were considered for completion of the survey, a traditional paper and pencil form was deemed most suitable as the school does not have the computer capacity to support an on-line administration in an appropriate time frame. I printed three labels for each student. Two labels had just the student's randomly generated code; the third had both the code and the student's name. I created a survey packet for each student which included a cover page to which I affixed the code label with the student's name. The cover page was otherwise blank. I affixed the labels with just student codes to each page of the survey. Information about my research study and request for assent were included on the first page of the survey. Each packet also contained an essay prompt as an alternative assignment to the survey. Students for whom consent was not granted received only the essay prompt in their packets. Such essay

assignments are commonly given during the study hall as some students report without work to complete; students would not find such an assignment to be unusual. Surveys for most students were in English; for limited or former limited English proficient students with Spanish as their first language, surveys were in Spanish.

I collaborated with the high school principal to determine the least intrusive means to administer the surveys. We decided, as indicated above, that the English Language Arts (ELA) study hall would be best for both the school and the study for several reasons. First, administration by the English teacher would minimize bias that might have resulted if the math teacher administered the surveys. Second, administration during a study hall would have the least impact on instructional time. Finally, all juniors and seniors are enrolled in ELA so I would be assured of reaching all subjects. I met individually or in small groups with all junior and senior English teachers to describe my research, to answer any questions they had about the research or the survey process, and to brainstorm any issues they surfaced with my plan. All teachers reported they felt the plan was sound, implementable, and would not negatively impact their instruction.

Survey responses were adjoined to demographic and performance data in my de-identified Excel spreadsheet using the randomly generated student code to link entries. With all data thus compiled, I imported the spreadsheet into SPSS for analysis of Likert-type questions using crosstab tables with Chi-Square tests to determine associations between variables. I also disaggregated the data by performance level, gender, English language learner status, special education status, current grade (junior and senior), and

self-identified attitude toward mathematics and repeated the tests in the disaggregated groups in which enough data were available.

Focus Groups

The final question on the survey asked students if they were willing to participate in focus group discussions to enhance my understanding of how students feel their attitudes toward mathematics are developed and influenced by others. One hundred and ninety-six of the five hundred and eighty-eight students (33%) who completed the survey agreed to participate in the focus group discussions (consent had been granted as part of the original solicitation to parents/guardians).

Because I wanted to ensure my focus groups comprised the range of ten performance categories and three self-described attitude toward mathematics categories (identified in question 3 of the survey – I like math, I don't like math, I have no strong feelings either way), I used stratified random sampling techniques to determine which of the one hundred and ninety-six students who indicated interest actually participated in the focus groups. Stratified random sampling is an effective means to ensure that all categories (or strata) of a population are represented in a sample and is particularly useful when, as with the current study, one or more of the categories is underrepresented in comparison to other categories (Gall, et al, 2007). I sorted the focus group candidates first by their attitude toward math, then by their performance category. Two students did not answer question 3 so they were eliminated from focus group participation. Table 4

below shows the number of students from those who agreed to participate in the focus groups stratified by self reported attitude toward mathematics and performance category. Comparison of the number of possible focus group candidates in the “I don’t like math, consistently high” category to the number of possible focus group candidates in “I like math, consistently high” reveals the need for stratified random sampling.

Table 4

Number of Focus Group Candidates by Attitude and Performance Category

PerfLev * FocusYesAtt Crosstabulation

Count

		FocusYes/Attitude			Total
		I don't like math	No strong feelings	I like math	
PerfLev	Con Avg	2	1	0	3
	Con High	1	2	23	27
	Con Low	2	2	1	5
	Fewer than 4 grades	3	2	10	15
	Grad Fluc	1	1	7	10
	Grad Neg	1	2	14	17
	Grad Pos	0	1	4	5
	Sig Fluc	8	6	25	39
	Sig Neg	16	16	21	53
	Sig Pos	6	3	13	22
Total		40	36	118	194

My intent was to create six focus groups, two for each attitude category, including a student from each performance category in each focus group. Analysis of student

responses revealed some categories under represented or not represented at all. For example, among students who reported "I don't like math" as their attitude and who agreed to participate in the focus groups, only one student demonstrated *consistently-high* performance and no students demonstrated *gradual-change-positive* performance. In categories where exactly two students were candidates for participation, both were selected. In categories where exactly one student was a candidate for participation, s/he was selected and one of the two focus groups representing his/her attitude toward mathematics category was under-represented. Where more than two candidates were available, a random number generator was used to select the two participants. I will discuss participation and representation in more depth below. Through this process, forty-seven students were identified and assigned to one of six focus groups.

Focus groups were conducted in succession on one day by an independent consultant and were videotaped. I notified all teachers whose class each student would miss and provided a list of student names to their vice principals for attendance purposes. All teachers involved agreed to assist students with any missed work. One student opted not to participate reducing the number of focus group participants to forty-six. Four students selected for participation were absent on the day the focus groups were conducted. This reduced the actual number of participants to forty-two (7% of eligible subjects).

Focus group questions served the purpose of allowing students to provide more detail about how they felt their attitudes toward mathematics developed and who they

thought influenced their attitudes. Through the focus group conversations, I also hoped to better understand how often students felt their attitudes toward math changed so I could attempt to describe the stability of attitude. As indicated above, conversations were videotaped, transcribed, and coded for analysis using the Weft QDA software program.

Conclusions and Limitations

Using three sources of data – survey questions, grade performance data, and focus group discussions – enabled me to identify consistencies and discrepancies in my data. The focus group discussions clarified initial discrepancies that emerged from the first two data sources. Quasi-statistical methods, which include simple numerical analysis to support the extent to which a claim from qualitative data is evident, were applied to the coded focus-group data to support conclusions (Maxwell, 2005).

Almost six hundred academic transcripts were analyzed in the initial data collection process. Gall, Gall, and Borg (2007) cite Seymore Sudman in suggesting "a minimum of 100 participants in each major subgroup and 20 to 50 in each minor subgroup" for survey analysis (p.176). For the current study, major subgroups included grade level and gender. Minor subgroups included SES status, special education status, and ELL status. Each value of all variables exceeded the minimum number of participants defined above, thus the sample size was adequate.

Because all subjects were from my district, the scalability of my findings is questionable. This study would need to be replicated in other urban as well as rural and

non-urban districts to confirm universality of the findings. However, it is reasonable to infer that replication of this study in districts with students who are demographically similar to those in Revere will have similar findings.

Some would say that additional limitations result from researcher bias due to my close association with the district and subject area (mathematics) of my study. By surfacing this concern and being mindful of it throughout the data collection and analysis process, I minimized its impact. I feel my passions also enhanced the study as they exemplify my interest in the topic and dedication to finding answers that will positively impact student attitudes. It is impossible, and many researchers say unnecessary, for a researcher to completely detach herself from the study she is conducting. As Maxwell (2005) puts it, “Separating your research from other aspects of your life cuts you off from a major source of insights, hypotheses, and validity checks” (p.38).

A goal of this study was to accentuate student voice. Focus groups most effectively enabled me to achieve this goal. I considered other methods throughout the process of developing my research topic, conducting my literature review, and writing my methods section. Observation was dismissed as it would not amplify the students’ perspective; rather my own which is not a primary interest of this study. Also, observation in classrooms of which I am not typically a part could result in variation from typical behavior and skew any conclusions I may have drawn from the observation. I dismissed individual interviews because research shows interactions among multiple participants, as with focus groups, encourages the sharing of feelings and beliefs that

individuals are unlikely to express during one-on-one interviews (Gall, et al., 2007). As indicated above, the survey generated a representative sample of student opinions and the focus groups ensured I understand what *students think* about the socio-cultural development of their attitudes toward mathematics.

CHAPTER 4

ANALYSIS

Introduction

In this chapter, I describe the data and identify trends in the data. I also connect these trends to the theoretical framework described in Chapter 2. I began my data analysis by looking at the demographic and performance level data. In doing so, I was better positioned to view the survey and focus group data in disaggregated form. I initially planned to analyze select survey and focus group questions together under the three broad themes described in Chapter 3 (see p.60). However, student responses to the focus group questions revealed different trends than expected. In order to feature the key aspects of student responses to focus group questions, I will analyze the survey questions according to the three broad themes; then analyze the focus group data separately; engaging student voice to enhance the survey findings.

Data was analyzed using SPSS to compare student performance levels with gender, grade level, SPED/ELL status, socioeconomic status and survey response variables. Throughout this section, when I refer to "students", I am referring to juniors and seniors enrolled in Revere High School at the time this study was conducted.

Description of Possible Values of Variables

Performance categories, defined in chapter 3, are indicated by the abbreviations Sig Pos (significant-change-positive), Sig Neg (significant-change-negative), Sig Fluc (significant-fluctuating), Grad Pos (gradual-change-positive), Grad Neg (gradual-change-negative), Grad Fluc (gradual-fluctuating), Con High (consistently-high), Con Avg (consistently-average), Con Low (consistently-low), and Fewer-than-4-grades. Gender is either male or female and grade is either 11 or 12.

Students fall into one of three categories of ELL status. Some have no ELL status indicating they are not now nor have they ever received ELL services. For these students the ELL Status is blank. Students with ELL status “1” currently receive ELL services while students with ELL status “2” no longer receive ELL services but did in the past. Students with ELL status enrolled in the district without a command of the English language as demonstrated through testing upon enrollment. These students immigrated to the United States from other countries and did not learn English as their primary language. As such, they receive English language support in addition to (in some cases in place of) the traditional curriculum until they demonstrate a level of proficiency in reading and writing to exit the ELL program. Similarly, special education (SPED) status was left blank for students who do not currently receive special education services and recoded as “1” for students who do. Students with SPED status have an IEP as described on page 37 in Chapter 2.

Finally, socio-economic status (SES) is blank for students with high SES, recorded as “R” for students with reduced lunch status, or recorded as “F” for students with free lunch status. Students with high status qualify for neither free nor reduced lunch. These designations are made based on a formula developed annually by the federal government that considers household income and number of family members[3].

Demographics

Simple frequencies in SPSS were used to identify demographic distributions of students. Subjects are split almost evenly by gender. A larger percentage of subjects (53.8%) are juniors versus 46.9% seniors. This follows the enrollment numbers as the junior class has a larger enrollment than the senior class. Subjects comprise 82% of the entire junior class enrollment and 92% of the entire senior class enrollment. These are both very high percentages and provide some assurance that responses are representative of both cohorts of students. I attribute the lower percentage of juniors in part to the fact that sixteen of the seventeen parents who did not grant consent were parents of juniors. I speculate that these parents are still more protective of their younger students than are the parents of seniors. 16.7% of subjects have English Language Learner status, 5.8% receive special education services, and 69.1% have low socio-economic status as indicated by their free (56.5%) or reduced (12.6%) lunch status. With the exception of

[3] Figure 6 in Appendix C shows the income guidelines for 2010-2011 which remained the same as the previous school year (United States Department of Agriculture, 2010).

the special education statistic, these metrics align with district data. I attribute the lower percentage of special education students to my intentional exclusion of severe special needs students from this study and to the matriculation of students out of special education programs as they age.

Performance Category Results

Table 5 below shows the number and percentage of students in each of the ten performance categories I created. Almost half (49.5%) of the students have demonstrated either significant fluctuations in grades (26.7%) or a significant negative change (22.8%) in grades between 4th grade and their current grade. An additional 15.5% of students have demonstrated either gradual fluctuations in grades (7.8%) or a gradual negative change (7.7%) in grades between 4th grade and their current grade. 2% of students perform consistently low. These data are significant as they demonstrate that two-thirds of students (67%) struggle to maintain higher grades (relative to their own historical performance); some unsuccessfully. Only 27.6% of students' performances can be described as good or improving. No performance trend could be identified for 5.4% of students due to insufficient historical grade data.

Table 5

Frequencies and Percentages of Performance Categories

	PerCategory			
		Frequency	Valid Percent	Cumulative Percent
Valid	Con Avg	14	2.4	2.4
	Con High	74	12.6	15.0
	Con Low	12	2.0	17.0
	Fewer than 4 grades	32	5.4	22.4
	Grad Fluc	45	7.7	30.1
	Grad Neg	46	7.8	37.9
	Grad Pos	17	2.9	40.8
	Sig Fluc	157	26.7	67.5
	Sig Neg	134	22.8	90.3
	Sig Pos	57	9.7	100.0
	Total	588	100.0	

Although these data do not speak directly to student attitudes toward math, research shows that declining and poor performance negatively impact attitude (Reyes, 1984; Wilkins, 2004). The negative trend in student performance data for Revere High School students does not bode well for increasing STEM interest among Revere students and could contribute to the lower proportion of Revere students choosing STEM majors compared to state and national trends as described in chapter 1. I now turn to the survey data to determine, among other things, if any associations between performance and attitude become evident.

Survey Results

Survey questions will be analyzed within the three broader themes described in Chapter 3: ***Attitude and Self-efficacy, People of Influence***, and ***Other Information***.

Attitude and Self-efficacy

One of the reasons that attitude and self-efficacy are difficult to pin point is that they are very complex constructs. Both are impacted by innumerable internal and external factors (Bandura, 1997). Identities develop to define the individual through our attitudes and self-efficacy beliefs. The next section of survey analysis is rather complex. I explore *Current Attitude Toward Mathematics, Attitudes Over Time Toward Mathematics*, and mathematical *Self-efficacy and Self-concept Beliefs* in succession. I look to open-response survey questions to explore factors that students attribute to their current attitudes toward math, to their long term attitudes toward math, and to their mathematical self-efficacy and self-concept beliefs. The data reveal that these three areas are closely related as described in chapter 2.

Current Attitude Toward Mathematics

Responses to survey question 3 in which students reported their current attitude toward mathematics are summarized in Table 6 below[4]. This question speaks to my first research question: "In what direction are Revere Public School students' attitudes toward

[4] Three students did not report their current attitude toward mathematics; analysis is based on the 585 responses provided.

math oriented?" Analysis reveals that a slight majority (51.5%) of Revere High School juniors and seniors reported that they like math.

Table 6

Distribution of Student Attitudes Toward Mathematics

Student Attitudes				
		Frequency	Valid Percent	Cumulative Percent
Valid	I don't like math	136	23.2	23.2
	I like math	301	51.5	74.7
	No strong feelings	148	25.3	100.0
	Total	585	100.0	

Although crosstab analysis of attitude toward math with various demographics shows some differences in percentages, subsequent analysis including Chi-Square tests of extreme attitude beliefs (I like math and I don't like math) with disaggregated data evidenced no significant relationship between grade level, socio-economic status, ELL status or SPED status and attitude.[5]

Analysis did show that the relationship between attitude toward mathematics and gender is statistically significant. Crosstab table 11 below shows that, of students with strong feelings about math, a greater percentage of girls (35.2%) reported "I don't like math" compared to just 26.5% of boys. Similarly, more boys (73.5%) report they like math compared to girls (64.8%). This difference is statistically significant at the .05

[5] See tables 7 through 10 in Appendix C.

level. Such a relationship was not evident when each of the extreme attitudes toward mathematics was compared to the "no strong feelings either way" category by gender.

The relationship between attitude toward mathematics and gender is consistent with earlier research describing the demographic characteristics of students who choose to study STEM fields as, among other things, male (Chen, 2009). Further analysis of qualitative data, explored later in this chapter, lent no insight to this association. This is a topic suggested for future research.

Table 11

Crosstab Analysis of Extreme Attitude Toward Mathematics with Gender

Gender * Attitude Crosstabulation

			Attitude		Total
			I don't like math	I like math	
Gender	Female	Count	82	151	233
		% within Gender	35.2%	64.8%	100.0%
	Male	Count	54	150	204
		% within Gender	26.5%	73.5%	100.0%
Total		Count	136	301	437
		% within Gender	31.1%	68.9%	100.0%

Note. X2 (1, N=437) = 3.86, p = .049

Attitude toward mathematics also appears to be very strongly related to performance. Table 12 shows that only students with consistently low performance indicated "I like math" with less frequency than "I don't like math' or "I have no strong

feelings either way". In all other performance categories, "I like math" was the most common response. Students who perform consistently high and who have gradual grade

Table 12

Crosstab Analysis of Attitude Toward Mathematics with Performance Category

PerCategory * Attitude Crosstabulation

			Attitude			Total
			I don't like math	No strong feelings	I like math	
PerCat	Con Avg	Count	5	4	5	14
		% within PerCat	35.7%	28.6%	35.7%	100.0%
	Con High	Count	6	10	57	73
		% within PerCat	8.2%	13.7%	78.1%	100.0%
	Con Low	Count	4	5	3	12
		% within PerCat	33.3%	41.7%	25.0%	100.0%
	Fewer than 4 grades	Count	7	6	19	32
		% within PerCat	21.9%	18.8%	59.4%	100.0%
	Grad Fluc	Count	6	17	21	44
		% within PerCat	13.6%	38.6%	47.7%	100.0%
	Grad Neg	Count	13	10	23	46
		% within PerCat	28.3%	21.7%	50.0%	100.0%
	Grad Pos	Count	3	2	12	17
		% within PerCat	17.6%	11.8%	70.6%	100.0%
	Sig Fluc	Count	41	35	80	156
		% within PerCat	26.3%	22.4%	51.3%	100.0%
	Sig Neg	Count	36	43	55	134
		% within PerCat	26.9%	32.1%	41.0%	100.0%
	Sig Pos	Count	15	16	26	57
		% within PerCat	26.3%	28.1%	45.6%	100.0%
Total		Count	136	301	148	301
		% within PerCat	23.2%	25.3%	51.5%	51.5%

change in a positive direction are far more likely to report “I like math” than either of the other two options (78.1% and 70.6% respectively). Interestingly, students with significant positive grade change (a sudden positive grade change) did not demonstrate this characteristic; only 45.6% of these students reported “I like math”. These students with sudden increase in grade may not have experienced mathematical success with enough frequency to fully identify with the role of “good math student”. Perhaps such an identity has not established itself in the students’ prominence hierarchies.

