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The Effects Of A Sustained, Job-Embedded Professional Development On Elementary Teachers' Math Teaching Self-Efficacy And The Resulting Effects On Their Students' Achievement

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ABSTRACT OF DISSERTATION

Krista Louise Althausen

College of Education

Eastern Kentucky University

2010

THE EFFECTS OF A SUSTAINED, JOB-EMBEDDED PROFESSIONAL
DEVELOPMENT ON ELEMENTARY TEACHERS' MATH TEACHING SELF-
EFFICACY AND THE RESULTING EFFECTS ON THEIR STUDENTS'
ACHIEVEMENT

ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Education in the
College of Education
at Eastern Kentucky University

By
Krista Louise Althausen

Richmond, Kentucky

December 18, 2010

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THE EFFECTS OF A SUSTAINED, JOB-EMBEDDED PROFESSIONAL DEVELOPMENT ON ELEMENTARY TEACHERS' MATH TEACHING SELF-EFFICACY AND THE RESULTING EFFECTS ON THEIR STUDENTS' ACHIEVEMENT

This study investigated the impact of a district-wide mathematics professional development program on elementary teachers' general and personal efficacy. It also explored connections among teacher efficacy and socioeconomic status with student achievement.

Using a quantitative approach, a job-embedded professional development initiative sustained over a 2-year period with 35 teachers was found to increase teachers' general and personal efficacy in teaching mathematics. The investigation of the professional development work was based on the principles of effective mathematics professional development, efficacy theory, and student achievement. To measure perceptions of teachers' general and personal efficacy, teachers of third graders in 10 Kentucky elementary schools were asked to complete the Math Teaching Efficacy Instrument (Enochs & Riggs, 1990) version of the Teacher Efficacy Scale (Gibson & Dembo, 1984). Of the 40 original participants, 35 returned usable surveys for a return rate of 88%. The measure of student achievement for this study was mathematics scores derived solely from the performance of third graders on Kentucky's state-mandated Kentucky Core Content Test for mathematics.

Teachers' general and personal efficacy was measured using a paired-samples *t* test. The *t* test revealed a significant difference in teachers' general and personal efficacy before and after the professional development program.

Student achievement was regressed over the measures of teachers' general efficacy, teachers' personal efficacy, and socioeconomic status (lunch status). This regression model yielded general efficacy and socioeconomic status as significant predictors of student achievement.

In addition, it was determined that a relationship exists between teachers' general efficacy and student socioeconomic status with student achievement in mathematics. Although the study did not find that teachers' personal efficacy was a significant predictor of student achievement, an indirect relationship could be implied because personal efficacy was correlated with general efficacy. Thus, the researcher concluded

that job-embedded, sustained professional development indirectly leads to improved student achievement in mathematics. This finding was true even when socioeconomic status was taken into account.

KEYWORDS: Professional Development, Teacher General Efficacy, Teacher Personal Efficacy, Socioeconomic Status, Student Achievement

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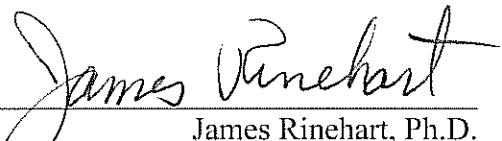
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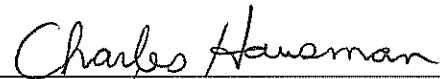
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This dissertation is dedicated to my husband, Scott Althaus, and to our children, Meghan and Bradley, for their support, patience, and sacrifices made so I could fulfill a lifelong dream. Thank you for the inspiration to get it done.

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CHAPTER ONE: INTRODUCTION

A central component of nearly every school district's initiative to help meet the demands of educating children is a professional development program for teachers. School districts are continuously challenged to provide effective professional development that focuses on increasing content knowledge through the use of research-based pedagogy. Increasing this challenge is the need to determine how to design professional development to strengthen educators' skills, knowledge, and attitudes to effectively attend to students' learning requirements. The No Child Left Behind Act of 2001 (NCLB) mandated the employment of "highly qualified" teachers (NCLB, 2001, p. 29). Buell, Kober, Pickerton, and Scott (2004) made the connection among a strong professional community, the improvement of instructional capacity, and raising academic achievement: The fundamental link is teachers.

Guskey (2003) stated that high-quality teachers are the key to improved student learning. The quandary is how teachers develop into effective educators to make the necessary connections to produce student achievement. Cohen and Hill (2000) identified professional development as the catalyst in the process to help teachers evolve into highly qualified educators.

The challenge for school district leaders and policymakers is to determine how best to provide professional growth opportunities for their educators. To produce sustained gains in student learning, effective opportunities must be provided for teachers to enhance both their pedagogical skill and content knowledge (Elmore, 2002). The National Staff Development Council (NSDC) outlined a framework to support an

intensive, ongoing, job-embedded, professional development program connected to practice as a means of producing stronger learning. This design is in direct contrast to traditional professional development, which could be described as a one-shot workshop that falls short, resulting in very little, if any, impact on teacher practices or student learning. Researchers and professional development designers have reached a broad agreement on the key features of effective professional development programs that lead to positive changes in teaching practices (Elmore, 2002; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; Wilson & Berne, 1999). These key features of a professional development program include research-based teaching and learning; aligning the professional development with school curriculum and assessments; and a goal of student learning.