To further assess any relationship between Attitude and performance, I clustered the performance categories directionally, excluded neutral responses, and conducted Chi-Square tests. The two clustered performance categories were ***Up*** (Con High combined with Grad Pos and Sig Pos) and ***Down*** (Con Low combined with Grad Neg and Sig Neg). As Table 13 below shows, this relationship has very strong statistical significance. Students with positive attitudes toward math have higher performance and students with negative attitudes toward math have lower performance. Likewise, we could say that students with high performance have more positively oriented attitudes toward math while students with low performance have negatively oriented attitudes toward math.

Table 13

Crosstab Analysis of Extreme Attitude Toward Mathematics with Clustered Performance Category

ClusteredPerf * Attitude Crosstabulation

			Attitude		Total
			I don't like math	I like math	
ClusteredPerf	Down	Count	53	81	134
		% within ClusteredPerf	39.6%	60.4%	100.0%
	Up	Count	24	95	119
		% within ClusteredPerf	20.2%	79.8%	100.0%
Total		Count	77	176	253
		% within ClusteredPerf	30.4%	69.6%	100.0%

Note. X2 (1, N=253) = 11.18, *p* = .001

Attitude Over Time Toward Mathematics

In question 4 of the survey, students were asked to describe their long-term feelings toward mathematics which are displayed below in Table 13[6,7]. Student responses here will inform my third research question: "How stable are Revere Public School students' attitudes toward mathematics?" The largest percentage (34.6) of students reported "I've always liked math". However, when the percentages of students reporting various attitude changes ("flip-flops between liking and not liking math" with "I used to like math but I don't anymore" and "I used to dislike math but now I like it")

[6] See prompt in Appendix A
[7] One student did not respond to this question and therefore is excluded from this analysis.

are combined we see that almost half of the students (47.3%) reported change(s) in attitude orientation; evidencing instability in student attitudes toward mathematics.

Table 14

Distribution of Student Attitudes Toward Mathematics Over Time

		Frequency	Valid Percent	Cumulative Percent
		AttitudeOverTime		
Valid	always liked	203	34.6	34.6
	didn't do	46	7.8	42.4
	flip-flop	165	28.1	70.5
	never liked	71	12.1	82.6
	never strong feelings	35	6.0	88.6
	used to don't	67	11.4	100.0
	Total	587	100.0	

Within demographics, differences were evident by gender[8]. Table 15 shows that boys (40.1%) were far more likely to say they have always liked math than girls (29.7%). Girls (31.4%) also reported their attitude toward math flip-flops more than boys (24.8%). These results are consistent with the data on current attitudes toward mathematics. Combined they indicate that efforts to engage female students and increase their interest in STEM fields may not be garnering the desired results.

[8] See tables 16-19 in appendix C for crosstabs of Attitude Over Time with SES level, ELL Status, SPED status and grade.

Table 15

Crosstab Analysis of Attitude Over Time with Gender

Gender * AttitudeOverTime Crosstabulation

			AttitudeOverTime						Total
			always liked	didn't do	flip-flop	never liked	never strong	used to don't	
Gender	Female	Count	90	29	95	41	11	37	303
		% within Gender	29.7%	9.6%	31.4%	13.5%	3.6%	12.2%	100.0%
	Male	Count	113	17	70	29	24	29	282
		% within Gender	40.1%	6.0%	24.8%	10.3%	8.5%	10.3%	100.0%
Total		Count	203	46	165	70	35	66	585
		% within Gender	34.7%	7.9%	28.2%	12.0%	6.0%	11.3%	100.0%

These results were confirmed when I re-analyzed responses grouped by extreme opinion and excluded neutral responses. For this analysis, I clustered the changing attitudes (didn't like math but now I do, my attitude toward math flip-flops, and I used to like math but now I don't) into one group called ***Change***. Students who reported they have never had strong feelings either way were excluded. Within clustered responses, gender was the only demographic for which differences were apparent and Chi-Square tests indicate statistical significance in this difference. These results are shown in Table 20 below:

Table 20

Crosstab Analysis of Clustered Attitude Over Time with Gender

Gender * ClustAttOT Crosstabulation

			ClustAttOT			Total
			always liked	change	never liked	
Gender	Female	Count	90	161	41	292
		% within Gender	30.8%	55.1%	14.0%	100.0%
	Male	Count	113	116	29	258
		% within Gender	43.8%	45.0%	11.2%	100.0%
Total		Count	203	277	70	550
		% within Gender	36.9%	50.4%	12.7%	100.0%

Note. X2 (2, N=550) = 9.91, p = .007

The instability of attitude described above with 47.3% of students indicating some change in attitude over time (see Table 19) is echoed in analysis of attitude over time with current attitude toward mathematics[9]. As table 21 below shows, only 63.8% of students who responded "I like math" said "I've always liked math". The percentages for "I don't like math" with "I've never liked math" and "I don't have strong feelings either way" with "I've never had strong feelings either way" are 48.5% and 19.6% respectively.

The table also shows inconsistency in some student responses. For example, three students responded "I don't like math" and responded "I used to dislike math but now I like it." Another nine students who responded "I like math" also responded "I used to like math but I don't anymore." Further analysis reveals that three of these twelve students

[9] Two additional students who did not report a current attitude toward mathematics are excluded from this analysis.

Table 21

Crosstab Analysis of Attitude Over Time with Attitude Toward Mathematics

Attitude * AttitudeOverTime Crosstabulation

			AttitudeOverTime						Total
			always liked	didn't do	flip-flop	never liked	never strong	used to don't	
Attitude	I don't like math	Count	1	3	27	66	5	34	136
		% within Attitude	.7%	2.2%	19.9%	48.5%	3.7%	25.0 %	100.0%
	No strong feelings	Count	10	4	78	4	29	23	148
		% within Attitude	6.8%	2.7%	52.7%	2.7%	19.6%	15.5%	100.0%
	I like math	Count	192	39	60	0	1	9	301
		% within Attitude	63.8%	13.0%	19.9%	.0%	.3%	3.0%	100.0%
Total		Count	203	46	165	70	35	66	585
		% within Attitude	34.7%	7.9%	28.2%	12.0%	6.0%	11.3%	100.0%

have ELL status; language may have been a barrier for them in responding to these two questions. I can not determine a reason for the inconsistent responses of the remaining students.

To confirm this relationship, I used the same grouping of attitudes over time with changing attitudes clustered into one group called ***Change*** as described above and excluded neutral responses to both attitude and attitude over time. Chi-Square tests of the relationship between attitude over time and attitude toward mathematics, shown in table 22 below, reveal 2-sided asymptotic significance of .000 demonstrating that students'

attitudes toward mathematics are related to their attitudes toward mathematics over time. The significance remained when layered with the demographics of ELL status, SPED status, SES status, grade, and gender. Thus, the association between current attitude toward mathematics and attitude over time is consistent across demographics. In these data, we see evidence of instability of student attitudes toward mathematics. In an effort to increase the number of students with positively oriented attitudes, this is a good indication as students are showing that their attitudes *do* change at times. When and how these attitude changes occur will be explored later in this chapter.

Table 22

Crosstab Analysis of Clustered Attitude Over Time with Extreme Attitude

Attitude * ClusteredAttOverTime Crosstabulation

			ClusteredAttOverTime			Total
			always liked	Change	never liked	
Attitude	I don't like math	Count	1	64	66	131
		% within Attitude	.8%	48.9%	50.4%	100.0%
	I like math	Count	192	108	0	300
		% within Attitude	64.0%	36.0%	.0%	100.0%
Total		Count	193	172	66	431
		% within Attitude	44.8%	39.9%	15.3%	100.0%

Note. X2 (2, N=431) = 236.35, *p* = .000

Analysis of attitude over time with performance category is displayed in Table 23 which shows that across performance categories, students are most likely to say they either have always liked math or they flip-flop between liking and not liking math. The

Table 23

Crosstab Analysis of Attitude Over Time with Performance Category

PerCategory * AttitudeOverTime Crosstabulation

			AttitudeOverTime						Total
			always liked	didn't do	flip-flop	never liked	never strong	used to don't	
Per Category	Con Avg	Count	5	2	2	3	2	0	14
		% within PerCategory	35.7%	14.3%	14.3%	21.4%	14.3%	.0%	100.0%
	Con High	Count	42	4	17	2	4	4	73
		% within PerCategory	57.5%	5.5%	23.3%	2.7%	5.5%	5.5%	100.0%
	Con Low	Count	1	2	3	3	1	2	12
		% within PerCategory	8.3%	16.7%	25.0%	25.0%	8.3%	16.7%	100.0%
	Fewer than 4	Count	14	3	8	5	1	1	32
		% within PerCategory	43.8%	9.4%	25.0%	15.6%	3.1%	3.1%	100.0%
	Grad Fluc	Count	14	7	11	5	3	4	44
		% within PerCategory	31.8%	15.9%	25.0%	11.4%	6.8%	9.1%	100.0%
	Grad Neg	Count	11	2	16	7	5	5	46
		% within PerCategory	23.9%	4.3%	34.8%	15.2%	10.9%	10.9%	100.0%
	Grad Pos	Count	7	1	4	0	1	4	17
		% within PerCategory	41.2%	5.9%	23.5%	.0%	5.9%	23.5%	100.0%
	Sig Fluc	Count	53	15	39	24	9	16	156
		% within PerCategory	34.0%	9.6%	25.0%	15.4%	5.8%	10.3%	100.0%
	Sig Neg	Count	39	6	47	16	4	22	134
		% within PerCategory	29.1%	4.5%	35.1%	11.9%	3.0%	16.4%	100.0%
	Sig Pos	Count	17	4	18	5	5	8	57
		% within PerCategory	29.8%	7.0%	31.6%	8.8%	8.8%	14.0%	100.0%
Total		Count	203	46	165	70	35	66	585
		% within PerCategory	34.7%	7.9%	28.2%	12.0%	6.0%	11.3%	100.0%

large number of cells in the table results in extensive stratification of the data. To better assess the relationship between attitude over time and performance, I aggregated the responses and analyzed these measures within the clustered attitudes over time and clustered performance groups described above. Chi-square tests support a very strong association between these variables as shown in Table 24. Also of interest, students with changing attitudes are far more likely to show low/decreasing performance (62.1%) than high/increasing performance (37.9%).

Table 24

Crosstab Analysis of Clustered Attitude Over Time with Clustered Performance Category

ClustPerf * ClusteredAttOverTime Crosstabulation

			ClusteredAttOverTime			Total
			always liked	Change	never liked	
ClustPerf	Down	Count	51	105	26	182
		% within ClustPerf	28.0%	57.7%	14.3%	100.0%
	Up	Count	66	64	7	137
		% within ClustPerf	48.2%	46.7%	5.1%	100.0%
Total		Count	117	169	33	319
		% within ClustPerf	36.7%	53.0%	10.3%	100.0%

Note. X2 (2, N=319) = 16.80, *p* = .000

Question 5 of the survey refers back to question 4 and asks students: “Why do you think you feel this way about math?” In their open-ended responses to this question, two main themes emerged. As a primary characteristic, 82% of students mentioned self-efficacy and self-concept beliefs, the content, or their teachers as a conduit of their

attitudes toward mathematics. As a secondary characteristic, 62% of comments involved the student's level of comprehension, his/her own ability, or the degree of difficulty s/he perceived in the content.

Students who referenced themselves wrote comments like, "I never understand what is going on", "It's just not my strong suit" or on the opposite end of the spectrum, "because I've always been good at it" or "It's just easy for me to do". Overall, 32% of students made such comments. When disaggregated by attitude toward mathematics, the percentage dropped to 24 for students who have *no strong feelings either way* toward math. It climbed to 35% for students who *don't like math* and 34% for students who *like math.* When analyzed more closely, the secondary characteristics of these comments reveal a telling trend. For students who like math, the self comments were most frequently (26%) in reference to ability. Only 9% referenced comprehension. Students who like math made far more comments like "I'm good at it" as opposed to "I understand it". These students reveal high self-concept regarding mathematics. That is, they describe themselves as able math students. In contrast, only 12% students who say they do not like math referenced lack of ability whereas 21% referenced lack of comprehension – a self-efficacy trait. These students were more likely to say "I don't understand it" as opposed to "I'm not good at it". Students with negatively oriented attitudes toward mathematics attribute their attitudes to self-perceptions that they will not successfully complete mathematical tasks where as students with positively oriented attitudes toward math attribute their attitudes to who they are as individuals. Students

with no strong feelings about math were somewhat more oriented toward comprehension than ability (19% compared to 13% respectively). However, these students made more neutral comments like “because sometimes I understand the topics and sometimes I don't” and “I am not particularly good or bad at it”. In general, their responses were as non-committal as their attitudes toward math!

Students who attribute their attitudes to the content made comments like, “It’s hard”, “Its boring and you don't use it in life”, or “Well, it depends on what lesson I'm on. For example, I don't like rational or irrational numbers, but I like doing statistics”. Overall, 32% of students commented on the content of their math courses. Students who don’t like math (35%) or who have no strong feelings either way (35%) were slightly more likely to reference content than their peers who like math (29%). The most common comments referenced the degree of difficulty of the content (25%). The orientation of the comments (easy versus hard) followed the orientation of attitude. Other repeated comments about content referenced whether it was fun/interesting/boring (15%) and the utility/universality of mathematics (9%). Again, orientation of comments followed the orientation of the student’s attitude toward math. One can infer that these students are more external in their locus of control. The students who don’t like math and who have no strong feeling either way have less sense that they control the events that affect them than do their peers who say they like math. Thus, they describe their attitudes in reference to the material rather than themselves. Since locus of control impacts self-efficacy beliefs and attitude, these student responses are telling.

Regarding teachers, most students made innocuous comments like, “It depends on the teacher. Some teachers can teach really well while others can't teach at all”. Just under half (46%) of teacher comments were similar to this. The remaining 54% of comments; however, were quite pointed with either a negative tone (“cuz my teachers don't know how to explain anything”) or a positive tone (“My teachers have a big part in why I like the subject. The teachers teach it in a fun way, and it's easier to understand”). Unfortunately, there were almost twice as many negatively themed comments as there were positively themed comments. Overall, 18% of students linked their attitudes toward mathematics to their teachers. The comments that students made attributing their attitudes to their teachers also demonstrate external locus of control. The lower percentage of students who attribute their attitudes to their teachers compared to the content indicates our efforts to improve attitudes would have more impact if we work on students’ beliefs in the area of the content.

While no students mentioned their peers as a source of attitude influence, 8 students did mention family members. Of note, seven of the eight students reported “I’ve always liked math”. The eighth student reported “I flip-flop a lot between liking and not liking math”. This number is small and represents only 1.5% of respondents. However, the link to attitude orientation is significant. Analysis later in this chapter of survey questions that are directly linked to family should provide greater insight.

Many students misunderstood question 6, which asked them to identify a grade level(s) at which they felt their attitude changed orientation, and reported the actual letter

grades they received for math classes. Only 213 students identified a grade level (or grade levels) at which they felt their attitude had changed. The data from this study supports prior research which shows more students indicate a switch from positive attitude toward math to negative attitude toward math as they matriculate through upper elementary and middle school. However, the most frequently reported grade for an attitude change in this study was actually 9^{th} (33%). Only slightly fewer students (32%) indicated grade 10 as a grade of attitude change. For students who said, "I used to dislike math but now I like it", the change to positive orientation was reported as most frequently happening in grade 10 (25%). For students who said, "I used to like math but I don't any more", the change to negative orientation most frequently occurred in grades 9 (25%) or 10 (25%). Students who said their attitude toward math flip-flopped, mentioned grades 9 (24%), 10 (22%), and 11 (21%) with greatest frequency. As indicated above, the reasons given for attitude and attitude change related to the student him/herself, teachers, or content of the course work.

I was surprised by the results of this question. My inclination was that students would identify middle or elementary school grades as the turning points for their attitude changes in mathematics. It is during middle school that students begin their in-depth study of algebraic concepts which is often where the degree of content difficulty begins to impact performance. Prior research shows that many students struggle for the first time at this point (Wilkins & Ma, 2003). However, these students indicated – whether the change was oriented positively or negatively – that it came later. Student indication

that changes in attitude occur at later grade levels could be related to the need to have repeated experiences with a particular outcome in order for the identity and self-efficacy beliefs to change (Burke & Stets, 2009). It is also likely that in their brief responses on the survey, students were recalling their most recent changes in attitude. Analysis of the more in-depth student responses to similar focus group questions should provide clarity and will be explored later in this chapter. In support of student indication that their attitude changes occurred early in their high school experiences, performance data show a decline in performance at grades 9, 10, and 11. Figure 7 below shows average change in grade for the 588 students in this study was negative from grade 8 to algebra, from algebra to geometry, and from geometry to algebra II[10]. I calculated these values by averaging the differences in consecutive years described on page 64 above. Initially, this analysis did not occur to me but its relevance due to the change in attitude data is evident.

[10] Students typically take algebra in 9th grade, geometry in 10th, and advanced algebra in 11th grade. Some students, particularly those who transfer in from other districts take these courses at different grades because they are required to take them in succession with each a pre-requisite for the next in the order here.

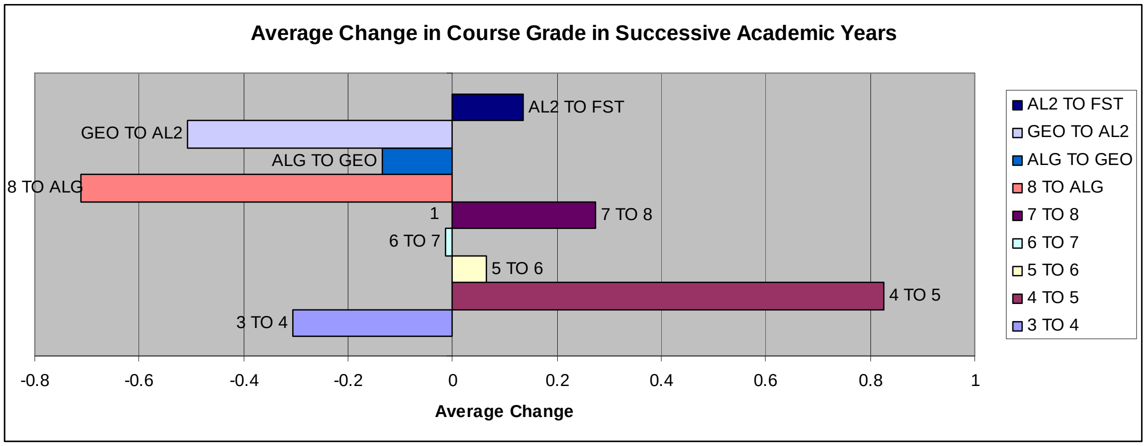

Figure 7: Average Change in Course Grade in Consecutive Years for Study Participants

Self-concept and Self-efficacy Beliefs

Questions 13[11], 14, and 15 were intended to explore students' self-concept and self-efficacy beliefs about mathematics. They ask "Do you think you are good at math", "How do you know this?" and "When you solve math problems, how sure are you that you got the right answer?" respectively. Student responses to this portion of the survey lend insight to both attitudes and the factors that students attribute to the development of attitudes. They inform the first two of my research questions: "In what direction are Revere Public School students' attitudes toward mathematics oriented?" and "What factors do Revere Public Schools students attribute to the development of their attitude toward mathematics?"

[11] Six students did not answer question 13. Table 25 shows the distribution of the 582 responses given.

Table 25

Distribution of Responses to "Do you think you are good at math?"

GoodAtMath				
		Frequency	Valid Percent	Cumulative Percent
Valid	no	98	16.8	16.8
	not sure	113	19.4	36.3
	yes	371	63.7	100.0
	Total	582	100.0	

Far more students (63.7%) reported that they are good at math than reported that they are not good at math (16.8%). Most demographic factors yielded similar distributions of response to this question[12]. The one demographic that showed statistically significant difference was SPED status. Table 30 shows a lower proportion of students with special education status report they are good at math compared to the proportion of their non-special education peers. Likewise, a higher proportion of students with special education status report they are *not* good at math in comparison to their non-special education peers.

[12] See tables 26 through 29 in appendix C

Table 30

Crosstab Analysis of "Do you think you are good at math?" with SPED Status

SPED * GoodAtMath Crosstabulation						
			GoodAtMath			Total
			no	not sure	yes	
SPED		Count	85	105	358	548
		% within SPED	15.5%	19.2%	65.3%	100.0%
	1	Count	13	8	13	34
		% within SPED	38.2%	23.5%	38.2%	100.0%
Total		Count	98	113	371	582
		% within SPED	16.8%	19.4%	63.7%	100.0%

The relationship between whether or not students think they are good at math and their special education status is evident when the neutral "I'm not sure" response is excluded from analysis. These results are shown below in table 31. Among students who are sure about whether or not they are good at math, students with special education status have decreased self-concept about mathematical ability. It is likely that their good math student identities have been replaced with not-good math student identities as a result of repeated struggles with mathematics. The status alone, one which is ascribed to students by others, could by inhibiting the development of a good-math-student identity. Because the more-knowing adults around these students have determined that they are not able to succeed academically without additional supports, special education students may be applying this information to their self-concept beliefs. These students' responses to question 14 (How they know if they are good at math or not) are very similar to those of their peers which will be discussed below and reveal no unique characteristics for

special education students. Deeper exploration with these students in particular is suggested for future research.

Table 31

Crosstab Analysis of Extreme Response to "Do you think you are good at math?" with SPED Status

SPED * GoodAtMath Crosstabulation

			GoodAtMath		Total
			no	yes	
SPED		Count	85	358	443
		% within SPED	19.2%	80.8%	100.0%
	1	Count	13	13	26
		% within SPED	50.0%	50.0%	100.0%
Total		Count	98	371	469
		% within SPED	20.9%	79.1%	100.0%

Note. X2 (1, N=469) = 14.11, p = .000

Excluding the neutral "I'm not sure" response to the question "Do you think you are good at math?" revealed a relationship between this question and gender. In light of the results above showing that boys have both more positive current attitudes toward math and more positive attitudes over time toward math, it is not surprising that boys also have higher self-concept beliefs about math. Table 32 below shows that, of students with extreme opinions about whether or not they are good at math, boys are more likely to respond in the affirmative while girls are more likely to respond in the negative.

Table 32

Crosstab Analysis of Extreme Response to "Do you think you are good at math?" with Gender

Gender * GoodAtMath Crosstabulation

			GoodAtMath		Total
			no	yes	
Gender	Female	Count	59	181	240
		% within Gender	24.6%	75.4%	100.0%
	Male	Count	39	190	229
		% within Gender	17.0%	83.0%	100.0%
Total		Count	98	371	469
		% within Gender	20.9%	79.1%	100.0%

Note. X2 (1, N=469) = 4.04, p = .044

Table 33 shows a relationship between student attitudes toward math and whether or not they think they are good at math[13]. Not surprisingly, almost all of students with positively oriented attitudes toward math (89.9%) said they are good at math. What is surprising is the percentages of students in the attitude categories of *I don't like math* and *No strong feeling either way* who also said they are good at it. Existing research shows, people prefer to engage in activities they anticipate they can complete successfully (Schunk, 1987). The question arises - if these kids think they are good at math, why don't they like it? Some of these students may simply find the subject uninteresting and/or irrelevant. Students articulated such beliefs during the focus group discussions.

[13] In addition to the 6 students who did not respond to question 13, three students who did not report their current attitude toward math are excluded from this analysis.

Table 33

Crosstab Analysis of "Do you think you are good at math?" with Attitude Toward Mathematics

Attitude * GoodAtMath Crosstabulation

			GoodAtMath			Total
			no	not sure	yes	
Attitude	I don't like math	Count	74	33	27	134
		% within Attitude	55.2%	24.6%	20.1%	100.0%
	No strong feelings	Count	19	54	74	147
		% within Attitude	12.9%	36.7%	50.3%	100.0%
	I like math	Count	5	25	268	298
		% within Attitude	1.7%	8.4%	89.9%	100.0%
Total		Count	98	112	369	579
		% within Attitude	16.9%	19.3%	63.7%	100.0%

Alternatively, identity theory points to the possibility of discord within the control system between the individual's identity standard for being a good math student and feedback s/he is receiving while acting in the role of good math student OR the absence of a good math student identity for these individuals. Either of these two cases could be a result of the student's own assumptions or could result from beliefs the teacher, classmates and/or others project onto the individual through social aspects of identity development (Roth, 2006; Stets & Burke, 2000). Regardless of where (or with whom) the discord originates, the inability to verify an identity will result in negative emotional responses by the individual (Burke, & Stets, 2009). These reasons could account for the differences between attitude and ability described by the 20.1% of students who say they

don’t like math and the 50.3% who have no strong feelings – all of whom say they are good at math. If this trend in perceived feedback does not change, the good math student identity for these students, if it exists at all, will continue to lose salience and prominence. Since these students already think they are good at math, we should approach their self-efficacy beliefs as a means to foster more positive attitudes.

The relationship between current attitude toward math and response to the question “Do you think you are good at math” was also evident when neutral responses were excluded. With very high correlation, responses to question 13 are oriented in the same direction as current attitude toward math. These results are shown in table 34 below:

Table 34

Crosstab Analysis of Extreme Response to “Do you think you are good at math?” with Extreme Attitudes

Attitude * GoodAtMath Crosstabulation

			GoodAtMath		Total
			no	yes	
Attitude	I don't like math	Count	74	27	101
		% within Attitude	73.3%	26.7%	100.0%
	I like math	Count	5	268	273
		% within Attitude	1.8%	98.2%	100.0%
Total		Count	79	295	374
		% within Attitude	21.1%	78.9%	100.0%

Note. X2 (1, N=374) = 225.80, p = .000

Across attitudes toward math, students most commonly attribute their knowledge of whether or not they are good at math to their grades. Overall, 62% of students responded that their grades in math classes or on tests and quizzes tell them whether or not they are good at math. For students who don't like math, difficulty understanding and struggling to do well also evidenced that they are *not* good at math (19%). These students made comments like, "I've tried, it just doesn't get through my head" and "because even though I try math has never been an easy subject for me". For students who like math completing problems faster than their peers and not needing help from the teacher to solve problems were also evidence that they are good at math. In fact, 31% of students in this attitude group provided responses along these lines as evidence that they are good at math.

As one would expect, student responses to the question "are you good at math?" are related to their performance categories. These results are shown in Table 35 below. Within these results, it is surprising how many students with consistently low (45.5%), gradually negative (68.9%), and significant negative (49.6%) performances reported that they are good at math. Responses of students with low or declining performance to question 14 (How do you know this?) followed the trend of all students who responded that they are good at math with the largest percentage (50%) referencing grades and almost the same percentage referencing how quickly and independently they solve problems (29%). These responses included comments like, "I am good at following logical steps for finding an answer as long as I practice." and "I am good when I apply

Table 35

Crosstab Analysis of "Do you think you are good at math?" with Performance Category

PerCategory * GoodAtMath Crosstabulation

			GoodAtMath			Total
			no	not sure	yes	
PerCat	Con Avg	Count	3	3	8	14
		% within PerCat	21.4%	21.4%	57.1%	100.0%
	Con High	Count	5	5	63	73
		% within PerCat	6.8%	6.8%	86.3%	100.0%
	Con Low	Count	2	4	5	11
		% within PerCat	18.2%	36.4%	45.5%	100.0%
	Fewer than 4 grades	Count	5	8	19	32
		% within PerCat	15.6%	25.0%	59.4%	100.0%
	Grad Fluc	Count	7	11	27	45
		% within PerCat	15.6%	24.4%	60.0%	100.0%
	Grad Neg	Count	10	4	31	45
		% within PerCat	22.2%	8.9%	68.9%	100.0%
	Grad Pos	Count	2	1	14	17
		% within PerCat	11.8%	5.9%	82.4%	100.0%
	Sig Fluc	Count	26	27	104	157
		% within PerCat	16.6%	17.2%	66.2%	100.0%
	Sig Neg	Count	31	36	66	133
		% within PerCat	23.3%	27.1%	49.6%	100.0%
	Sig Pos	Count	7	14	34	55
		% within PerCat	12.7%	25.5%	61.8%	100.0%
Total		Count	98	113	371	582
		% within PerCat	16.8%	19.4%	63.7%	100.0%

myself". Note the disclaimers: "as long as I practice" and "when I apply myself". They are typical of the comments made by students in this group. These responses are important because they lend insight to how theses students define what it means to be "good at math" and because these disclaimers could actually be student signals for why they feel they have low performance.

Within clustered performance categories and excluding neutral responses, the strength of the association between performance cluster and mathematical self-concept belief shows high statistical significance. Table 36 shows that orientation of self-concept to be directly related to the student's performance:

Table 36

Crosstab Analysis of Extreme Response to Good at Math with Clustered Performance Category

ClustPerfCat * GoodAtMath Crosstabulation

			GoodAtMath		Total
			no	yes	
ClustPerfCat	Down	Count	43	102	145
		% within ClustPerfCat	29.7%	70.3%	100.0%
	Up	Count	14	111	125
		% within ClustPerfCat	11.2%	88.8%	100.0%
Total		Count	57	213	270
		% within ClustPerfCat	21.1%	78.9%	100.0%

Note. X2 (1, N=270) = 13.73, *p* = .000

Responses to survey question 15 (When you solve math problems, how sure are you that you got the right answer?[14,15]) identify aspects of student self-efficacy and self-concept beliefs about mathematics; both of which are shown by existing literature to inform attitude. As table 37 shows, more than half of the students reported that their confidence in being correct really depends on the problem they are asked to complete. Thus, most students have situational confidence that is connected to the content. An additional 27.6% of students replied "Pretty sure. I almost always get the right answer."

Table 37

Distribution of Responses to Confidence in Answering Correctly

RightAns				
		Frequency	Valid Percent	Cumulative Percent
Valid	Depends	299	51.2	51.2
	I'm sure	39	6.7	57.9
	If finish right	36	6.2	64.0
	Pretty sure	161	27.6	91.6
	Usually not sure	49	8.4	100.0
	Total	584	100.0	

The distribution of responses was consistent across demographics except for gender. Boys demonstrated higher levels of confidence than their female peers (see Table 38 below). 43.1% of boys responded that they are either sure or pretty sure they

[14] See full prompt with answer choices in Appendix A
[15] Four students did not answer this question. Analysis is based on the 584 responses that were given.

have a problem right compared to just 26.1% of girls. This data coupled with the data above showing gender differences in current attitude toward math and attitude over time toward math are troubling. Despite strong efforts over the last several decades to engage girls with STEM programs and STEM education, historic self-efficacy and self-concept trends regarding gendered roles persist.

Table 38

Crosstab Analysis of Confidence in Answering Correctly with Gender

Gender * RightAns Crosstabulation

			RightAns					Total
			Depends	I'm sure	If finish right	Pretty sure	Usually not sure	
Gender	Female	Count	180	13	11	66	33	303
		% within Gender	59.4%	4.3%	3.6%	21.8%	10.9%	100.0%
	Male	Count	119	26	25	95	16	281
		% within Gender	42.3%	9.3%	8.9%	33.8%	5.7%	100.0%
Total		Count	299	39	36	161	49	584
		% within Gender	51.2%	6.7%	6.2%	27.6%	8.4%	100.0%

The reason for the persistence of this gender gap is not evident through data collected in the current study. Perhaps, despite the gender gap evident in this study, progress has been made and the gap is actually narrower than it once was. It is possible

that the environments in which the current female subjects were raised inhibits knowledge of STEM opportunities for girls. Alternatively, female students may have fewer opportunities for validation of STEM oriented identities while other identities are afforded higher rates of validation from parents, teachers, and peers for gendered roles. As described in Chapter 2, social constructs of identity occur as others *assign* individuals to particular groups for whom social norms are defined (Stets & Burke, 2000). Of interest but beyond the scope of the current study would be comparison of these data to responses by more affluent students and comparison of these data to similar data (if it exists) from cohorts of students in past decades. Such comparisons would enable assessment of whether these metrics have improved over time or over demographics even if they have not improved for current study subjects. Discussions with female students about how they come to define and identify themselves mathematically would also lend insight.

Summary of Results – Attitude and Self-efficacy

The majority of Revere High School juniors and seniors reported that they like math. This is particularly true of students who perform consistently high or who have gradual grade change in the positive direction. It appears that significant (sudden) grade change has less impact on orienting attitude positively than does steady, sustained grade change. Male students were less likely to report “I don’t like math” than female students and students who perform consistently low were more likely to report “I do not like

math" or "I have no strong feelings either way" than "I like math".   Students attributed their attitudes to their own ability and comprehension levels, to the content (particularly how difficult or easy they find it), and to their teachers.

Student attitudes toward mathematics do change. Most students indicated this change in attitude occurs in the first two years of high school. Attitudes toward math over time are related to current attitudes. This indicates some level of stability which is likely related to the persistence of identity and self-efficacy beliefs.

Students based their own assessment of whether or not they are good at math on their grades more than anything else. In addition to grades, for students who don't like math, struggling to understand is evidence that they are not good at math and for students who like math, completing problems quickly and without help is evidence that they are good at math. Most Revere students reported that they are good at math. Special education students have lower self-concept regarding mathematical ability than their peers and boys have more confidence in their ability to correctly answer math questions than do girls.

People of Influence

As discussed in chapter 2, existing research tells us that parents, peers, and teachers influence student attitudes. Specific survey questions explore students' understanding of their parents' and peers' attitudes toward math and how students come to know the orientation of these attitudes. Open-ended questions about the influence of

others explore students' descriptions of how teachers, parents, friends, siblings, extended family members, and others influence their own attitudes toward math. These questions will now be analyzed under four groupings entitled *Mothers/Female Guardians*, *Fathers/Male Guardians*, *Friends*, and *Attitude Influencers*.

Mothers/Female Guardians[16]

Questions 7 and 8 of the survey asked students whether or not they think their mothers like math and how they know this. Four students did not respond to question 7 and an additional twenty replied that this question does not apply. Table 39 below shows the distribution of the five hundred and sixty-four responses to question 7.

Table 39

Distribution of Responses to Mother's Attitude Toward Math

MomAtt				
		Frequency	Valid Percent	Cumulative Percent
Valid	no	113	20.0	20.0
	not sure	342	60.6	80.7
	yes	109	19.3	100.0
	Total	564	100.0	

Over 60% of students did not know how their mothers feel about math. This indicates that many mothers do not talk to their children about mathematics. In fact,

[16] For the remainder of this work, references to mother implies mother or female guardian.

when asked in question 8 how they know what their mother's attitude is, only sixty-eight of the students (12%) who responded to this question mentioned conversations with their mothers.

Disaggregation by demographics indicates an association between how students perceive their mothers' attitudes toward mathematics and both ELL status and the student's current attitude[17]. Students with ELL status reported positive orientation of the mother's attitude more frequently than their non-ELL peers as shown in table 44 below. This is particularly true of former-ELL students who also reported a negative orientation of their mothers' attitudes with far less frequency than their peers.