In 2009, Kentucky legislatures passed Senate Bill 1, which mandates more concise, rigorous content standards and effective implementation tools for teachers. Professional development is an essential component of this education reform. Effective teacher training will be needed to implement the new Kentucky's core academic standards (Higher Education Work Group, 2009); research-based teaching methods, and technology appropriate to support these programs. Research studies suggest that well-designed professional development makes a positive impact on teacher practice and influences student achievement (Desimone, Porter, Garet, Yoon, & Birman, 2002; Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 2003; Stein, Smith, & Silver, 1999).

Principles and Standards for School Mathematics (National Council of Teachers of Mathematics [NCTM], 2000) identified the vital importance of teacher knowledge, understanding, and skill for student learning. Reform efforts heralded by Kentucky's new

core academic standards advocate a shift from teacher-centered to student-centered instruction. This shift emphasizes the need for alternative ways to teach and assess student learning. Teaching practices are often cited as the primary reason for lack of student achievement. Many teachers do not have sufficient conceptual understanding of mathematics and rely on rote computation and algorithms for instruction (Ball, 1990; Battista, 1994; Boaler, 1999; deBerg & Grieve, 1999; Gerretson, Bosnick, & Schofield, 2008; Goos, 2004; Ma, 1999; Smith, 1996). Consequently, districts and principals diligently search for the right kinds of mathematics professional development to help teachers educate their students.

Research into effective professional development for mathematics teachers echoed the same essential elements of professional development in general. Firestone, Mangin, Martinez, and Polovsky (2005) stated that successful content knowledge training consists of the subject matter being presented in a classroom-friendly form that includes materials, examples, and student activities. Opportunities for teachers to incorporate these concepts and suggestions into their daily teaching are also critical (Firestone et al., 2005). Mathematics teacher training should concentrate on pedagogical strategies, which include an in-depth focus on methods that require teachers to manipulate materials and ideas to explore concepts and make connections between math concepts and student learning.

According to Firestone et al. (2005), teachers should be introduced to a set of activities, materials, or ideas and then be given the opportunity for practice and reflection. These learning opportunities for teachers should model the instructional strategies they are expected to use. To be effective, these activities and strategies should represent an integral part of teachers' daily practice rather than additional tasks. According to Stiff

(2000), mathematics professional development should include time: time for teachers to examine reform-based curricula, time to collaborate with colleagues, and time to integrate new mathematics content and teaching strategies. Additional research-based recommendations indicate that mathematics teachers should receive small to moderate levels of instruction in mathematics theory and applications of mathematics as well as content standards, curriculum materials, technology use, and strategies for assessing student learning (Telese, 2008).

NCTM (1991) stressed the importance of focusing on high standards and in-depth learning opportunities for teachers. The professional development standards set by NCTM focus on (a) modeling good mathematics teaching, (b) knowing mathematics and school mathematics, (c) knowing students as learners of mathematics, (d) knowing mathematical pedagogy, (e) developing as a teacher of mathematics, and (f) defining teachers' roles in professional development. Professional development should be challenging, authentic, collegial, and collaborative, addressing the teaching process and how students learn. It must provide teacher-centered, curriculum-specific opportunities, and long-term support targeted at developing teachers who can teach mathematics to every student (NCTM, 1991).

In a sense, all teachers can and do teach—but teachers differ in the kinds of learning practices that become accepted as appropriate by teachers and students (Boaler, 1999). How children learn mathematics has been defined by two different theories: the behaviorist theory and the constructivist theory. Both theories have had a significant impact on how mathematics is taught in the United States. The behaviorist theory states that learning occurs when a connection is established between some stimulus and a

person's response to it (Battista, 1999). Goos (2004) described the behaviorist approach to teaching as traditional, dominated by the use of textbooks. In the classroom, the behaviorist learning environment resembles students listening to and watching the teacher demonstrate computational skills and mathematical procedures, and then imitating what was demonstrated by completing problems from a textbook, followed by memorization and reproduction of procedures (Battista, 1999; Goos, 2004).

In contrast, the constructivist theory reflects reform-oriented mathematics classrooms where very different learning practices, such as discussion and collaboration, are valued in building a climate of intellectual challenge (Goos, 2004). According to Steffe and D'Ambrosio (1995), constructivist teachers study the knowledge constructions of their students and interact with students in a learning space designed by, at least in part, the teacher's working knowledge of students' understanding of concepts and ideas. The definition implies that constructivist mathematics teachers listen to learners in ways that allow them to build a model of each learner's mathematical knowledge. Within this context, the teacher's reflection focused on how the students comprehended the math content and their level of ability to construct models and apply that knowledge to new constructs.

The process of teachers reflecting on their instruction and student learning was seen as an essential factor for constructing teacher knowledge, particularly teacher pedagogical knowledge (Wilson, Shulman, & Richert, 1987). In a constructivist classroom, the learning environment includes teachers encouraging students to think and explore mathematics using hands-on activities and manipulatives to construct meaning. Students work in groups, discuss ideas, and construct knowledge gained from their peers.

Constructivism leads to new beliefs about excellence in teaching and learning and about the roles both teachers and students play in the process (Steffe & D'Ambrosio, 1995). Bandura (1993) and Ware and Kitsantas (2007) explained how teaching methods encourage a deep learning approach of the concepts on behalf of the learner to better develop a conceptual understanding of the mathematics content being taught. Deep learning is initiated by the constructivist approach to teaching and uses deliberate, planned, goal-oriented learning instructional strategies that can be used to move learners from low levels of learning (e.g., rote learning or memorization of facts) to higher levels of learning (e.g., understanding of complex and abstracted phenomena through critical and creative thinking skills). These strategies for deep learning are effective at facilitating higher levels of learning because they actively involve learners in ways that force them to use diverse ways of thinking and learning. As a result of deep learning, students experience higher levels of learning, which leads to student achievement and a sense of self-efficacy for teachers (Bandura, 1993).