Table 44

Crosstab Analysis of Mother's Attitude Toward Math with ELL Status

Crosstab

			MomAtt			Total
			no	not sure	yes	
ELL		Count	102	292	79	473
		% within ELL	21.6%	61.7%	16.7%	100.0%
	1	Count	5	13	7	25
		% within ELL	20.0%	52.0%	28.0%	100.0%
	2	Count	6	37	23	66
		% within ELL	9.1%	56.1%	34.8%	100.0%
Total		Count	113	342	109	564
		% within ELL	20.0%	60.6%	19.3%	100.0%

[17] Crosstab tables for other demographics can be reviewed in tables 40-43 in Appendix C

For analysis of the relationship between the student's attitude toward math and the mother's attitude toward math, two additional students who did not indicate their own attitudes were excluded. Table 45 shows that students who do not like math have less knowledge of their mother's attitude as they more frequently reported that they do not know whether or not their mothers like math. These same students reported that their mothers like math with far less frequency than do students who either like math or have no strong feeling either way.

Table 45

Crosstab Analysis of Mother's Attitude Toward Math with Student's Attitude Toward Math

Attitude * MomAtt Crosstabulation

			MomAtt			Total
			no	not sure	yes	
Attitude	I don't like math	Count	33	86	13	132
		% within Attitude	25.0%	65.2%	9.8%	100.0%
	No strong feelings	Count	29	84	31	144
		% within Attitude	20.1%	58.3%	21.5%	100.0%
	I like math	Count	51	170	65	286
		% within Attitude	17.8%	59.4%	22.7%	100.0%
Total		Count	113	340	109	562
		% within Attitude	20.1%	60.5%	19.4%	100.0%

To assess the strength of associations among the Mother's attitude toward math and the demographic variables used in this study, I analyzed responses from only those

students who were sure (one way or another) about the orientation of their mothers' attitudes toward math. These result support the findings above and Chi-Square tests indicate statistical significance in the relationship between mother's attitude toward math and ELL status as well as the relationship between mother's attitude toward math and the student's current attitude toward math. For the latter analysis, I also excluded students who reported their current attitude toward math as "no strong feelings either way". The results, shown in tables 46 and 47 below, support the findings above; Students with ELL status are more likely to report that their mother likes math and students generally, report their mother's attitude toward math to be oriented in the same direction as the students own attitude toward math.

Table 46

Crosstab Analysis of Extreme Mother's Attitude Toward Math with ELL Status

Crosstab

			MomAtt		Total
			no	yes	
ELL		Count	102	79	181
		% within ELL	56.4%	43.6%	100.0%
	1	Count	5	7	12
		% within ELL	41.7%	58.3%	100.0%
	2	Count	6	23	29
		% within ELL	20.7%	79.3%	100.0%
Total		Count	113	109	222
		% within ELL	50.9%	49.1%	100.0%

Note. X2 (2, N=222) = 13.15, *p* = .001

Table 47

Crosstab Analysis of Extreme Mother's Attitude Toward Math with Extreme Current Attitude Toward Math

Attitude * MomAtt Crosstabulation

			MomAtt		Total
			no	yes	
Attitude	I don't like math	Count	33	13	46
		% within Attitude	71.7%	28.3%	100.0%
	I like math	Count	51	65	116
		% within Attitude	44.0%	56.0%	100.0%
Total		Count	84	78	162
		% within Attitude	51.9%	48.1%	100.0%

Note. X2 (1, N=162) = 10.17, p = .001

Students who reported that their mothers either like or dislike mathematics commonly pointed to conversations with their mothers as evidence. Thirty-seven percent of students who said their mothers don't like math made comments like, "She told me" and "she has told me plenty of times, especially when she sees me do my homework." Twenty-six percent of students who said their mothers like math made similar comments.

Students also said they know their mothers do not like math because they're not good at it (37%) and because their mothers can't or won't help them with homework (14%). In students' words: "She told me she never liked math in high school either and she also is bad at it", "When math levels started to get increasingly difficult she would tell me never to ask her for help", "When I was a child I'd ask her for help and she would try but she didn't understand much either, and she told me that she doesn't like math."

For students who said their mothers like math, evidence came from help on homework (30%) and from their mothers' professions, college majors, and assuming responsibility for household bills/taxes (27%). These students said: "my mom would help me with an equation if I do not know how to do it and she'll explain it to me", "My mother has always loved math and routinely expresses this. Her first real job was working in a payroll department and she got it because of her talent in math", "Because she is good at it and went to college to be a statistician", "she says it is her favorite subject and tends to do all the housework for bill and taxes."

Student comments show that they associated their mothers' attitudes toward math to ability, or self-efficacy, just as they did their own. In several instances, students admitted to drawing conclusions about the orientation of their mother's attitude as in the following statement "I just know that she isn't good at it so I am assuming she doesn't like it." The students who said their mothers like math clearly relate the mother's attitude to the roles their mothers play through their work identities and/or student identities. The same can be said of students who said their mothers do not like math in the sense that not one of these students mentioned their mother's career or schooling.

Fathers/Male Guardians[18]

Questions 9 and 10 of the survey asked students whether or not they think their fathers like math and how they know this. Five students did not respond to question 9

[18] For the remainder of this work, references to father implies father or male guardian.

and an additional forty-four replied that this question does not apply. Table 48 below shows the distribution of the Five hundred and thirty-nine responses to question 9.

Table 48

Distribution of Responses to Father's Attitude Toward Math

DadAtt				
		Frequency	Valid Percent	Cumulative Percent
Valid	no	58	10.8	10.8
	not sure	305	56.6	67.3
	yes	176	32.7	100.0
	Total	539	100.0	

Almost 57% of students did not know how their fathers feel about math. This indicates that many fathers do not talk to their children about mathematics. In fact, when asked in question 10 how they know what their father's attitude is, only forty-nine of the students (9%) who responded to this question mentioned conversations with their fathers – students are having even fewer conversations about math with their fathers than with their mothers.

Table 48 also shows that students think their fathers' attitudes toward math are oriented positively more frequently than their mothers. Only half as many students reported that their fathers don't like math compared to the number who reported that their mothers don't like math. Just as was the case with how students reported knowing the orientation of their mothers' attitudes, students who said their fathers don't like math

know this through conversation and because the students think their fathers aren't good at it. A difference here is that only 5% of students who reported their father does not like math mentioned inability to help with homework (compared to 14% with mothers). Students who said their fathers like math, just as with their mothers, say they know this through conversation, because the father helps them with homework (29%) and because of the father's job, college major, or assuming responsibility for bills/taxes (27%).

Students report their father's attitude toward math differently based on gender and their own current attitude[19]. Table 53 shows that girls were more likely than boys to say that their fathers are not good at math and boys were more likely than girls to say their father is good at math. Student responses to question 10 (how students know whether or not their fathers like math) lent no insight to the gender disparity.

Table 53

Crosstab Analysis of Father's Attitude Toward Math with Gender

Gender * DadAtt Crosstabulation

			DadAtt			Total
			no	not sure	yes	
Gender	Female	Count	39	156	80	275
		% within Gender	14.2%	56.7%	29.1%	100.0%
	Male	Count	19	149	96	264
		% within Gender	7.2%	56.4%	36.4%	100.0%
Total		Count	58	305	176	539
		% within Gender	10.8%	56.6%	32.7%	100.0%

[19] Crosstab tables for other demographics can be reviewed in tables 49-52 in Appendix C

The student's attitude toward math is related to his/her perception of the father's attitude toward math. Table 54 shows the crosstab analysis for these two variables. Students who like math are more likely to report that their fathers like math and less likely to report that their fathers don't like math. Also, students who don't like math are more likely than their peers to report that their fathers don't like math.

Table 54

Crosstab of Father's Attitude Toward Math with Current Attitude Toward Math

Crosstab

			DadAtt			Total
			no	not sure	yes	
Attitude	I don't like math	Count	22	70	33	125
		% within Attitude	17.6%	56.0%	26.4%	100.0%
	No strong feelings	Count	15	86	39	140
		% within Attitude	10.7%	61.4%	27.9%	100.0%
	I like math	Count	21	147	103	271
		% within Attitude	7.7%	54.2%	38.0%	100.0%
Total		Count	58	303	175	536
		% within Attitude	10.8%	56.5%	32.6%	100.0%

To assess the statistical significance of these results, I re-analyzed the data (for all demographics) using only the responses of students who were certain of their father's attitude toward math. Chi-Square tests confirm dependence between gender and father's attitude as well as dependence between student's attitude and father's attitude with statistical significance (see Tables 55 and 56).

Table 55

Crosstab Analysis of Extreme Father's Attitude Toward Math with Gender

Crosstab

			DadAtt		Total
			no	yes	
Gender	Female	Count	39	80	119
		% within Gender	32.8%	67.2%	100.0%
	Male	Count	19	96	115
		% within Gender	16.5%	83.5%	100.0%
Total		Count	58	176	234
		% within Gender	24.8%	75.2%	100.0%

Note. X2 (1, N=234) = 8.29, p = .004

Table 56

Crosstab Analysis of Extreme Father's Attitude Toward Math with Extreme Current Attitude Toward Math

Attitude * DadAtt Crosstabulation

			DadAtt		Total
			no	yes	
Attitude	I don't like math	Count	22	33	55
		% within Attitude	40.0%	60.0%	100.0%
	I like math	Count	21	103	124
		% within Attitude	16.9%	83.1%	100.0%
Total		Count	43	136	179
		% within Attitude	24.0%	76.0%	100.0%

Note. X2 (1, N=179) = 11.11, p = .001

Note. Students who replied "No strong feelings" as their attitude were excluded.

The data for mothers and fathers reveal strong links to the students' own attitudes. Holding their parents in high regard, students will select them as models for mathematical behavior and define their self-efficacy beliefs in relation to how they perceive their parents' abilities. Thus, students report their parents' attitude toward math as similar to their own. As analysis above shows, boys have more positive attitudes toward math than do girls. Students may be extending this same proportionate description of attitude to their fathers versus their mothers.

Friends

Students are more sure about their friends' attitudes toward math than they are about their parents' attitudes toward math as indicated by the lower percentage who responded "I'm not sure" to question 11 (See table 57 below). However, a relationship between the students' attitudes toward math and the attitudes they ascribe to their friends was not evident with any statistical significance. This implies that peer influence is less significant to the development of student attitudes toward math than is parent influence. Students look to parents as models for their own mathematical behaviors and attitudes with greater frequency than peers.

Table 57

Distribution of Responses to Friends' Attitudes Toward Math

FriendAtt				
		Frequency	Valid Percent	Cumulative Percent
Valid	no	224	38.4	38.4
	not sure	252	43.2	81.5
	yes	108	18.5	100.0
	Total	584	100.0	

How students report their friends' attitudes toward math is not related to any of the key demographic descriptors used in this study. In response to question 12 (How do you know whether or not your friends like math) students indicated that they learn this information through conversations with their friends and by knowing their friends' performance levels. Students frequently made comments such as "I know they really don't like math because hey have said that to me", "I know this because when others ask us our favorite subjects, most of them say math", and "A lot of my friends have good grades in math and they say how much they enjoy it." More than half (53%) of the students who responded to this question referenced conversations with peers as their way of knowing; 34% mentioned grades. Students who said their friends like math also said that their friends take high level (honors or AP) course or elect to take extra math classes (29%).

Students did not generally feel that their friends influence their own attitudes toward math (this will be discussed in more depth in the next section); however, their

responses to this question inform my second research question about what experiences and environmental factors students associate with attitude influence. Through conversations with their friends in which students discuss their varied experiences, students learn about different classroom environments and develop definitions of effective instruction, fun activities, and cool teachers (Bandura, 1977).

Attitude Influencers

Questions 16 and 17 of the survey asked students “Are there any people in your life who you think have shaped your attitude toward math” and “How do you know each of these people you listed in #16?” Question 17 also offered a list of individuals that I hoped would activate reflection (“friend, uncle, aunt, parent, coach, grandparent, brother, sister, etc.”). In retrospect, the list may have been too leading as students answered questions 16 and 17 almost exclusively with the suggested responses. Some students mentioned godparents or cousins and *many* students listed their teachers. Since none of these were included in the list provided, I conclude that students did think beyond the list and, even if the list was leading, responses will shed light on part a of my second research question (Who (if anyone) do students identify as influencing their attitudes toward math).

I also realized in reading responses that students found these questions generally redundant. For example, one student’s response to question 16 was, “Yes, my uncle has led me towards math. Always saying Math is number one key in life.” This same

student's response to question 17 was, "He is my uncle". Such combinations of responses are typical. Thus, I merged all student responses to both questions ensuring anyone mentioned in either question was included in the final composite response along with any description the student provided of how each individual had influenced his/her attitude. Combined, there were three hundred and fifteen responses.

Overwhelmingly, students identified their teachers as the most influential in the development of their attitudes toward math. Overall, 52% of students responding to question 16/17 mentioned one or more teachers as impacting his/her attitude. Other people mentioned were fathers (20%), mothers (16%), other family members (12%) and siblings (10%). These statistics vary by attitude toward math. The disaggregated results are shown in Table 45 below. Here we see that students who like math identify parents and siblings more frequently than their peers in the other two attitude categories. Students with no strong feelings toward math identified teachers with more frequency than their peers. Across attitude subgroups, students reported that their fathers influence their attitudes toward math more so than so their mothers. It is likely that so many students identified other family members because the nature of our district's socio-economic status is such that many students are actually being raised by extended family members.

Table 58

People Who Influence Math Attitudes by Student Attitude Toward Math

	I like math (N=189)	I don't like math (N=58)	No strong feelings (N=65)	All (N=315)
Mother	19.0%	8.6%	12.3%	15.6%
Father	22.8%	12.1%	18.5%	19.7%
Teacher(s)	50.3%	53.4%	60.0%	52.4%
Other Family	11.6%	15.5%	9.2%	11.7%
Sibling(s)	14.3%	6.9%	3.1%	10.5%

Many student responses hinted at ways in which others influence their attitudes toward math. Several students wrote about individuals “pushing” or “encouraging” them. For example, “my 3rd grade math teacher was the only person who pushed me to like math”, and “my parents have always encouraged me to try harder and they always give me confidence”. Other comments were similar those given to describe how students know whether or not their parents and friends like math. They reference receiving help and professions: “Yes my mother she use to always get me books to do when I was younger”; “My dad because I help him out with all the measurement and probability he does in his job”

The identification of siblings as a source of influence was somewhat surprising as this is not documented in existing literature. Given what we know about models and how they influence behavior and self-efficacy beliefs, it makes sense that students look to their older siblings to define themselves. It appears that students who like math have

developed effective learning strategies, or at least positive attitudes, by watching their brothers and sisters. Students commented, “I think my brother influenced me because he really enjoyed math and was good at it” and “My brother and sister both have professions in the mathematics field and have been role models to me. They have instilled in me that math is important”.

As mentioned above, teachers have the strongest influence on student attitudes. This occurs both as a negative influence and as a positive influence. Referring to their teachers, students who like math said, “Yes, I have had good math teachers which get you engaged and excited to go to class.”; “yes, my 10th grade math strategies teacher made me like math because he helped me find my weak spots so he found easy ways to help me understand.” Students who don’t like math wrote, “My teachers play a role in why I dislike math. My 10th grade teacher was kind of hard and quick with her lessons which made me feel rushed to the point that I wouldn't give myself time to fully study and understand it.”; “In my 9th grade class there was this teacher who would make you stand up and say the multiplication tables without any help, she made me hate math forever.” Finally, students with no strong feelings toward math wrote: “Teachers have definitely shaped my attitude toward math. There are teachers who have helped me when I had difficulty with math and there are teachers who have not.”; “teachers have shaped my attitude toward math depending on their teaching methods.”

In all of these responses, we hear students hint at their self-efficacy beliefs and features of the learning environment. Students clearly look at teachers as the controllers

of these aspects of their learning experiences and have strong feeling about what teachers do and don't do to foster positive attitudes. Students elaborated on these comments during the focus group discussions which will be analyzed later in this chapter.

Summary of Results –People of Influence

Students defined their mothers' and fathers', attitudes toward math based on conversation, the amount of help they receive in completing homework, and through their parents' jobs/educational majors. Students with ELL status more frequently reported that their mothers like math and boys more frequently reported that their fathers like math. Looking only at those students who felt they knew the orientation of their fathers' attitude toward math (excluding students who said they are not sure), we see that students from all three attitude levels reported that their fathers like math more often than they reported that their fathers do not like math. This is especially interesting because the same is not true for mothers. There we see the mother's attitude (from the student's perspective) oriented in the same direction as the student's attitude.   Students who have no strong feelings toward math reported an even split in the polarity of their mothers' attitudes. Mothers and fathers both influence student attitudes toward math but more students identified their father's influence.

Students defined their friends' attitudes toward math based on conversation, their friends' grades, and the difficulty level of courses their friends take. However, students did not feel that their friends have a strong impact on their own attitudes toward math.

Students, especially those who like math, feel that their siblings influence their attitudes toward math. The most wide-spread influence is that of teachers and it can impact the student's attitude positively and negatively.

Other Information

The final responsive question on the survey (question 18) asked students simply: "Is there anything else you can tell me that you think will help me understand how students come to like or dislike math?" Student responses to this question mimicked their other responses in that they referenced ability, grades, teachers, and learning experiences – the latter two with great frequency. It is likely that so many students referenced their teachers here because there were no specific questions about teachers on the survey. A factor that sets these responses apart from the others is the greater depth of responses students provided through their details. Four hundred and thirty-six of the students responded to this question. Fifty-eight percent of them mentioned their teachers. Students often made comments like, "a lot is the teacher if they make it fun then people will like it more" and "Sometimes not liking the teacher makes you hate the subject." Thirty percent of students commented on their teachers' instructional methods: "Most of the math teachers don't conform to teaching more than one way. Every student has a different way of learning, teachers do not understand that."; "If the teacher finds ways to keep you interested in math rather than just taking notes, students will enjoy it more."

Within the frame of instructional methods, students called for variety in instruction including group work, activities, and hands-on projects. They also called for more “one-on-one” time with the teacher and a slower pace in instruction: “Don't move the classes too fast. Leave a few minutes at the end of class for extra questions or to meet with students one-on-one and check on their progress.”; “Math is a good subject Its just sometimes the teachers teach you something and you don't fully understand it and their already teaching you something new It all gets confusing.”

Students also mentioned personal traits of the teacher – their patience in explaining mathematical concepts (“It all depends on the teacher, If they can make it fun, and have the patience to teach you, I'm sure people will like math, but if you have a bad teacher who isn't patient, you probably won't like it”), their levels of passion and excitement (“The teacher's approach has a lot to do with shaping attitudes. I think students who have more creative lesson plans, such as hands-on projects, and a passionate teacher are more likely to enjoy math”), and whether or not the make class fun (“Well some students may dislike math if they think math problems get really confusing to understand. Maybe students would like math if the teachers make it fun for their students.”). Other students mentioned the general utility of the mathematics they are learning as a factor in their attitudes. Although some students mentioned the usefulness and universality of mathematics in response to question 5 (Why do you think you feel this way about math?) as a reason to *like* math, responses to question 18 were exclusively negative. Examples include: “I dislike math because I'm not going to need most of what

held me back in recent years." and "Sometimes I ask myself when we are learning about graphs, and all these different types of equations how are they going to help me or how I'm even going to use them. Adding, subtracting, division, and multiplication are the only things people need to know."

These results are not shocking. Student preference for hands on activities and connections to real-world situations in their study of mathematics is well documented in the literature. What these results do show is that students are not generally finding these experiences in their mathematics classrooms at Revere High School. Student responses, including some of the examples above, demonstrate that students feel their teachers have a tremendous control over their self-efficacy and self-concept beliefs regarding mathematics. Their responses point to teachers as the source of their difficulties "If the teacher can teach good…" This is also highlighted in the fact that very few students (only 2) mentioned individual ability in response to this question. An additional 86 students mentioned understanding but their comments centered on the teacher's effectiveness in helping them understand as opposed to their own ability to understand (i.e. "I remember having a teacher in 7th grade that was very smart. She was a graduate of MIT. She just couldn't teach ways we could understand…"). Here we see students identifying external locus of control which, as indicated in chapter 2, has a negative impact on self-concept. This will further erode the salience and prominence of Revere students' good math student identities.

Focus Groups

The six focus group discussions provided the opportunity for the researcher to explore all of the ideas from the survey in greater depth. Participants spanned performance levels and attitude categories so their responses are representative of all subjects. As mentioned at the beginning of the analysis section of this chapter, I was surprised by some of the focus group results. For instance, parents, siblings, other family members and friends were discussed during the focus groups. Students did not identify any of them as major influencers of their attitudes toward math during the focus group discussions. In fact, almost all of the students report that their friends, whether they share the same attitude toward math or not, have no effect on their own attitudes. This supports the findings from the survey discussed earlier in this chapter. The focus group data regarding parents also aligned with the survey results. More students spoke about their fathers than their mothers but the incidence of students saying either parent influenced his/her attitude toward math is relatively low. Other than the low occurrence, this portion of the data rendered no significant insights.

Some students mentioned particular topics, such as fractions, geometry or statistics, as influencing them to like or dislike math; however, the vast majority spoke of their teachers and the learning environments they create as having a strong impact on attitude. The focus group responses indicate that the orientation of attitude toward math can, and frequently does, change with the teacher. Student comments most often referenced perceived personality traits of the teacher (mean or nice, willing to help or not,

caring or not) or the structure of the classroom environment (activity based or passive). Based on these results, I will report the findings of the focus group analysis within the three major, teacher-related, themes that emerged during the coding process. These are: ***Positive Teacher Effect on Attitude, Negative Teacher Effect on Attitude, and Structure of the Classroom Environment.***

While these themes deviate from those used to analyze the survey results, they nonetheless shed light on how students feel their attitudes toward math are shaped, who they feel shapes their attitudes, and the types of events that result in reversals of orientation. Student responses inform research questions 2a (Who (if anyone) do students identify as influencing their attitude toward mathematics?), 2b (What are the experiences that students identify as influencing their attitudes toward mathematics?), 2c (In what ways does the mathematics classroom environment influence students' attitudes toward mathematics?), 3a (If attitudes are unstable, to what do students attribute reversals of orientation?), and 3b (How long lasting do student report reversals of orientation to be?). Finally, I will revisit what students say about when (at what grade levels) they feel their attitudes toward math are developed and/or heavily influenced. Recall that the survey data on this topic indicated grades 9, 10, and 11 as most common; conflicting with existing literature that indicates middle school grades as most common for change in attitude (Wilkins & Ma, 2003).

Positive Teacher Effect on Attitude

The following exchange exemplifies how teacher personality traits and structure of the classroom environment can foster positive attitudes toward math. Three students in one of the focus groups comprised of students who have no strong feelings toward math had the same teacher. Despite their attitude category, these students' comments identified scenarios and teacher/classroom characteristics that make them like math. The interviewer asked, "Is there something, looking back at your whole life, things that either turned or changed your attitude about math? It could've been a teacher, a topic, an experience?" Kerrie's[20] response prompted the following exchange:

Kerrie: Yeah. Some teachers get frustrated when you ask them questions, and they expect you to get it the way that they explained it to you, but you don't get it, and you keep asking them, and they get frustrated and stuff. My math teacher this year, I love my math teacher, because I stayed after school, and he explained it to me, and I get it. I think he's a really good teacher.

Dottie: I know. I love him. He was a good teacher, Mr. Adams.

Coleman: Yeah, like, Mr. Adams — the way he runs the class is awesome, because he involves everyone. He doesn't let you sit there and slack off, but at the same time, he won't yell at you. He'll get you involved, and when you're involved, that's how you learn.

[20] All student names are pseudonyms.

Kerrie: He talks to every single person in the class. He doesn't just talk to the people in the front, and he doesn't tell the people in the back to quiet down. He calls on you and tells you to answer a question. He'll call on everyone in the class, so he's really involved.

Dottie: And then he'll really — if you do something wrong, he won't be like, "Oh no. *That's* not how you do it!" He'll just be like, "No, that's not how you do it, but you can do it a different way," or something. He'll be really nice about it.

Coleman: He's open to any different way.

Kerrie: He's a really good teacher.

Coleman: And any way you want to learn, he's open to try to work around that. Say if you don't get things —

Interviewer: You can just put the answer down, and you don't show him how it got there, that's OK?

Coleman: He'll have you explain it. You have to explain it, even if it's not on paper. In words is good enough. As long as you know how to do it, that's all he cares about. And that's how I think a class should be run.

The students' words show that they feel this teacher supports them by helping them, fosters self-efficacy by kindly correcting their errors, enables them to have some control over their work by allowing multiple methods of solution and distributes control of the learning environment to students by allowing some chatter while maintaining high

expectations for participation (involving everyone). These students' comments about how their teacher positively influenced their attitudes are similar to those of their peers.

Student who like math said:

Tricia: Well, like me, I haven't really had something happen to me that got me to really like math. I just always have. But I guess my freshman year, my teacher, she — like, she made math even easier for me. Like, I felt like I was so smart in that class, and I feel like algebra was like the easiest out of all the maths I've ever taken, so I guess my freshman year was when I really started to like math a lot more. But other than that, you know.

…

Kathy: There was probably in eighth grade. Cause growing up, on and off, in elementary school and my first year in middle school I was, like — I wasn't considered, like, smart; but I had a learning disability. So I wasn't really — things would become complicated to me; but eighth grade my teacher actually would take the time and explain it to me; and when I did wrong, or counted it wrong, I would do better. After that, was just able to do it on my own. Ever since then I've gotten As and Bs in math…that one teacher helped me. Like I was staying after school with her for hours…And then it would just be, like, me and her, one-on-one, and I would come back every day — every week the same day a

and she would just work over it with me; if I'd go on in class, if I had any problems in class or whatever.

And a student who doesn't like math said:

Corrine: I think eighth grade. I don't think it was the subject I liked because I remember like I didn't like taking tests, but the teacher actually cared and worked with me if I stayed after and she made things make sense more. So—I think eighth grade.

In all of these student responses we again hear reference to the students' sense that the teacher did what was necessary to help the student understand, cared about the students, and made them feel able. These experiences generate higher levels of self-efficacy as student expectations of success increase. As a result, the good math student identities of these students become more prominent and salient. Student behavior changes in a way that will foster success (staying after); further increasing salience and prominence. Across attitudes toward math, teachers who foster positive self-efficacy beliefs and establish caring, supportive relationships with their students improve student attitudes toward math.

Negative Teacher Effect on Attitude

Students who spoke about negative teacher effect on their attitudes toward math were primarily from the I don't like math and I have no strong feelings toward math attitude categories. Some students who like math also spoke about negative teacher effect on attitude but these students were more likely to point to content than teachers. Sean's comments below exemplify this and are similar to those of his peers. The interviewer asked, "Was there ever a time that you didn't like math? And can you say when? What made it change?" and Sean replied:

Sean: Triangles. I don't like like sine and cosine arc tangent and cotangent. I hate it. It's like the worst part of math.

Interviewer: So for you, Sean, it's the topic that seems to change your mind. You said that about calculus as well.

Sean: Yes.

Interviewer: It's not the teacher so much.

Sean: No.

Interviewer: It's just that some topics don't—

Sean: For the most part I've had really good teachers in math and they've been able to like convey math well to me but there are just some topics that I just don't get.

Students in the other two attitude categories (I don't like math and I have no strong feelings either way); however, frequently commented on their perceptions of the teacher's personality traits and the classroom environment. In the excerpt below, Noreen speaks of a single incident that she says made her dislike math:

Interviewer: And freshman year you didn't like it?

Noreen: No.

Interviewer: Why?

Noreen: Well I liked math. I didn't like the teacher.

Interviewer: Oh, it was the teacher.

Noreen: Yes. I guess he was supposed to if there was an answer—let's say if my answer was twenty I was supposed to write 20=20. And we had twenty questions and I was supposed to get an 89, and he gave me a 69 because he took a point off every time I didn't write 20=20.

Interviewer: Yes.

Noreen: He said I could have been cheating, but I don't get why—I already had my answer. All I had to write was 20=20. So I got mad and I stopped doing work in his class. I thought it was mean.

Noreen said that she still does not like math two years after this incident. This is a student whose grades were in the A/B rage for the three years preceding the incident and

have been a D+ each year since. In speaking about her attitude toward math the year after the incident, Noreen said:

Interviewer: And what happened last year that you didn't like it?

Noreen: I just didn't understand it. I don't know.

Any educator would say it makes sense that Noreen's performance fell when she "stopped working in his class" and the cumulative nature of mathematics would result in a lingering effect on subsequent classes. Noreen's performance indicates as much.

Several of the students said they come to dislike math when their teachers express frustration about the students' lack of progress. They feel the teachers are not helping them in the ways they need to be helped and the teachers are blaming the students for something the students feel they can not control. Here are two examples:

Corrine: I like her. It's just like I'll ask her something and she'll just walk away like "don't ask me!"

Steven: That's like my teacher too. My teacher this year when you ask her something she's like where have you been the last five days—apparently here but just not getting it and she's like, she doesn't answer the question.

Kate: I don't like that either it makes you not want to ask the question.

Steven: I'm asking the question because I, I literally don't know it, so why can't you just answer it.

Interviewer: Yes.

Kate: And then you ask the person that sits next to you and they don't know it either.

Steven: And they get you for talking.

Kate: Yes. And it's just like, well.

Steven: Isn't it like her job to help us out? So basically there's just where have you been the last five days.

Interviewer: Sure.

Steven: I've been here listening to you. Clearly you haven't said it!

…

Dottie: Well, last year, I had a teacher like for FST and stats, like for the same one, and I liked her and all, but sometimes when I would ask her something, she would be mad because she didn't want to repeat herself, and I understand that she understood it, because she's the teacher, and she knows it, but if I asked her, and then she explained it, and I really didn't understand that way of explaining it, I would be like, "Well, I don't understand what that means," and she would explain it the same way instead of trying to look at it from a different perspective. Because if you're going to explain something to me and I didn't understand it, don't tell me the same thing, you know, because it's not going to make it any different.

Kerrie: Yeah. Some teachers get frustrated when you ask them questions, and they expect you to get it the way that they explained it to you, but you don't get it, and you keep asking them, and they get frustrated and stuff.

In both of these exchanges, students articulated the idea that they can do the math if the teachers will just show other ways to approach the problems. Teachers are likely frustrated because the students' lack of understanding will undermine the teacher identity and lower his/her math teacher self-efficacy. Rather than working with the student toward understanding, the teacher blames the student and (particularly as evidenced in the first example) accuses the student of not paying attention. Students take this as an affront to their own good math student identities and withdraw ("…it makes you not want to ask the question") or become frustrated themselves ("I've been here listening to you. Clearly you haven't said it!")

The scenarios described in both examples above also demonstrate the reciprocal determination of environment and self. Students ask questions in their attempt to understand the material and verify their good math student identities. When the teacher rebuffs the student for not understanding, the self-verification process is interrupted and students change their behavior (stop asking questions) to end the discord occurring in the good math student identity control system. This math classroom environment has changed how the student behaves and the good math student identity has lost prominence.

This student's withdrawal has also changed the classroom environment into one in which students less frequently act to ensure their own comprehension (ask questions).

Structure of the Classroom Environment

To get at the structures of the mathematics classrooms in which these students participate, the researcher asked them to describe the kinds of things they do in class, if it is mostly note-taking or not, and whether or not they are engaged in group work and projects. The questions were framed within attitude toward mathematics with follow up questions like "does that make you like math more or less?" The interviewer also asked three of the focus groups, "If you could design the perfect math class, what would be the things that you'd build in that would help you learn well and be excited. Would you go independent or group work? Would you go for projects, not projects; worksheets; weekly quizzes, daily quizzes?" This series of questions was designed to inform research question 2c (In what ways does the mathematics classroom environment influence students' attitudes toward mathematics?).

These students described most of their math classes as traditionally structured. Ed's and Dee's responses below are typical of many students:

Ed: Like you get there, and there's, like, a warm-up and you do it, and then she starts teaching and she talks and talks and talks; and you're just copying what she says. You just kind of listen and you just — you know, you copy and you keep going.

And she says, “Oh, well there’s a ticket to leave” and you do it, and you pass it in. But you really sit there and you write what she’s doing, just writing. You can’t talk to anyone.

…

Dee: Well for me, there wasn’t a lot of group work. It was normally they taught a lesson. They gave you a page in the book to do the practices, and that night they gave you homework on what you learned that day, so that’s how my class has gone, and I don't know about the other ones.

Interviewer: And that’s all through high school?

Dee: Yeah. Pretty much.

Exceptions to the traditional approach were identified as Geometry, where several students said they frequently worked on projects with partners and a new course implemented for seniors this year called Advanced Mathematical Decision Making. The latter course is specifically designed to incorporate projects and group work and the teachers instructing this course were trained in these methods as part of the implementation process.

Most students said that these traditionally structured math classes negatively affect their attitudes toward math. They find their classes boring and uninteresting as exemplified in the following exchange with Steven and Greg:

Greg: Well in advanced algebra she pretty much gives us notes and makes us do work. Nothing else. She doesn't compare the stuff we're learning to real world things and it's just boring but in physics, he compares it to real world things and it makes me think it's going to be useful and I'm going to be able to use it eventually.

Interviewer: Do you, is there any time when you work in groups with other students in math?

Greg: In advanced algebra. No.

Interviewer: Any time in high school?

Greg: Not really.

Interviewer: No. Steven?

Steven: Basically she's boring.

Greg: We're talking about the same teacher.

Interviewer: All right.

Steven: She's really boring. And she likes, we get there and do the do now. You don't know how to do the do now and you just sit in the seat and then she'll make us notes. Take the notes and if you didn't write, she gives us ten minutes to write it and if you can't write it in time she takes it out and then she gives you the homework. If you don't do the homework you get an F. so—yes.

Interviewer: No projects.

Steven: No. She's a really boring teacher.

Interviewer: Have you done any projects in math in high school?

Steven: No.

Later in the conversation, both Greg and Steven said they would prefer more projects with Greg requesting real world connections and Steven saying, “at least something different than the everyday thing.” Both of these students say they have no strong feelings either way about math. Students from the other attitude categories responded similarly. Another problem that students identified with traditional teaching methods is their inability to learn methods at the same time they are transcribing notes:

Kathy: Before the eighth grade all my math teachers would just sit down and give us notes, constantly. Like, from bell to bell it would be notes, notes, notes; and I like — I just can’t take notes for an hour. I don't learn.

Lori [referring to her current teacher]: That’s one thing, like, she understands. She’ll give us the whole sheet of notes so we don't have to write it.

Interviewer: Yeah.

Lori: Cause she says when you write the notes and she explains it at the same time so you can just listen and then students ask questions when you get the worksheet.

Interviewer: Right.

Lori: That way when you have all the notes typed out in front of you it’s a lot easier because then you can just match it with what the teacher’s saying.

Interviewer: Okay. That's a good addition. I hadn't thought of that.

Kathy: Concentrating on writing down, you get all the right information down; and then listening to what he or she is saying? It's really hard.

Interviewer: Good.

Lori: And a lot of teachers don't understand that if they take the whole class period giving out notes like they think they're doing something; but no one's listening.

Ginny: We're not really learning either. We're sitting there and paying attention to what's being written, but we're not functioning and saying, okay, how did you do this problem? We don't ask questions until the end, and she's, like, "I just went over that." Yeah, but you were just talking about the notes. You didn't explain it.

Lori: It goes, like, in one ear and out the other. It doesn't stick.

Ginny: Yeah.