Self-efficacy is defined as the beliefs people have about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1993). *Teacher efficacy* can be defined as “the extent to which a teacher feels capable to promote student learning, can affect teachers’ instructional efforts in areas such as choice of activities, level of effort, and persistence with students” (Ware & Kitsantas, 2007, p. 303). Teacher efficacy has been found to be associated with many powerful forces in instructional strategies and willingness to embrace innovations. Efficacy expectations influence teachers’ thoughts and attitudes, their choice of classroom activities, the amount of effort they are willing to expend, and their

determination to overcome obstacles (Smith, 1996; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998; Ware & Kitsantas, 2007). Teacher efficacy was separated into two categories in the efficacy measurement instrument used by RAND (Ashton, Buhr, & Crocker, 1984). These two categories were general efficacy and personal efficacy. General efficacy described factors that related to what teachers believe they can accomplish as a group, extending beyond one's own specific individual capabilities. Personal efficacy described a teacher's individual perception of his or her own effectiveness (Hoy & Woolfolk, 1990)

The task of creating learning environments conducive to the development of cognitive skills depends on the self-efficacy of teachers. Bandura (1993) emphasized that those who have a high sense of efficacy are more likely to use inquiry and student-centered teaching strategies that can motivate students. Bandura also stated that teachers who have a low sense of self-efficacy are more likely to use teacher-directed strategies, such as lecture and reading from a text, methods which rely on negative sanctions to get students to study. Self-efficacy is not simply a matter of how capable one is, but how capable one believes oneself to be. Teacher efficacy has been suggested as a concept through which to describe teacher quality (Bandura, 1993, Ware & Kitsantas, 2007). A teacher's performance and commitment to work is related to his or her belief that effective teaching can bring about student learning regardless of external factors.

Purpose of the Study

The purpose of this study was twofold. The purpose for the first part of this study was to investigate the impact of a two-year professional development program on personal efficacy and general efficacy of mathematics teachers in 10 selected elementary

schools in a southeastern state. The focus of the professional development program was on enhancing teachers' grade-specific knowledge of mathematics content and pedagogy. One scale to measure teacher efficacy in a content area is the Science Teaching Efficacy Beliefs Instrument (STEBI), which was developed by Riggs (1988). This instrument measures teachers' personal efficacy and general efficacy beliefs for mathematics teaching and learning. Participants in this study responded to items on a Likert-type scale. Because a comparable instrument for mathematics did not exist, the word *mathematics* replaced the word *science* on the STEBI. Test validity was determined to ensure the mathematics teaching efficacy survey measured what it was designed to measure. A paired-samples *t* test was used to identify growth in teachers' mathematics personal and general efficacy.

The purpose of the second part of this study was to investigate the relationship between teaching efficacy and student socioeconomic status (SES) relative to student achievement in mathematics. A multiple regression was used to analyze the students' mathematics scores from the Kentucky Core Content Test (KCCT) as mandated by the CATS assessment, the teachers' personal efficacy and general efficacy scores, and student SES to determine if a relationship exists between the indicated variables.

Research Questions

The following questions were investigated:

1. What was the impact of a two-year professional development program focusing on conceptual understanding of mathematics content on teachers' personal and general efficacy teaching mathematics?

2. What is the relationship between teachers' personal and general efficacy teaching mathematics and students' SES with students' achievement in mathematics?

Hypotheses

The following hypotheses were tested:

Null Hypothesis 1: There will not be a relationship between a two-year professional development program focusing on conceptual understanding of mathematics content and teachers' perceived mathematics efficacy.

Null Hypothesis 2: There will not be a relationship between teachers' perceived mathematics efficacy and students' test scores on a state-standardized mathematics test after controlling for student SES.

Definitions of Terms

Professional development: High-quality professional development is defined as experiences that enable educators to facilitate the learning of students by acquiring and applying knowledge, understanding, skills, and demonstrating abilities that address the instructional improvement goals of the school district or the individual school, or the individual professional growth needs of the educator over a systematic, sustained period of time (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009).

Self-efficacy: Bandura (1993) defined self-efficacy as the beliefs people have about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives.

Socioeconomic status (SES): Bond (1981) defined socioeconomic status as an individual's or group's position within a hierarchical social structure. Socioeconomic

status depends on a combination of variables, including occupation, education, income, wealth, and place of residence. Sociologists often use socioeconomic status as a means of predicting behavior.

Student achievement: For this study, student achievement was defined as scores of the third graders in 10 selected Kentucky elementary schools on state-mandated mathematics assessment measures for the 2008-2009 school year (Kentucky Department of Education [KDE], 2009).

Teacher efficacy: For the purpose of this study, the statements were categorized into two groups: general efficacy and personal efficacy. *General efficacy* is defined as the reflection of the teachers' beliefs about the general factors associated with how students learn mathematics. Factors for general efficacy refer to problems faced outside the classroom or nonacademic problems such as an unsupportive environment, home environment, teaching task, resources, administrative support, school staff, and socioeconomic status of student population. *Personal efficacy* is defined as the individual teacher's perception of his or her effectiveness to teach mathematics (Hoy & Woolfolk, 1990)

Establishing a Need for Professional Development on Mathematics Achievement

A rural school district in the southeast United States identified the need to address declining mathematics achievement across grade levels. Mathematics instruction at the elementary level consisted of teacher-focused direct instruction with an emphasis on developing procedural knowledge through practice worksheets. Middle school teachers reported that many of their incoming students did not know the multiplication tables; could not add, multiply, or divide fractions or decimals; and struggled with estimating

answers to arithmetic calculations to determine the reasonableness of solutions. The school district's initial response included the adoption of various supplementary mathematics programs, sending teachers to workshops, and mandating 60-90 minutes of daily mathematics instruction (Madison County Schools, 2007). The only results of these actions were that teachers used the same instructional strategies for longer periods of time and student achievement continued to decline.