The situation described by Kathy, Lori, and Ginny makes perfect sense yet many teachers expect students to write and listen at the same time. Especially for students who struggle, this division of attention between two tasks almost ensures failure of one or the other or both. As Ginny points out ("We're not really learning either. We're sitting there and paying attention to what's being written, but we're not functioning..."), the students' passive roles inhibit processing of the content (Roth, 2005; Tobin, 2005).

Although students, not surprisingly, described group work and projects as more engaging, most call for a mix of traditional methods with activity. Mostly, students

described the need for variety in the classroom structure. It is as if these students already know that social interaction and communication between teacher and student and communication between student and student are catalysts for cognitive development (Brodie, 2006; Vygotsky, 1978).

Grade Levels of Changes in Attitude Toward Mathematics

The focus group interviews reveal changes in attitude toward math at earlier grade levels than were identified in the survey data. Table 59 shows the number of occurrences in which students mentioned a particular grade level and whether or not they mentioned the grade level positively or negatively. Students still mentioned grades nine and ten more frequently than the other grades; however, we see here some evidence that attitude changes frequently occur at middle school grades and earlier. These results align more closely with existing research than did the survey results. Of the forty-six students who participated in focus group discussions, more than a quarter of students mentioned experiences in each of seventh and eighth grades. As described above, student comments focused on the personality traits of the teacher and the learning environment. For example, "I think—I liked it in fifth grade because my teacher taught with a lot of games and made it interesting but in sixth grade I had this teacher that was really like hard and stuff like that and she didn't really work with anybody and I always stayed after, too and I still got like a C. So I think it started going downhill from there. Eighth grade was the only time that I liked it after that. That teacher really worked with me."

Table 59

Grade Levels at Which Focus Group Participants Indicate Change in Attitude Occurred

	Grade in School									
	1	2	3	4	5	6	7	8	9	10
Mentioned Grade Positively		1	2	2	1	7	2	6	11	4
Mentioned Grade Negatively	1		3	2	2	2	9	6	2	10
Total	1	1	5	4	3	9	11	12	15	14

I feel that neither the survey questions nor the focus group questions adequately explore grade levels of attitude change. Part of this issue results from all subjects being either juniors or seniors in high school. It is likely that their responses, particularly on the survey, focused on their most recent experiences. The focus group discussions provided more insight but grade level of attitude change was not specifically discussed in depth in all of the focus group sessions. Research with younger subjects might strengthen response accuracy about experiences and attitudes in upper elementary school. The current study yielded very little information about that grade range. This is a suggested area for future research.

Summary of Results – Focus Groups

Teachers have a strong impact on student attitudes toward math and influence them in positive and negative directions. Changes in student attitude often occur with a single teacher and remain until the student experiences a class with a teacher whose

personality traits and/or whose learning environment changes the polarity. These changes in attitude occur throughout middle school and high school. Students often project their feelings toward the teacher onto the subject area.

Students prefer teachers who make them feel supported and who foster their sense of mathematical self-efficacy. They want teachers who will spend extra time with them, treat them fairly, and who are patient with the student’s learning process. Students want their teachers to take their questions seriously and address them through alternative instructional methods.

CHAPTER 5

CONCLUSIONS AND TOPICS FOR FURTHER STUDY

Introduction

> *"It begins with one voice and builds with other voices. The collective crescendo is just now reaching a volume where we are all hearing and understanding."*
>
> -Joseph Brown

I became interested in the teaching and learning of mathematics at a very young age. My curiosity was piqued as a senior in high school when I was fortunate to be in the Calculus class of Mr. Harold Stengel. I'd always been a fairly good math student. I found the subject interesting, logical, and, well, easy. I wasn't a great student – I did enough to get the kind of grades that would please my parents and not much more. What struck me my senior year was how much I enjoyed Mr. Stengel's class. I *wanted* to do really well, I couldn't wait to try the homework problems and I recall wondering why my other math classes had not made me feel the same way. It was then I decided I wanted to teach high school mathematics. Later, I wondered why so many students entered my math classes having pre-determined that they would fail. Or if not fail, at least waste their time since math was beyond them and/or useless in their lives. I knew they were

wrong. I just had to make them believe that. If I could just change their attitudes! Thus began the journey that crescendos in the coming pages.

Summary of the Study

Having determined that my interest in the development of student attitudes toward mathematics is shared by many in the educational, business, and government sectors, I began my research study by looking to the existing literature on student attitudes toward mathematics and how they are influenced. Gleaning ideas about performance, self-concept, parent influence, teacher influence, and peer influence from the literature and identifying student voice as lacking, I developed a framework for my study.

I also explored various theoretical frames as possible lenses through which to view my data. Ideas about identity formation and verification along with developing self-efficacy beliefs through modeled behavior led me to Identity Theory and Social Learning Theory. I needed to understand how performance, self-concept, parents, teachers, and peers influence student attitudes from the student perspective. Following the procedures outlined in chapter 3, I culled student performance data from our student information system and set about locating the students' voices through the survey and focus group discussions described in chapters 3 and 4.

Findings

Data show that students in Revere generally experience declining performance in successive years of high school. The one exception is senior year where grades, on average, improve over junior year grades. Just over half of the students studied report their attitudes toward mathematics to be positively oriented. This is especially true for boys. Attitude is related to performance with students who perform consistently high and who have experienced gradual increases in performance reporting positive attitude orientation more frequently than their peers.

Over 60% of students studied say they are good at math. This is surprisingly high in light of data that shows 67% of students' performance is declining. One would expect students to have decreased mathematical self-concept as their performance declines. When considered within attitude toward math, the percentages of students who don't like math and who have no strong feelings toward math are surprisingly high as well; 20% and 50% respectively of these students report that they are good at math. These results show that students do not generally relate their ability in mathematics to their performance – a finding supported by student comments. Students look to performance (grades) as the primary indicator of whether or not they are good at math but many report they are good at math, despite poor performance, when conditions support their learning. These conditions include adequate effort on their own part and characteristics of the teacher. Students feel they can demonstrate they are good at math when they have patient teachers who are passionate about math and who make class fun by engaging students in

group and hands-on activities that relate to real world practices. These student comments reveal their attempts to preserve their own positive mathematical self-concept by imploring the teacher to help them in ways the students feel will foster achievement. Just about half of students with consistently low or significant negative grade changes say they are good at math. Three quarters of students with gradual decline in performance say they are good at math. The only demographic that showed a statistically significant difference on this metric was special education status; these students report lower mathematical self-concept.

Compared to the self-concept beliefs just discussed, student mathematical self-efficacy beliefs are low. This too is surprising as one would expect self-efficacy belief and self-concept beliefs to be consistent. Only about one-third of students reported that they are generally sure or pretty-sure that they answer a math problem correctly. This varied by gender with boys reporting more positive self-efficacy beliefs than girls.

Over the long term, students in this study indicate changes in attitude. These changes occur throughout their schooling but particularly in the middle school and early high school years. Boys report that they have always liked math with much greater frequency than girls, and attitude over time is closely related to the student's current attitude. A change in orientation of attitude can occur based solely on the teacher the student has for math class in a particular year. Orientation may persist or be reversed when the student experiences his or her next teacher.

Students attribute their attitudes toward math to themselves, the content, or to their teachers. Students who attribute their attitudes to themselves reference their ability levels (students who like math) and comprehension levels (students who do not like math). Students who attribute their attitude toward math to the content reference the level of difficulty as being easy (students who like math) or hard (students who do not like math). The students involved in this study do not feel that their friends influence their attitudes toward math. Surprisingly few students know whether or not their mothers/female guardians and fathers/male guardians like math. Nonetheless, students report that their parents influence their attitudes toward mathematics, especially their fathers. This is particularly true of students who like math. These students also report that their older siblings influence their attitudes toward math. By far, more students report that their teachers influence their attitudes toward math than anyone else. In addition to the teacher traits described above which generate positive attitude orientation, students say that their teachers engender negatively oriented attitudes when they teach the same way every day, lecture and give notes for whole class periods, treat them in ways that students perceive to be unfair, blame the students for lack of understanding after a new lesson has been taught, and do not provide students with adequate one-on-one help beyond the class period.

Revisiting the Research Questions

This study was intended to inform current student attitudes in Revere within the context of the national problem of inadequate flow in the science, technology, engineering, and mathematics pipeline. My hope was and remains to identify ways to foster positive student attitudes toward mathematics. I will now revisit reach of my research questions.

1. In what direction are Revere Public School students' attitudes toward mathematics oriented

Just over half (51.5%) of Revere High School juniors and seniors have positively oriented attitudes toward math. That is, these students report that they like math. An additional 23.2% of students have negatively oriented attitudes toward math and 25.3% have no strong feelings either way about math. Thus, Revere Public School students' attitudes toward math are positively oriented.

2. What factors do Revere Public Schools students attribute to the development of their attitude toward mathematics

Students attribute their attitudes toward math primarily to themselves, the content, and their teachers. They point to their own ability and level of comprehension as well as the degree of difficulty of the content. However, students feel all of these factors are largely controlled by their teachers. Except for students with special educations status,

students feel they are good at math when they have adequate support from the teacher and when their classroom experiences are varied.

a. Who (if anyone) do students identify as influencing their attitude toward mathematics

More than anyone, students identify their teachers as influencing their attitudes toward math. Parents also influence attitudes, especially fathers. Older siblings and extended family members are identified as influential but to a lesser degree.

b. What are the experiences that students identify as influencing their attitudes toward mathematics

Students describe the experiences that influence their attitudes toward math in terms of the relationship they have with their teacher and the type of learning environment created by the teacher. Since the latter will be discussed in the next question, I address only the former here. When students described experiences that positively influence their attitudes, they describe scenarios that include a teacher who the student felt went out of his/her way to help the student understand. They often described extra time the teacher spent with them after school. They spoke of the teacher's patience and persistence in helping the student achieve comprehension. When students spoke of experiences that influenced their attitudes negatively, they spoke of teachers who they felt treated them unfairly. For example, teachers who took points off exam and

homework grades because students didn't show work or didn't record the final answer according to some exacting format. They also spoke of teachers not answering their questions and blaming the student for lack of comprehension. Students reported that such scenarios caused them to disengage from the course, to not ask questions, and to dislike math.

c. In what ways does the mathematics classroom environment influence students' attitudes toward mathematics

The classroom environment has a strong impact on student attitudes toward mathematics. Because teachers control the environment, these factors are largely associated with the teacher him/herself. As indicated above, students want their teachers to be supportive. In addition, students prefer classroom environments that feature a mix of lecture/note taking with activity. Students see the utility of note taking but feel it becomes monotonous when applied every day or for full class periods. Students report working with peers facilitates their learning, especially in courses with large class size where teachers may not have time to get to everyone. They also would like teachers to connect the concepts they are learning to real-life situations through projects. Students say that working on projects and with peers both have a positive influence on their attitudes as such activities decrease boredom and monotony.

3. How stable are Revere Public Schools students' attitudes toward mathematics

Revere students' attitudes toward mathematics can be described as unstable. Only about half (49%) of the students studied report their attitude now to be the same as it has always been. Attitudes are more stable for students who report that they like math; 63% of these students report that they have always liked math. Of students who report that they do not like math or they have no strong feelings either way, this percentage who report attitude stability drops to thirty-three.

a. If attitudes are unstable, to what do students attribute reversals of orientation?

Students attribute reversals of orientation to the teacher they have in that particular school year and the classroom environment created by that teacher. They often project the feelings they have for the teacher onto the subject itself. Their feelings for the teacher are generally a function of how much help and support they perceive from the teacher and whether or not the teacher is able to make math fun/enjoyable for them.

b. How long-lasting do students report reversals of orientation to be?

Students describe the orientation of their attitude to be persistent until they experience a teacher who reverses it. Some students spoke of their attitudes changing annually and others spoke of one teacher who they describe as making them hate math for life.

I feel this study has answered all of the research questions adequately. The findings lend insight into how the attitudes of students in Revere develop, change, and are sustained. There are a number of inferences that can be drawn from this study and clear implications for practice in Revere and beyond. I speak to these in the next section.

Inferences and Implications

The findings from this study support the literature that identifies performance, self-concept, teachers, and (to a lesser degree) parents as impacting student attitudes toward mathematics. However, this study refutes findings in the literature that friends influence students' attitudes toward math. Connecting student voice to the prior research strengthens both the findings of this study and the findings of previously published studies.

Teachers and the classroom environment have the greatest impact on student attitudes toward math. About half of the students in Revere feel their mathematics experiences have generally been positive – they have experienced teachers who they feel have met their needs, they have been able to demonstrate strong performance, and they like math. But the other half of the students in Revere are struggling and frustrated. Students with low or declining performance (recall from chapter 4 that 67% of these students demonstrate declining performance) often feel that their mathematics grades do not adequately reflect their ability. The survey responses and focus group discussions reveal a great number of students who feel stifled by their teachers in their attempts to

learn. Many students in Revere are not experiencing mathematics in ways they feel are relevant or in ways that meet their learning needs. The relationships among performance, self-concept, and self-efficacy identified in this study reveal the need for further research in this area and will be discussed in the Topics for Future Study section below.

In chapter 2, I discussed literature on teachers and the influence they have on student attitudes. Part of the problem with instructional methods is attributed to un-credentialed and inexperienced teachers in urban environments. This is not the case in Revere. Every teacher at Revere high school is licensed by the state in mathematics. There are some who do not have degrees in mathematics but all have passed the comprehensive state teacher exam – they have the requisite content knowledge. I have to wonder then why our students are not experiencing the instructional practices that are known to be effective in both fostering achievement and positive attitudes. Perhaps the question should not be about student attitudes but, rather, about instructional methods employed by the Revere Mathematics Department. Students communicate this problem to exist across grade levels but to be worse at the high school level.

I know from our interactions when I was Director of Mathematics that teachers in Revere are aware of effective instruction. I wonder if teachers would describe the learning environment in as traditional terms as the students do. We need to learn from our teachers if there are barriers inhibiting the implementation of project-based and collaborative learning. And if so, we need to work with teachers to remove the barriers. I anticipate not enough planning time, rushing through curricula to meet state testing

requirements, and the volume of students each teacher services are viewed as impediments to project-based instruction. Nonetheless, students report that some teachers employ effective instructional methods such as group work and hands-on projects with great success. These are the teachers the students identified as inspiring their positive attitudes toward math. How do we leverage the expertise of these teachers in order to scale-up efficacy?

As I write this, Revere High School is planning to restructure beginning next school year. The new high school design will feature a separate “academy” for freshman, 80 minute instructional blocks, and twice weekly common planning for all teachers. I mention this because the long blocks of time are ideal for experiential learning and because the common planning creates the opportunity for sharing among teachers. I feel hopeful that we can leverage these resources to improve student attitudes toward mathematics.

A challenge that will remain despite these new resources is the level of teacher dedication and personality traits. In the confines of teacher unions and contracts, there is little I can do about curmudgeons. I can assure students that those who identify themselves early in their careers will not be granted tenure. I can also work with teachers to help them understand the traits that students find off-putting. I know myself that I often expressed exasperation when students did not understand something I “just taught”. Had I known how negatively students perceived these expressions, I would not have

made them. Just knowing would have made a difference for me and may for other teachers.

Topics for Future Study

Already, I have identified a topic for future study related to how teachers perceive the learning environments they create and what barriers exist that inhibit their use of effective instructional methods such as hands-on, real-world applications with projects and group work. It would be interesting to see whether or not teachers perceive the learning environments in similar ways as students do.

Also discussed above, Revere students describe higher mathematical self-concept than their performance data and their self-described mathematical efficacy beliefs warrant. Existing research describes American students' self-concept rates as inflated (Hufton, et al., 2002). This could be a reason for the incongruence here. The current study explored self-concept only through the two survey questions (Are you good at math? and How do you know this?) and was approached minimally during the focus group discussions. In addition, the researcher did not specifically ask students about their documented grade performance on the survey. A few students were asked about and/or discussed their grades/performance during the focus groups but this was neither universally nor deeply explored. Other than the information provided in consent forms (which subjects may or may not have seen since they were sent to parents) students were not informed that the researcher had accessed and analyzed their performance data.

Thus, students may have described their ability without considering grades or performance as evidence.

Interactions among the constructs of performance, self-concept, and self-efficacy for Revere students as well as more specific exploration of declining student performance trends at Revere High School are areas for additional research. The design of the current study caused students to be grouped for focus groups by self-described attitude rather than performance. As a result, performance was not highlighted in these discussions. In retrospect, I feel the researcher and the interviewer, without careful consideration of the matter, de-emphasized performance to prevent embarrassment of lower-performing students in discussions that also included their higher-performing peers. Targeted conversations that explore self-concept and self-efficacy *within* performance would provide students with the opportunity to describe how they feel the latter impacts the former two. Perhaps interviews with individual students in which we discuss their survey and focus group responses, along with their performance data would lend new insight.

This study also suggests future research involving parents. As indicated in chapter 4, very few parents appear to be speaking to their children about mathematics. The majority of students have no idea whether or not their parents like math or not. The data show a relationship between the parent's attitude toward math and the student's attitude toward math. Of interest would be a study that incorporates the parents' voice. This would enable analysis of the extent to which students' impressions of their parents' attitudes align with the orientation reported by the parent. Perhaps a study in which

students in a treatment group received increased parental communication about mathematics while students in a control group did not. Would this yield a difference in pre/post treatment attitudes toward math for the treatment group as measured against the control group? Such a study would yield greater insight into whether or not students report their attitudes toward math based on their parents' attitude toward math OR if students report their parents' attitudes toward math as similar to their own.

Also of interest would be research that specifically looks at sibling influence on attitude toward mathematics. This association is intuitive in terms of people selecting models to emulate, but it was largely un-documented in the existing literature. I wonder if older siblings even know that they have an impact on their brothers' and sisters' attitudes toward math. This is an influence we may be able to leverage to foster more positive attitude orientation.