During the 2006-2007 school year, the district had conducted a needs assessment on the state of teaching and learning mathematics in elementary classrooms. The district's school board convened a committee of district administrators, teachers, mathematics leaders, and consultants to collect and analyze data and develop an action plan (Madison County Schools, 2007). The findings indicated the following:

- Teachers relied on textbooks for the selection of content and instructional strategies with little or no consideration of student cognition when planning and implementing instruction.
- Direct instruction was the norm for most classrooms, with students learning in a whole-group setting with little or no active participation.
- Student learning consisted of performing paper-and-pencil calculations using standard procedures and algorithms.
- Differentiation of instruction was not evident in classrooms during mathematics instruction.
- Teachers lacked the understanding of the role of state and national content standard to mathematics instruction; many reported having no opportunity in previous professional development sessions to access the national standards.

- New technology had been installed in the classrooms and there was little evidence the teachers were using it as part of their mathematics instruction.
- There was minimal evidence that formative assessment strategies were being used to measure student progress in mathematics to provide immediate attention to students' learning needs; end-of-year summative assessments were the norm.
- Teachers were attending professional development training programs focused on mathematics that were offered at other sites, only to return to their classrooms and resume what they had been doing prior to the training.
- There was little to no improvement in mathematics instruction attributable to the professional development training programs teachers were attending.

The committee recommended that developing elementary school teachers' knowledge of mathematics content, pedagogy, curriculum, and assessment was a critical and necessary priority. District administrators began to understand the need to develop teacher capacity to provide reform-based mathematics instruction: elementary teachers needed intensive, job-embedded, content-specific mathematics professional development.

Relevance of the Study

The Kentucky Council on Postsecondary Education ([KCPE] 2006b) compiled data about the remediation rates for students who qualified for developmental mathematics in public colleges and universities across the nation. The report containing data over a four-year span (2002-2006) indicated developmental needs in mathematics have changed very little: in 2002, 41% of students showed developmental needs; in 2004, 44%; and in 2006, 41% of students had these same developmental needs. Similar results

are reported nationwide. ACT (2009) results indicated 41% of incoming freshman college students were underprepared in 2002 and 44% were under prepared in 2004. These results were based on the students who scored less than 18 on their mathematics ACT exams. Scrutiny is being focused on answers to grueling questions about why increasing numbers of high school graduates are not mathematically prepared for postsecondary education.

The required mathematics ACT score for incoming freshman was increased from 18 to 19 in the fall of 2009. The ACT 2009 data indicated 60% of the students who took the test scored lower than 19, which supports Newman's (2007) prediction that more than 50% of incoming freshmen for 2009 would qualify for developmental mathematics. If these statistics are not sufficiently alarming, a report prepared by Parsad and Lewis (2003) for the U.S. Department of Education indicated developmental mathematics college courses have the highest failure rates. *The Developmental Education of Kentucky's Entering Public Postsecondary Class of 2004* (KCPE, 2006a) showed that 48% of Kentucky college students who were enrolled in a developmental mathematics course did not successfully complete this course with a grade of D or better. It is apparent the necessary background in elementary, middle, and high school mathematics essential for success in college is lacking and the number of students whose education foundation is missing this critical component is increasing at a steady rate each year.

The necessary reform of school mathematics content has raised the issue of the relationship between efficacy in teaching mathematics and the vision of mathematics pedagogy supported by the reform. Smith (1996) explained the conflict as a mismatch between the pedagogy of current reform and the traditional instructional methods. The

instructional strategy of telling mathematics, which teachers have traditionally felt efficacious in teaching, defined the mathematical content that teachers extensively studied (Smith, 1996). Instructional strategies that consist of teaching by telling, demonstration, and rote practice are no longer acceptable (Battista, 1999).

Traditional instructional methods and resources provided a clear direction of how and what teachers must teach to affect student learning (Goos, 2004). The latest reform initiatives removed both the defined mathematics content and the clear direction of teaching. Teaching principles with which the teachers were most familiar have been deemed ineffective (Battista, 1999; Goos, 2004). Considerable emphasis is now focused on unfamiliar mathematics content and broad instructional strategies. In light of the recent reforms and the recognized need to improve student achievement in mathematics, teacher efficacy in mathematics and its impact on student achievement must be investigated and better understood.

The focus of this study was to compare the changes in teacher self-efficacy following a two-year job-embedded professional development program that emphasized hands-on mathematics instruction with the use of manipulatives in addition to aligning mathematics content with national standards. Such a professional development program was not found in the literature. Also not found in the literature was a similar professional development program designed to examine the change in teachers' self-efficacy beliefs with respect to teaching mathematics. If the results of this investigation provide empirical evidence that teacher efficacy has a positive relationship with student achievement, it will indicate a direction policy makers and educators might want to follow.

Primarily, professional development opportunities should be designed in ways that provide teachers with grade-specific knowledge of mathematics and the know-how to effectively teach this mathematics to all students, regardless of SES. Teachers' attitudes towards mathematics can change as a result of participating in a professional development program because the program can have a positive influence on the teachers' self-efficacy. These few implications attest to the significance of this study and provide a sense of direction that connects teacher efficacy to student achievement.

Assumptions

Conclusions drawn from this study were based upon two assumptions:

1. The respondents provided accurate and honest answers to the questions on the efficacy survey.
2. The efficacy survey is a valid and reliable instrument.

Limitations

The findings were limited to the schools and teachers in the sample group. These schools are not necessarily representative of all of the elementary schools in Kentucky and the teachers in the study. These limitations mean the results might not be generalizable, a problem that could be overcome by replication in a different geographic setting with a larger sample. Self-reporting of efficacy is a limitation, particularly when self-reporting is sought in the context of a specific professional development program. This limitation might be overcome in future studies by requiring participating teachers to complete the efficacy instrument prior to and outside the context of the professional development initiative.

Significance of the Study

This study will contribute to the literature knowledge base on teacher self-efficacy in mathematics instruction. It will also provide insights into one school district's attempts to achieve a positive impact on the teaching and learning of elementary school mathematics. The findings of this study may provide information useful to improving practices to increase teachers' perceptions of their efficacy, their attitudes toward teaching mathematics, and their students' achievement and mathematics competency.

Summary

The reform of Kentucky's public schools, as mandated by Senate Bill 1, was based on concise, rigorous content standards that call for teachers to make changes in the curriculum they teach and in the instructional strategies they practice in their classrooms. This reform effort has led to an increased focus on the design of professional development and the level of investment districts and teachers are willing and able to make. The review of literature provides strong support of the common goal of all professional development programs: to increase student achievement. There is little empirical data to support the confidence that professional development will translate to student achievement. For student achievement to be attainable, key features of a professional development program must consist of research-based teaching and learning, aligning the professional development with school curriculum and assessments, and a goal of student learning.

Teacher efficacy is a key feature believed to be a powerful force in implementing new instructional strategies and a willingness to embrace innovative teaching ideas. Efficacy expectations influence teachers' thoughts and attitudes, their choice of

classroom activities, the amount of effort they are willing to expend, and their determination to overcome obstacles. This study's first purpose was to compare the changes in teacher self-efficacy following a two-year job-embedded professional development program that emphasized hands-on mathematics instruction. This study's second purpose was to investigate whether a relationship existed between teachers' personal and general efficacy teaching mathematics and SES relative to students' achievement in mathematics.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

This chapter begins with a description of mathematics instruction in Kentucky and across the nation. Mathematics instruction is then discussed in terms of its impact on how students learn mathematics, the effect it has on student achievement, and how student achievement is influenced by teacher efficacy. Researchers have attempted to capture the meaning of teacher efficacy by various different measures. Several of these measures are identified and explained in this chapter. Teacher efficacy is presented to illustrate its profound effect on a teacher's classroom instruction and the level of student achievement. Research is included on the subject of designing and implementing an effective professional development program to strengthen teachers' knowledge of instructional practices to improve teacher efficacy. The review of literature further describes the relationship between teacher efficacy and its impact on student achievement in mathematics.

The context of student achievement is developed in this chapter to trace the relationship of two variables: teacher efficacy and SES. Each construct is described independently. The chapter concludes with an examination of the relationship of these variables to student achievement.

Mathematics Instruction

Evidence from Trends in International Mathematics and Science Study ([TIMSS] Stigler, Gonzales, Kawanka, Knoll, & Serrano, 1999) and other national reports provides a warning: U.S. students do not rank well compared to students of other nations with which the United States competes economically (U.S. Department of Education, Institute

of Education Sciences [DOE IES], 2007). Identified in this warning are major factors leading to low student performance (remediation) as well as an increase in student drop-out rates in high school. Low student performance and high drop-out rates not only have a major impact at the postsecondary level, but also at the workforce training level.

According to a report published by the U.S. Chamber of Commerce (2009), students who enter the workforce from high school and college are unprepared for the jobs for which they applied. One of the weakest areas identified by future employers is basic math skills that should have been mastered at the high school level. It is only when students reach the workforce level that a look in the rear-view mirror identifies the source of the problem and then aggressive steps must be taken to fix them. To compete internationally in both mathematics education and workforce education, much work is needed to improve student learning. One way to improve student learning is to examine national test scores to identify the areas in which students scored the lowest.

National test results (U.S. DOE IES, 2007) reveal mathematics achievement in Kentucky needs improvement. Of the 50 states that participated in the 2009 National Assessment of Educational Progress ([NAEP] U.S. DOE IES, 2009) fourth-grade assessment, Kentucky students' average scale scores were lower than those of students in 23 states, higher than 10 states, and not different from 16 states. Kentucky's average score for fourth graders was 239, the same average score achieved by the entire nation's public schools. The national average NAEP score for fourth graders has remained constant since 2007 (U.S. DOE IES, 2009). When Kentucky's scores are compared to those of the nation as a whole, growth is measured against a stagnant benchmark.

The eighth graders' average score was 279, not markedly different from that of the national average score of 282 (U.S. DOE IES, 2009). At the high school level, there is cause for alarm. The Kentucky's 2009 ACT profile report indicates that only 40% of students taking the test are ready for college algebra. According to a report by Kilpatrick, Swafford, and Findell (2001), *Adding It Up: Helping Children Learn Mathematics*, too few children in the United States are leaving elementary and middle school with adequate mathematics skills and understanding.