The data on decreased mathematical self-concept beliefs among special education students is troubling. The fact that some special education students report positively oriented attitudes toward math indicates that there are factors we could capture and replicate. The special education students in this study reported factors that contribute to their attitudes toward mathematics as similar to those of their non-special education peers but the lack of specific focus on these students inhibits more complete detail. The scope of the current study did not explore this area in depth. In fact, the literature review leading to this study did not explore this area in depth. A study designed to investigate

just these students and their attitudes could identify key factors associated with this demographic.

The current study also surfaced a lingering gender gap in regard to current attitude toward math, long term attitude toward math, self-concept beliefs, self-efficacy beliefs, and impression of father's attitude toward math. In all of these areas, the responses of female students were oriented significantly less positively than were the responses of male students. This too was a surprise for me. I anticipated that the decades-old push to close this gap by engaging more female students in higher-level STEM course work and STEM focused activities would have evidenced a greater impact. Again, my research was not centrally focused in this area and it is a topic for future research. Two suggested veins of study are 1) Is the gender gap evident in other communities – those that are similar to Revere and those that are dissimilar to Revere? and 2) How does the gender gap evident in this study compare to longitudinal data about gender gaps in attitude toward mathematics? Perhaps, despite the differences here, there has been improvement. The impact of teacher gender on female students' attitudes may also provide insight. I vaguely recall reading about this relationship years ago but it did not surface during the literature review for this study; if current research exists, I expect it would have come up in broader searches for impact on attitude. Thus, I identify any relationship between teacher gender and student attitudes toward mathematics and specifically a relationship for female students as a topic for future study.

Finally, the survey data and focus group data from the current study on grade levels of changes in attitude were inconsistent with existing research. This topic should be explored in greater depth to determine whether or not students in this study were reflecting on recent events in reporting grade 9 and grade 10 as times of orientation reversal. Another way to approach this dynamic would be to replicate the study with younger students and compare the time frames of responses. Alternatively, one could conduct a longitudinal study in which one cohort of students is surveyed and focus groups conducted every couple of years to track attitude changes across their K-12 education.

Limitations of the Study

The section above identifies insufficient methods of the data collection that resulted in some aspects of attitude development being less than perfectly clear. Suggestions for studies that could enhance clarity are defined there as well.

This study was conducted with subjects from *two* grade levels on *one* school in *one* school district. The demographic characteristics of the students in this school and district and features specific to this school and district including their cultures and norms, their faculty, and their mathematics curriculum impact the scalability of these findings. As indicated in chapter 3, the results of this study are likely to align with similar studies conducted in districts similar to Revere. A determination as to whether or not results are

similar in more affluent school districts, or suburban school districts, or rural school districts can only be determined through replication of the study in such environments.

Conclusion

> *What we call the beginning is often the end. And to make an end is to make a beginning. The end is where we start from.*
>
> -*TS Eliot*

As I started my work on this dissertation, I sought to understand how students' attitudes toward math develop and whether or not there were things the students thought teachers (really I) could do to foster more positive attitudes toward math. That beginning was the end of the period of time when I "just" wondered. Now, as I close this dissertation, I come to a new end. One in which I understand that teachers, the types of activities in which they engage students, and the nurturing (or not) environments they create have the greatest impact on attitude for the students in my school district. As detailed in the previous pages, I learned many other things as well but teacher influence is most salient. I've also learned that there are many factors piquing my curiosity in new ways and which warrant further research. This is the end of my period of exploration and learning about students' attitudes toward math in Revere. In this ending, I begin the work of acting on what I have learned. I still need some time to process and determine next steps but I assure the reader, this ending is really just the beginning.

APPENDIX A

SURVEY

Survey in English

In Students' Words: The Development of Students' Attitudes Toward Mathematics – a Social Perspective

Dear Student,

My name is Dianne Kelly. I am a student in the Leadership in Urban Schools Doctoral Program at the University of Massachusetts, Boston. I am also the Assistant Superintendent of Schools here in Revere. I am conducting research about 11th and 12th grade Revere High School students' attitudes toward math. The purpose of this research is to help parents and teachers better understand students' view on what makes students like or dislike math – hopefully helping us find ways to develop more positive attitudes toward math.

If you are reading this, your parent or guardian has already given permission for you to complete this survey. Still, you do not have to fill out the survey if you don't want to. If you choose not to complete the survey, you can complete the essay assigned by your English teacher instead which is also in your envelope. By completing this survey, which should take about 30 minutes, you are giving me permission to use the information in my research study about student attitudes toward math. All information will be completely confidential and at no time will your name be used. If you choose to participate, your answers might help adults better understand some things that kids think make them like or dislike math. That can help us create better math classes so more kids will like math.

Have a good day,

1

In Students' Words: The Development of Students' Attitudes Toward Mathematics – a Social Perspective

1. What grade are you in? (circle one) 11^{th} 12^{th}

2. What is your gender? (circle one) Male Female

3. Which statement best describes your attitude toward math right now? (circle one)
   I like math   I don't like math   I don't have strong feelings either way

4. Which statement best describes how you have felt about math over time? (circle one)
   a. I've always liked math
   b. I used to like math but I don't any more
   c. I flip-flop a lot between liking and not liking math
   d. I used to dislike math but now I like it
   e. I've never liked math
   f. I've never had strong feelings either way

5. Why do you think you feel this way about math?

6. If you picked b, c, or d in #4, what grade or grades were you in when the change(s) happened? (if you picked a, e, or f, skip this question).

7. Does your mother/female guardian like math? (circle one) YES NO Not Sure Not applicable

8. If you said YES or NO for #7, how do you know this?

2

9. Does your father/male guardian like math? (circle one) YES NO Not Sure Not applicable

10. If you said YES or NO for #10, how do you know this?

11. Do most of your friends like math? (circle one) YES NO Not sure

12. If you said YES or NO for #11, how do you know this?

13. Do you think you are good at math? (circle one) YES NO Not sure

14. If you said YES or NO for #13, how do you know this?

15. When you solve math problems, how sure are you that you got the right answer? (circle one)

    a. I'm sure. I always get the problems right.
    b. Pretty sure. I almost always get the right answer.
    c. It depends on the problem. Sometimes I get them right, sometimes I don't.
    d. Yes because if I finish it, I usually get it right. I stop if I don't know what to do.
    e. I'm usually not sure if I did the problem right or not.

16. Are there any people in your life who you think have shaped your attitude toward math?

In Students' Words: The Development of Students' Attitudes Toward Mathematics – a Social Perspective

17. How do you know each of these people you listed in #16? (friend, uncle, aunt, parent, coach, grandparent, brother, sister, etc.)

18. Is there anything else you can tell me that you think will help me understand how students come to like or dislike math?

I'd like to learn more about these ideas by speaking to some students during focus groups. Focus groups are discussions that take place among a group of people. Our focus groups will take place during an upcoming SAT period and will include you, Jack Leonard who is my teacher at UMass Boston, and some of your classmates. You should know that the focus groups will be videotaped to make sure notes from the focus groups are accurate. At no time will your picture, voice or name be used in any of the documents that result from this study.

19. Are you willing to participate in a focus group? (circle one) YES NO
NOTE: If you say yes now but change your mind later, you do not have to be in a focus group. Simply tell your guidance counselor that you have changed your mind and do not wish to participate.

Thank you for taking the time to complete this survey. I will let you know what my research shows when my study is complete.

4

Survey in Spanish

Palabras de los Estudiantes: El Desarrollo de las Actitudes de los Estudiantes hacia las Matemáticas - Una Perspectiva Social

Estimado Estudiante,

Mi nombre es Dianne Kelly. Soy una estudiante en la Dirección del Programa de Doctorado de las Escuelas Urbanas en la Universidad de Massachusetts, Boston. También soy la Asistente del Superintendente de las Escuelas aquí en Revere. Estoy llevando a cabo la investigación sobre las actitudes de los estudiantes en los grados 11° y 12° de la Revere High School hacia las matemáticas. El propósito de esta investigación es el de ayudar a padres y maestros a entender mejor el punto de vista de los estudiantes sobre lo que hace que los estudiantes les gusta o no las matemáticas - esperando que nos ayude a encontrar formas de desarrollar actitudes más positivas hacia las matemáticas.

Si usted está leyendo esto, su padre o guardián ya ha dado permiso para que usted complete esta encuesta. Sin embargo, usted no tiene que llenar la encuesta si no quiere. Si usted decide en no completar la encuesta, en cambio usted puede completar el ensayo asignado por su profesor de Inglés que está también en el sobre. Al completar esta encuesta, que debería tomar alrededor de 30 minutos, usted me está dando permiso en usar la información en mi estudio de investigación sobre las actitudes de los estudiantes hacia las matemáticas. Toda información será completamente confidencial y en ningún momento su nombre será usado. Si usted decide participar, sus respuestas pueden ayudar a los adultos a comprender mejor algunas cosas que los niños piensan que hace que les guste o no las matemáticas. Eso nos ayudará a crear mejores clases de matemáticas así a mas niños les gustará las matemáticas.

Que tenga un buen día,

1

Palabras de los Estudiantes: El Desarrollo de las Actitudes de los Estudiantes hacia las Matemáticas - Una Perspectiva Social

1. ¿En que grado estás? (marque una)   11   12

2. ¿Cual es tu género? (marque una)   Masculino   Femenino

3. ¿Qué estado describe mejor tu actitud hacia las matemáticas en este momento? (marque una)
   Me gusta las matemáticas   No me gustan las matemáticas
   No tengo sentimientos muy fuertes de cualquier manera

4. ¿Qué estado mejor describe de cómo te has sentido acerca de las matemáticas a través del tiempo? (marque una)
   a. Siempre me gustaron las matemáticas
   b. Me gustaban las matemáticas pero ya no
   c. Cambio mucho de parecer entre gustarme o no las matemáticas
   d. No me gustaban las matemáticas antes pero ahora sí me gustan
   e. Nunca me gustaron las matemáticas
   f. Nunca tuve sentimientos muy fuertes de cualquier manera

5. ¿Por qué crees que te sientes así acerca de las matemáticas?

6. ¿Si escogiste b, c, o d en la # 4, en que grado o grados estabas cuando los cambios ocurrieron? (Si escogiste a, e, o f, omite esta pregunta).

7. ¿Le gusta a tu madre/guardián femenino las matemáticas? (marque una)
   SI   NO   NO ESTOY SEGURO/ A   NO ES APLICABLE

8. ¿Si dijo SI o NO en la # 7, como lo sabes?

2

Palabras de los Estudiantes: El Desarrollo de las Actitudes de los Estudiantes hacia las Matemáticas - Una Perspectiva Social

9. ¿Le gusta a tu padre/guardián masculino las matemáticas? (marque una)
SI   NO   NO ESTOY SEGURO/A   NO ES APLICABLE

10. ¿Si dijo SI o NO a la # 10, como lo sabes?

11. ¿Le gustan las matemáticas a la mayoría de tus amigos? (marque una)   SI   NO   NO ESTOY SEGURO/A

12. ¿Si dijo SI o NO a la # 11, como lo sabes?

13. ¿Tu crees que eres bueno en matemáticas? (marque una)   SI   NO   NO ESTOY SEGURO/A

14. ¿Si dijo SI o NO a la # 13, como lo sabes?

15. ¿Cuándo resuelves los problemas de matemáticas, que tan seguro/a estás de que tienes la respuesta correcta? (marque una)

   a. Estoy seguro/a. Siempre tengo los problemas correctos.
   b. Bastante seguro. Casi siempre tengo la respuesta correcta.
   c. Depende en el problema. A veces tengo la respuesta correcta, a veces no.
   d. Si la termino, generalmente es correcta. Me detengo si no se que hacer.
   e. Generalmente no estoy seguro/a si hice el problema bien o no.

16. ¿Hay alguna persona en su vida que usted piensa que han dirigido a su actitud hacia las matemáticas?

3

Palabras de los Estudiantes: El Desarrollo de las Actitudes de los Estudiantes hacia las Matemáticas - Una Perspectiva Social

17. ¿Como conoces a estas personas que mencionaste en la # 16? (amigo, tío, tía, padres, entrenadores, abuelos, hermano, hermana, etc.)

18. ¿Hay algo más que usted me puede decir que usted piensa que me ayudará a entender cómo los estudiantes llegan a gustarles o no las matemáticas?

Me gustaría aprender más acerca de estas ideas al hablar con algunos estudiantes durante grupos de enfoque. Grupos de Enfoque son debates que tienen lugar entre un grupo de personas. Nuestros grupos de Enfoque se llevarán a cabo durante el próximo período de SAT y le incluyen a Jack Leonard quien es mi maestro en UMass Boston, y algunos de sus compañeros de clase. Usted deberá saber que los grupos de enfoque serán grabados en video para asegurarnos que las notas son exactas. En ningún momento su imagen, voz o nombre será utilizado en cualquiera de los documentos que resulten de este estudio.

19. ¿Está dispuesto a participar en un grupo de enfoque? (marque una) SI NO

NOTA: Si usted dice si en este momento pero luego cambia de parecer, no debe de estar en un grupo de enfoque. Simplemente dígaselo a su consejero que usted cambió de parecer y no desea participar.

Gracias por tomarse el tiempo en completar esta encuesta. Cuando mi trabajo esté completo yo les dejaré saber que demostró mi investigación.

4

APPENDIX B

FOCUS GROUP QUESTIONS

In Students' Words: The Development of Students' Attitudes Toward Mathematics – a Social Perspective

For students who indicate **positive attitude** toward math:

1. Students who said they like math on the survey said they like math because [fill in after survey]. What do you think about that?

2. Was there any big event or experience that made you think "Gee, I really like math"? If so, what was it?

3. Was there ever a time that you didn't like math? If so,

    When?

    What made it change?

    Does it change often? If so, why?

4. Tell me about the math classes you've been in.

    How were classes structured? (a lot of independent work, lecture, group work, projects, etc.)

    What kinds of class structures do you like the most? Why?

    What role do you play in your math class? How do you influence what happens in class?

    How does your life outside of class impact what you do in class?

    What role do teachers play in your math classes? How does this vary with different teachers?

    How does what happens in math class make you either like math more or like math less?

    What happens if the work in math class is too hard? Too easy? How does this make you like math more or like math less?

    What do you do if you're not sure how to move on with solving a math problem?

    How important is the structure of the math class to making you either like or dislike math?

1

5. Tell me about your friends.

   Why do you think your friends like/dislike math?

   What do your friends say or do that let's you know this?

   Does that impact how you feel about math at all?

   Do you think how you feel about math influences your friends?

6. Tell me about your parents/guardians.

   Why do you think your parents/guardians like/dislike math?

   What do your parents/guardians say or do that let's you know this?

   Does that impact how you feel about math at all?

   Do you think how you feel about math influences your parents/guardians?

7. Is there anyone else in your life who has influenced how you feel about math? If so, what did they say or do that influenced you?

8. Is there anything else you think you should explain that will help people understand how you came to like math and what/who influences your attitudes?

In Students' Words: The Development of Students' Attitudes Toward Mathematics – a Social Perspective

For students who indicate **negative attitude** toward math:

1. Students who said they dislike math on the survey said they don't like math because [fill in after survey]. What do you think about that?

2. Was there any big event or experience that made you think "Gee, I really don't like math"? If so, what was it?

3. Was there ever a time when you liked math? If so,

   When?

   What made it change?

   Does it change often? If so, why?

4. Tell me about the math classes you've been in.

   How were classes structured? (a lot of independent work, lecture, group work, projects, etc.)

   What kinds of class structures do you like the most? Why?

   What role do you play in your math class? How do you influence what happens in class?

   How does your life outside of class impact what you do in class?

   What role do teachers play in your math classes? How does this vary with different teachers?

   How does what happens in math class make you either like math more or like math less?

   What happens if the work in math class is too hard? Too easy? How does this make you like math more or like math less?

   What do you do if you're not sure how to move on with solving a math problem?

   How important is the structure of the math class to making you either like or dislike math?

3

5. Tell me about your friends.

   Why do you think your friends like/dislike math?

   What do your friends say or do that let's you know this?

   Does that impact how you feel about math at all?

   Do you think how you feel about math influences your friends?

6. Tell me about your parents/guardians.

   Why do you think your parents/guardians like/dislike math?

   What do your parents/guardians say or do that let's you know this?

   Does that impact how you feel about math at all?

   Do you think how you feel about math influences your parents/guardians?

7. Is there anyone else in your life who has influenced how you feel about math? If so, what did they say or do that influenced you?

8. Is there anything else you think you should explain that will help people understand how you came to dislike math and what/who influences your attitudes?

In Students' Words: The Development of Students' Attitudes Toward Mathematics – a Social Perspective

For students who indicate **no strong feelings either way** toward math:

1. Students who said they like math on the survey said they like math because [fill in after survey]. Students who said they dislike math on the survey said they dislike math because [fill in after survey]. What do you think about that?

2. Was there ever a time when you had stronger feelings in one direction about math? If so,

   When?

   What made it change?

   Does it change often? If so, why?

3. Tell me about the math classes you've been in.

   How were classes structured? (a lot of independent work, lecture, group work, projects, etc.)

   What kinds of class structures do you like the most? Why?

   What role do you play in your math class? How do you influence what happens in class?

   How does your life outside of class impact what you do in class?

   What role do teachers play in your math classes? How does this vary with different teachers?

   How does what happens in math class make you either like math more or like math less?

   What happens if the work in math class is too hard? Too easy? How does this make you like math more or like math less?

   What do you do if you're not sure how to move on with solving a math problem?

   How important is the structure of the math class to making you either like or dislike math?

5

4. Tell me about your friends.

   Why do you think your friends like/dislike math?

   What do your friends say or do that let's you know this?

   Does that impact how you feel about math at all?

   Do you think how you feel about math influences your friends?

5. Tell me about your parents/guardians.

   Why do you think your parents/guardians like/dislike math?

   What do your parents/guardians say or do that let's you know this?

   Does that impact how you feel about math at all?