Mathematics instruction in the United States focuses on low-level skills and rarely attends explicitly to the important mathematical relationships (Rowan, Harrison, & Hayes, 2004; Stigler et al., 1999; Weiss, Pasley, Smith, Banilower, & Heck, 2003). Weiss et al. (2003) conducted 364 structured observations of mathematics and science lessons looking for learning at high levels and teaching explicitly designed to teach important mathematical relationships. They found that only 16% of the lessons received high ratings and only 14% of those lessons were rigorous. Furthermore, the majority of the lessons lacked adequate opportunities for sense-making. The findings of this study indicate that high-quality questioning and an emphasis on developing conceptual understanding is a persistent need for U.S. teachers (Weiss et al., 2003). These findings are consistent with research indicating teachers know the reform recommendations, yet few teachers apply these recommendations in their classrooms (Stigler et al., 1999). Meeting the challenge of reform-based teaching will require teachers to have deep insights about mathematics, about students as learners of mathematics, and about pedagogy that will support students' learning.

Student Achievement

Data from the TIMSS (U.S. DOE IES, 2007) suggests U.S. students' scores decline as they progress through school. For example, in 2007, fourth-grade students performed at the international average. That same year, eighth-grade students performed close to the international average, and 12th-grade students performed at a level lower than the international average.

Additional findings from the TIMSS report (U.S. DOE IES, 2007) suggest that many of the fixes implemented in many U.S. schools are not associated with high performance in other nations. Strategies such as more homework and more seat work with additional rote instruction and memorization have not proven to be effective variables in explaining student achievement in countries scoring higher than U.S. students. The data analyzed from the TIMSS report focuses on what other countries are doing differently in their instruction of mathematics. Teachers from other countries use extensive conceptual challenges and encourage students to explore, investigate, and solve problems with greater insight into mathematics principles, unlike teachers in the United States who use a model of instruction that focuses heavily on memorization of facts without also emphasizing deeper understanding of subject knowledge (Ball, 1996; Cohen & Hill, 2000; Wilson, Floden, & Ferrini-Mundy, 2002). The results of the TIMSS report identify three critical variables to improve student achievement. Teachers need to design their instructional focus on rigorous content, base their curriculum on content standards, and design instructional practice based on constructivist teaching.

Mathematics is one of the subject areas assessed by the NAEP, the only nationally representative and continuing assessment of what students in the United States know and

can do in various subject areas. According to statistics reported by the U.S. DOE IES (2009), fourth- and eighth-grade students in Kentucky made minimal gains on the NAEP assessment. Along with stagnant NAEP scores, the national ACT (2009) scores across all subjects have not shown a significant change in the average score in more than 15 years: in 1995, the average ACT score reported was 20.2 and, in 2009, it was 21.0. Results for math scores are even more troubling. On the national level, 42% of the students scored a 22 (the readiness benchmark in mathematics) in 2009, whereas in Kentucky, 26% of the student population scored a 22. The average score for Kentucky students was 19; the national average was 21 (ACT, 2009).

Research on the factors contributing to student achievement repeatedly cite teacher expertise as one of the most important factors in determining student achievement (Ball, 1990; Ball, Thames, & Phelps, 2008; Battista, 1999; Darling-Hammond & Ball, 2004; Stiff, 2000). Schools are awash in years of failed reforms in mathematics education because teachers tend to teach mathematics using strategies with which they are comfortable. Evidence suggests that U.S. teachers lack essential knowledge in how students learn mathematics and this lack of knowledge has a direct impact on how they teach mathematics (Ball, 1990; Ma, 1999). According to Blank and Langesen (2001), 40% of elementary and middle school mathematics teachers do not feel qualified to teach the content in their curriculum and only 7% of elementary teachers have minored or majored in mathematics education or mathematics. Many teachers report that they do not have sufficient conceptual understanding of mathematics and rely on rote computations and algorithms for instruction (Gerretson et al., 2008).

There seems to be universal agreement that students' mathematical achievement is unlikely to improve without serious attention to the ongoing professional development of teachers of mathematics (Ball et al., 2008; Battista, 1994; Telese, 2008). The 2000 National Survey of Science and Mathematics Education (Weiss, Banilower, McMahon, & Smith, 2001) found that more than half of the elementary, middle, and high school mathematics teachers recognized at least a moderate need for professional development using inquiry-/investigation-oriented teaching strategies, understanding student thinking, and assessing student learning in mathematics. In spite of the need, 68% of elementary teachers reported spending less than 16 hours of related professional development in mathematics over the last three years (Weiss et al., 2001). The research findings and student achievement data reflect the compelling need for professional development opportunities for mathematics teachers focused on developing knowledge of effective mathematics instruction, curricula, and assessment from pre-kindergarten through Grade 8.

Teacher Efficacy

The crucial component to the success of the current reform based on the research findings of the NCTM (2000, 2006) is teachers working in the classrooms with students every day. The way in which teachers implement effective instructional practices when teaching mathematics has been linked to teacher self-efficacy (Battista, 1994). Self-efficacy beliefs determine how people feel, think, motivate themselves, and behave (Bandura, 1993). Battista (1994) suggested that teacher efficacy can be a concept through which to describe teacher quality. A teacher's quality of performance and commitment to work is related to his or her belief that effective teaching can bring about student learning

regardless of external factors (Guskey, 1987). Teacher efficacy can be defined as “the extent to which a teacher feels capable to promote students learning, can affect teachers’ instructional efforts in areas such as choice of activities, level of effort, and persistence with students” (Ware & Kitsantas, 2007, p. 303). Teacher efficacy has been found to be associated with many powerful forces in instructional strategies and willingness to embrace innovations. For example, in-service teachers who have high teacher efficacy use a greater variety of instructional strategies (Committee on Science, Engineering, and Public Policy [COSEPUP], 2007). These instructional strategies include successful hands-on mathematics activities and use of meaningful text that contributes to a higher level of conceptual understanding that makes sense to all students.

Literature on teacher self-efficacy is abundant; however, there is limited research on mathematics teacher efficacy, specifically regarding elementary in-service teachers. Studies focusing on mathematics content knowledge show that many in-service teachers have a moderate level of procedural knowledge of mathematics and a very low level of conceptual knowledge (Vinson, 2001). This lack of knowledge lends itself to mathematics anxiety that is directly related to perceptions of one’s own mathematical skills. Pajares and Miller (1994) discussed the negative correlation between mathematics anxiety and mathematics performance, noting teacher attitudes are directly linked to student attitudes towards mathematics. Teachers who portray mathematics anxiety transmit these negative feelings about mathematics to students. Therefore, teachers’ expressions of negative attitudes toward mathematics could cause students to achieve at a much lower performance level in mathematics (Vinson, 2001).

Efficacy expectations influence teachers' thoughts and attitudes, their choice of classroom activities, the amount of effort they are willing to expend, and their determination to overcome obstacles (Ware & Kitsantas, 2007). It is not simply a matter of how capable one is, but how capable one believes one is. One way to raise self-efficacy beliefs is to improve mathematics knowledge and reduce negative feelings toward mathematics. Because individuals have the capability to alter their own thoughts and feelings, their self-efficacy beliefs can powerfully influence their own teaching ability (Vinson, 2001).

In order to facilitate the development of highly efficacious mathematics for in-service teachers, an in-depth exploration utilizing effective mathematics instruction should occur. Effective mathematics instruction is "learning in action" (Vinson, 2001, p. 91). That action includes games, simulations, problem-solving activities, discoveries, and challenges. In-service teachers reported that the use of these manipulatives and real-life mathematics events helped them make mathematics meaningful (Vinson, 2001).

Measurements of Efficacy

Many constructs have been developed to measure teacher efficacy (Tschannen-Moran et al., 1998). The following explanations of these different measurement instruments are intended to help with a better understanding of how teacher efficacy is measured.

RAND Measure

The RAND measure was designed to gauge teacher efficacy as a strong predictor for student achievement (Armor et al., 1976; Ashton et al., 1984; Tschannen-Moran et al., 1998). Teachers in these studies were asked to indicate their level of agreement with two

statements on a 5-point Likert scale from *strongly agree* to *strongly disagree*. The sum of the scores on the two items was the measure used to determine teacher efficacy. The two statements on this instrument address two categories: general teaching efficacy and personal teaching efficacy. The first statement, “When it comes right down to it, a teacher really can’t do much because most of a student’s motivation and performance depends on his or her home environment,” measures general teaching efficacy. The second statement, “If I really try hard, I can get through to even the most difficult or unmotivated students,” measures personal teaching efficacy (Ashton et al., 1984, p. 33).

Teacher Locus of Control

Rose and Medway (1981) developed the Teacher Locus of Control instrument to measure teachers’ responses to statements referring to situations of student successes and failures. The instrument consists of 28 items with a forced-choice format between two competing explanations for the situations described. Half of the items consist of student successes and the other half relate to student failures. For example, one question from this measurement instrument is as follows:

Suppose you are teaching a student a particular concept in arithmetic or math and the student has trouble learning it. Would this happen (a) because the student wasn’t able to understand it, or (b) because you couldn’t explain it very well? (Rose & Medway, 1981, p. 189)

Responsibility for Student Achievement

As noted in the instrument’s name, this 30-item instrument developed by Guskey (1981, 1987) was designed to measure responsibility for student achievement. Of the 30 items, 28 have a forced-choice format between two alternatives where participants are asked to give a weight or percentage to each of the choices. One choice states that the event was caused by the teacher and the other choice states that the event happened

without the teacher's control. For example, a question from this measurement instrument is as follows: "If a student does well in your class, would it probably be (a) because that student had the natural ability to do well, or (b) because of the encouragement you offered?" (Guskey, 1981, p. 46).

Webb Efficacy Scale

The Webb Efficacy Scale was designed as an attempt to extend the measurement of teacher efficacy developed by Ashton et al. (1984). It consists of seven items with a forced-choice format and requires participants to determine if they strongly agree with Statement 1 or Statement 2. For example, one of the items that require participants to choose the statement with which they agree most strongly is as follows:

(A) A teacher should not be expected to reach every child; some students are not going to make academic progress. (B) Every child is reachable; it is a teacher's obligation to see to it that every child makes academic progress. (Ashton et al., 1984, p. 5)

Teacher Efficacy Scale

Gibson and Dembo (1984) developed a 30-item measure of teacher efficacy. The factor analysis conducted using this scale confirmed the existence of two factors: personal teaching efficacy and general teaching efficacy. Other researchers have used this instrument to confirm the existence of two efficacy factors in their studies (R. Anderson, Greene, & Loewen, 1988; Hoy & Woolfolk, 1993; Saklofske, Michaluk, & Randhawa, 1988; Soodak & Podell, 1993). Measurement results obtained through use of the Gibson and Dembo instrument indicate teachers' behaviors in the classroom, their willingness to try new ideas, and their attitudes towards teaching, are related to teacher efficacy. Tschannen-Moran et al. (1998) stated teacher efficacy appears to have an influence on student achievement, attitude, and affective growth.

Researchers have found that many efficacy instruments neglect the particular teaching of specific contexts. In response to this dilemma, the Gibson and Dembo (1984) instrument was modified to explore teachers' sense of efficacy within specific content or curriculum areas, particularly the teaching of science, classroom management, and special education. An example of a statement from the original instrument is as follows: "When a student gets a better grade than he usually gets, it is usually because I found better ways of teaching" (Gibson & Dembo, 1984, p. 581).