   Do you think how you feel about math influences your parents/guardians?

6. Is there anyone else in your life who has influenced how you feel about math? If so, what did they say or do that influenced you?

7. Is there anything else you think you should explain that will help people understand how you came to be indifferent about math and what/who influences your attitudes?

APPENDIX C

ADDITIONAL ANALYSIS TABLES

ANALYSYS OF ATTITUDE AND VARIOUS DEMOGRAPHICS

Attitude and Grade

Table 7

Crosstab Analysis of Attitude Toward Mathematics with Grade

Crosstab					
			Grade		Total
			11.00	12.00	
Attitude	I don't like math	Count	72	64	136
		% within Grade	23.3%	23.2%	23.2%
	I like math	Count	155	146	301
		% within Grade	50.2%	52.9%	51.5%
	No strong feelings	Count	82	66	148
		% within Grade	26.5%	23.9%	25.3%
Total		Count	309	276	585
		% within Grade	100.0%	100.0%	100.0%

Table 7 shows slightly more seniors report “I like math” than do juniors and slightly more juniors report “no strong feelings” toward math compared to seniors; however, these results are not significantly different.

Attitude and Socio-economic Status

INCOME ELIGIBILITY GUIDELINES

Effective from July 1, 2009 to June 30, 2010

HOUSEHOLD SIZE	FEDERAL POVERTY GUIDELINES ANNUAL	REDUCED PRICE MEALS - 185 % ANNUAL	MONTHLY	TWICE PER MONTH	EVERY TWO WEEKS	WEEKLY	FREE MEALS - 130 % ANNUAL	MONTHLY	TWICE PER MONTH	EVERY TWO WEEKS	WEEKLY
48 CONTIGUOUS STATES, DISTRICT OF COLUMBIA, GUAM, AND TERRITORIES											
1	10,830	20,036	1,670	835	771	386	14,079	1,174	587	542	271
2	14,570	26,955	2,247	1,124	1,037	519	18,941	1,579	790	729	365
3	18,310	33,874	2,823	1,412	1,303	652	23,803	1,984	992	916	458
4	22,050	40,793	3,400	1,700	1,569	785	28,665	2,389	1,195	1,103	552
5	25,790	47,712	3,976	1,988	1,836	918	33,527	2,794	1,397	1,290	645
6	29,530	54,631	4,553	2,277	2,102	1,051	38,389	3,200	1,600	1,477	739
7	33,270	61,550	5,130	2,565	2,368	1,184	43,251	3,605	1,803	1,664	832
8	37,010	68,469	5,706	2,853	2,634	1,317	48,113	4,010	2,005	1,851	926
For each add'l family member, add	3,740	6,919	577	289	267	134	4,862	406	203	187	94

Figure 6: Free/reduced Lunch Income Eligibility Guidelines 2010-2011. Source: http://www.fns.usda.gov/cnd/governance/notices/iegs/IEGs10-11.htm

Table 8

Crosstab Analysis of Attitude Toward Mathematics with Socio-economic Status

Crosstab

			SocEc			Total
				F	R	
Attitude	I don't like math	Count	41	82	13	136
		% within SocEc	22.5%	24.9%	17.6%	23.2%
	I like math	Count	91	168	42	301
		% within SocEc	50.0%	51.1%	56.8%	51.5%
	No strong feelings	Count	50	79	19	148
		% within SocEc	27.5%	24.0%	25.7%	25.3%
Total		Count	182	329	74	585
		% within SocEc	100.0%	100.0%	100.0%	100.0%

The most notable statistic from Table 8 shows that a students who qualify for reduced lunch report liking math with greater frequency than their classmates who qualify for free lunch and their classmates of higher SES. These students also report not

liking math with less frequency than both other groups. Nonetheless, the results are substantially similar and differences are not significant.

Attitude and Special Education Status

Table 9

Crosstab Analysis of Attitude Toward Mathematics with Special Education Status

Crosstab

			SPED		Total
				1	
Attitude	I don't like math	Count	125	11	136
		% within SPED	22.7%	32.4%	23.2%
	I like math	Count	286	15	301
		% within SPED	51.9%	44.1%	51.5%
	No strong feelings	Count	140	8	148
		% within SPED	25.4%	23.5%	25.3%
Total		Count	551	34	585
		% within SPED	100.0%	100.0%	100.0%

Although more students with special education status report they do not like math, attitudes are very similar when disaggregated by this demographic.

Attitude and ELL Status

Table 10

Crosstab Analysis of Attitude Toward Mathematics With ELL Status

Crosstab

				ELL Status		Total
				1	2	
Attitude	I don't like math	Count	115	7	14	136
		% within ELL Status	23.6%	25.9%	20.0%	23.2%
	I like math	Count	240	18	43	301
		% within ELL Status	49.2%	66.7%	61.4%	51.5%
	No strong feelings	Count	133	2	13	148
		% within ELL Status	27.3%	7.4%	18.6%	25.3%
Total		Count	488	27	70	585
		% within ELL Status	100.0%	100.0%	100.0%	100.0%

Higher percentages of students with ELL status (both students who currently receive ELL services and those who Used to receive ELL services but no longer do) report that they like math. It seems these students are less indecisive about their attitudes toward math as so few reported “I have no strong feelings either way” compared to their peers. However, results do not vary substantially when disaggregated by this demographic.

Attitude Over Time and Socio-economic Status

Table 16

Crosstab of Attitude Over Time Toward Mathematics with Socio-economic Status

Crosstab

			SocEc			Total
				F	R	
Attitude Over Time	always liked	Count	54	123	26	203
		% within SocEc	29.7%	37.4%	35.1%	34.7%
	didn't do	Count	18	24	4	46
		% within SocEc	9.9%	7.3%	5.4%	7.9%
	flip-flop	Count	59	82	24	165
		% within SocEc	32.4%	24.9%	32.4%	28.2%
	never liked	Count	24	38	8	70
		% within SocEc	13.2%	11.6%	10.8%	12.0%
	never strong feelings	Count	14	18	3	35
		% within SocEc	7.7%	5.5%	4.1%	6.0%
	used to don't	Count	13	44	9	66
		% within SocEc	7.1%	13.4%	12.2%	11.3%
Total		Count	182	329	74	585
		% within SocEc	100.0%	100.0%	100.0%	100.0%

Students with SES status are more likely to say they have always liked math than their non-SES peers. They are also more likely to say they used to like math but now they don't. These differences do not vary significantly.

Attitude Over Time and English Language Learner Status

Table 17

Crosstab Analysis of Attitude Over Time Toward Mathematics with ELL Status

Crosstab						
				ELL		Total
				1	2	
Attitude Over Time	always liked	Count	163	12	28	203
		% within ELL	33.4%	44.4%	40.0%	34.7%
	didn't do	Count	38	1	7	46
		% within ELL	7.8%	3.7%	10.0%	7.9%
	flip-flop	Count	138	5	22	165
		% within ELL	28.3%	18.5%	31.4%	28.2%
	never liked	Count	62	3	5	70
		% within ELL	12.7%	11.1%	7.1%	12.0%
	never strong feelings	Count	32	2	1	35
		% within ELL	6.6%	7.4%	1.4%	6.0%
	used to don't	Count	55	4	7	66
		% within ELL	11.3%	14.8%	10.0%	11.3%
Total		Count	488	27	70	585
		% within ELL	100.0%	100.0%	100.0%	100.0%

Note. Due to low counts in some cells, the Monte Carlo method was used.

More ELL students say they have always liked math. This is particularly true of students currently receiving ELL services. Fewer of these students also say that their attitude toward math flip-flops and that they didn’t like math but now they do. Again, results do not vary greatly by this demographic.

Attitude Over Time and Special Education Status

Table 18

Crosstab Analysis of Attitude Over Time Toward Mathematics with SPED Status

Crosstab

			SPED		Total
				1	
AttitudeOverTime	always liked	Count	194	9	203
		% within SPED	35.2%	26.5%	34.7%
	didn't do	Count	46	0	46
		% within SPED	8.3%	.0%	7.9%
	flip-flop	Count	155	10	165
		% within SPED	28.1%	29.4%	28.2%
	never liked	Count	64	6	70
		% within SPED	11.6%	17.6%	12.0%
	never strong feelings	Count	33	2	35
		% within SPED	6.0%	5.9%	6.0%
	used to don't	Count	59	7	66
		% within SPED	10.7%	20.6%	11.3%
Total		Count	551	34	585
		% within SPED	100.0%	100.0%	100.0%

More students with SPED status have never liked math and used to like math but no longer do. These students are also less likely to report that they always liked math. Differences are not statistically significant.

Attitude Over Time and Grade

Table 19

Crosstab Analysis of Attitude Over Time Toward Mathematics with Grade

Crosstab

			Grade		Total
			11.00	12.00	
AttitudeOverTime	always liked	Count	101	102	203
		% within Grade	32.7%	37.0%	34.7%
	didn't do	Count	27	19	46
		% within Grade	8.7%	6.9%	7.9%
	flip-flop	Count	90	75	165
		% within Grade	29.1%	27.2%	28.2%
	never liked	Count	39	31	70
		% within Grade	12.6%	11.2%	12.0%
	never strong feelings	Count	20	15	35
		% within Grade	6.5%	5.4%	6.0%
	used to don't	Count	32	34	66
		% within Grade	10.4%	12.3%	11.3%
Total		Count	309	276	585
		% within Grade	100.0%	100.0%	100.0%

There is virtually no difference by grade level for attitude toward mathematics over time. Seniors are slightly more likely than juniors to report that they have always liked math. These results are not statistically significant.

Good at Math and Socio-economic Status

Table 26

Crosstab Analysis of "Do you think you are good at math?" with Socio-economic Status

Crosstab						
			SocEc			Total
				F	R	
GoodAtMath	no	Count	32	57	9	98
		% within SocEc	17.8%	17.4%	12.2%	16.8%
	not sure	Count	32	62	19	113
		% within SocEc	17.8%	18.9%	25.7%	19.4%
	yes	Count	116	209	46	371
		% within SocEc	64.4%	63.7%	62.2%	63.7%
Total		Count	180	328	74	582
		% within SocEc	100.0%	100.0%	100.0%	100.0%

Students who qualify for reduced lunch status replied no to this question with less frequency and replied "I'm not sure" with greater frequency than their peers. However, differences are not statistically significant.

Good at Math and English Language Learner Status

Table 27

Crosstab Analysis of "Do you think you are good at math?" with ELL Status

Crosstab						
			ELL			Total
				1	2	
GoodAtMath	no	Count	83	4	11	98
		% within ELL	17.1%	15.4%	15.5%	16.8%
	not sure	Count	92	10	11	113
		% within ELL	19.0%	38.5%	15.5%	19.4%
	yes	Count	310	12	49	371
		% within ELL	63.9%	46.2%	69.0%	63.7%
Total		Count	485	26	71	582
		% within ELL	100.0%	100.0%	100.0%	100.0%

Students who are currently receiving ELL services (ELL status 1) are less sure about whether or not they are good at math. These students responded "yes" to this question with much less frequency than their former ELL status and no ELL status peers. The difference is not statistically significant.

Good at Math and Grade

Table 28

Crosstab Analysis of "Do you think you are good at math?" with Grade

Crosstab

			Grade		Total
			11.00	12.00	
GoodAtMath	no	Count	44	54	98
		% within Grade	14.3%	19.7%	16.8%
	not sure	Count	66	47	113
		% within Grade	21.4%	17.2%	19.4%
	yes	Count	198	173	371
		% within Grade	64.3%	63.1%	63.7%
Total		Count	308	274	582
		% within Grade	100.0%	100.0%	100.0%

These results show that slightly more seniors feel they are not good at math compared to juniors. The differences are not statistically significant.

Good at Math and Gender

Table 29

Crosstab Analysis of "Do you think you are good at math?" with Gender

Crosstab					
			Gender		Total
			Female	Male	
GoodAtMath	no	Count	59	39	98
		% within Gender	19.6%	13.9%	16.8%
	not sure	Count	61	52	113
		% within Gender	20.3%	18.5%	19.4%
	yes	Count	181	190	371
		% within Gender	60.1%	67.6%	63.7%
Total		Count	301	281	582
		% within Gender	100.0%	100.0%	100.0%

Girls report that they are not good at math with grater frequency and that they are good at math with less frequency than boys. Again, these differences are not statistically significant.

Mother's Attitude and Socio-economic Status

Table 40

Crosstab Analysis of Mother's Attitude Toward Math with Socio-economic Status

Crosstab

			MomAtt			Total
			no	not sure	yes	
SocEc		Count	39	98	38	175
		% within SocEc	22.3%	56.0%	21.7%	100.0%
	F	Count	63	198	57	318
		% within SocEc	19.8%	62.3%	17.9%	100.0%
	R	Count	11	46	14	71
		% within SocEc	15.5%	64.8%	19.7%	100.0%
Total		Count	113	342	109	564
		% within SocEc	20.0%	60.6%	19.3%	100.0%

Students with reduced lunch status report that their mothers do not like math with less frequency than their peers. Students without SES status are more sure about their mothers attitudes (responded I don't know with less frequency) and more frequently report that their mothers like math. These results are not statistically significant.

Mother's Attitude and Special Education Status

Table 41

Crosstab Analysis Mother's Attitude Toward Math with SPED Status

Crosstab

			MomAtt			Total
			no	not sure	yes	
SPED		Count	103	323	105	531
		% within SPED	19.4%	60.8%	19.8%	100.0%
	1	Count	10	19	4	33
		% within SPED	30.3%	57.6%	12.1%	100.0%
Total		Count	113	342	109	564
		% within SPED	20.0%	60.6%	19.3%	100.0%

Students with special education status report that their mothers do not like math with greater frequency and that their mothers like math with less frequency than their non-special education peers. These results are not statistically significant.

Mother's Attitude and Grade

Table 42

Crosstab Analysis of Mother's Attitude Toward Math with Grade

Crosstab

			MomAtt			Total
			no	not sure	yes	
Grade	11.00	Count	58	184	61	303
		% within Grade	19.1%	60.7%	20.1%	100.0%
	12.00	Count	55	158	48	261
		% within Grade	21.1%	60.5%	18.4%	100.0%
Total		Count	113	342	109	564
		% within Grade	20.0%	60.6%	19.3%	100.0%

There is virtually no difference between how 11th grade students report their mothers' attitudes toward math compared to how 12th grade students report their mothers' attitudes toward math.

Mother's Attitude and Gender

Table 43

Crosstab Analysis of Mother's Attitude Toward Math with Gender

Crosstab

			MomAtt			Total
			no	not sure	yes	
Gender	Female	Count	57	172	65	294
		% within Gender	19.4%	58.5%	22.1%	100.0%
	Male	Count	56	170	44	270
		% within Gender	20.7%	63.0%	16.3%	100.0%
Total		Count	113	342	109	564
		% within Gender	20.0%	60.6%	19.3%	100.0%

Table 34 shows that girls report that their mothers like math with greater frequency than boys do. Nonetheless, these results are not statistically significant.

ANALYSIS OF FATHER'S ATTITUDE AND VARIOUS DEMOGRAPHICS

Father's Attitude and Socio-economic Status

Table 49

Crosstab Analysis of Father's Attitude Toward Math with SES

Crosstab

			DadAtt			Total
			no	not sure	yes	
SocEc		Count	25	88	58	171
		% within SocEc	14.6%	51.5%	33.9%	100.0%
	F	Count	26	175	96	297
		% within SocEc	8.8%	58.9%	32.3%	100.0%
	R	Count	7	42	22	71
		% within SocEc	9.9%	59.2%	31.0%	100.0%
Total		Count	58	305	176	539
		% within SocEc	10.8%	56.6%	32.7%	100.0%

Students who qualify for free or reduced lunch know less about their fathers' attitudes toward math. Students with higher SES report that their fathers do not like math with greater frequency. These results are not statistically significant.

Father's Attitude and English Language Learner Status

Table 50

Crosstab Analysis of Father's Attitude Toward Math with ELL Status

			DadAtt			Total
			no	not sure	yes	
ELL		Count	50	259	139	448
		% within ELL	11.2%	57.8%	31.0%	100.0%
	1	Count	3	12	10	25
		% within ELL	12.0%	48.0%	40.0%	100.0%
	2	Count	5	34	27	66
		% within ELL	7.6%	51.5%	40.9%	100.0%
Total		Count	58	305	176	539
		% within ELL	10.8%	56.6%	32.7%	100.0%

Former ELL students are less likely than their peers to say their fathers do not line math. Students with ELL status, are more likely to say their fathers do like math compared to their peers with no ELL status. Current ELL students also appear more sure about their fathers' attitudes toward math. These results are not statistically significant.

Father's Attitude and Special Education Status

Table 51

Crosstab Analysis of Father's Attitude Toward Math with SPED Status

			DadAtt			Total
			no	not sure	yes	
SPED		Count	56	286	166	508
		% within SPED	11.0%	56.3%	32.7%	100.0%
	1	Count	2	19	10	31
		% within SPED	6.5%	61.3%	32.3%	100.0%
Total		Count	58	305	176	539
		% within SPED	10.8%	56.6%	32.7%	100.0%

Students with special education status are less sure about their fathers' attitudes toward math; however, these results are not statistically significant.

Father's Attitude and Grade

Table 52

Crosstab Analysis of Father's Attitude Toward Math with Grade

Crosstab

			DadAtt			Total
			no	not sure	yes	
Grade	11.00	Count	27	166	94	287
		% within Grade	9.4%	57.8%	32.8%	100.0%
	12.00	Count	31	139	82	252
		% within Grade	12.3%	55.2%	32.5%	100.0%
Total		Count	58	305	176	539
		% within Grade	10.8%	56.6%	32.7%	100.0%

There is virtually no difference in how juniors report their fathers' attitudes toward math compared to how seniors report their fathers' attitudes toward math.

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