Science Teaching

Based on the instrument developed by Gibson and Dembo (1984) to measure efficacy, Riggs and Enochs (1990) developed an instrument to measure efficacy of teaching science: the STEBI. This instrument contains 25 items on a 5-point Likert scale from *strongly agree* to *strongly disagree*. Results from the STEBI are consistent with Gibson and Dembo's establishing of two separate factors, the first one labeled *personal science teaching efficacy* and the second one labeled *science teaching outcome expectancy*. An example of a personal science teaching efficacy statement from the instrument is as follows: "I understand science concepts well enough to be effective in teaching elementary science" (Riggs & Enochs, 1990, p. 25). A science teaching outcome expectancy statement example from the instrument is as follows: "When a student does better than usual in science, it is often because the teacher exerted a little extra effort" (Riggs & Enochs, 1990, p. 25).

Classroom Management

Emmer and Hickman (1990) adapted the Gibson and Dembo (1984) instrument to reflect the area of classroom management. This instrument consists of a 36-item measure

with three efficacy subscales: efficacy for classroom management and discipline, external influences, and personal teaching efficacy. An example of a statement from this measurement instrument is as follows: “I believe the teacher should direct the students’ transition from one learning activity to another” (Emmer & Hickman, 1990, p. 763).

Special Education

Coladarci and Breton (1997) reworded the 30-item instrument developed by Gibson and Dembo (1984) to apply specifically to special education. Meijer and Foster (1988) developed an 11-item instrument, modified from Gibson and Dembo, to study the possibility of referrals to special education in the Netherlands. Other instruments have been developed to measure teacher efficacy. Some of these are long and detailed measures, while others are short and very general. An example of a statement from the special education measure is as follows: “If one of my special education students couldn’t do a class assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty” (Coladarci & Breton, 1997, p. 234).

Ashton Vignettes

A series of vignettes was developed by Ashton et al. (1984) to describe situations teachers may experience. Teachers were asked to respond to the situations by making judgments about the cause or causes. The instrument included 50 items describing problem situations concerning various areas of teaching including motivation, discipline, academic instruction, planning, evaluation, and work with parents. An example of a vignette is as follows: “Your school district has adopted a self-paced instructional program for remedial students in your area. How effective would you be in keeping a

group of remedial students on task and engaged in meaningful learning while using these materials?”(Ashton et al., 1984, p. 36).

Brief Eclectic Measures

Dissatisfied with existing measures of teacher efficacy, several researchers have used combinations of measurement items from various instruments to compose their own testing instrument for teacher efficacy (Midgley, Feldlaufer, & Eccles, 1989; Raudenbush, Rowen, & Cheong, 1992). One example is a survey designed to identify the extent to which students participate in their mathematics discussion and activities. One statement from this instrument is as follows: “In my mathematics class, I really pay attention to what the teacher is saying” (Waxman, Huang, Anderson, & Weinstein, 1997, p. 53).

Teacher Self-efficacy Scale

Bandura (1997) created a 30-item instrument with seven subscales that included influence on decision making, influence on school resources, instructional efficacy, disciplinary efficacy, enlisting parental involvement, enlisting community involvement, and creating a positive school climate. These items are measured on a 9-point scale. An example of one question is as follows: “How much can you influence the decisions that are made in your school?” (Tschannen et al., 1998, p. 208).

For this study, the Math Teaching Efficacy Beliefs Instrument (MTEBI) was used to gather data relevant to the research questions. The MTEBI was constructed using the STEBI survey because a mathematics content-specific efficacy instrument did not exist. The researcher needed an instrument to specifically measure teachers’ personal efficacy and general efficacy beliefs for mathematical teaching and learning. The MTEBI is a 25-

item survey that uses a 6-point Likert-type scale (1 = *Strongly disagree*, 6 = *Strongly agree*).

An example of a personal efficacy statement from the instrument is as follows: “I am continually finding better ways to teach math.” A general efficacy statement example from the instrument is as follows: “When a low achieving child progresses in math, it is usually due to extra attention given by the teacher.”

Teacher Efficacy and Student Achievement

School is the place where children develop the cognitive competencies and gain the knowledge and problem-solving skills essential for participating effectively in larger society (Bandura, 1993). The task of creating learning environments conducive to children’s development of cognitive skills depends on the self-efficacy of teachers. Those who have a high sense of efficacy are more likely to use inquiry and student-centered teaching strategies that can motivate students (Hoy, Tarter, & Hoy, 2006). Teachers who have a low sense of self-efficacy are more likely to use teacher-directed strategies, such as lecture and reading from a text—strategies that rely on negative sanctions to get students to study (Bandura, 1993).

Scholfield (as cited in Vinson, 2001) indicated teachers who received a high-achieving rating on their abilities to teach mathematics produced high-achieving students who originally had a negative attitude toward mathematics. Those teachers who received a mid- to low-achieving rating on their abilities to teach mathematics had students with a positive attitude toward mathematics but who maintained the lowest achievement scores. Teachers who express experiencing mathematics anxiety have been found to spend less time planning mathematics lessons and using mathematics instruction time for

nonmathematics-related activities more than their less-anxious colleagues (Vinson, 2001). Pajares and Miller (1994) have investigated the effects of mathematics self-efficacy on mathematics anxiety. They found that self-efficacy had a strong direct effect on reducing, if not eliminating, mathematics anxiety.

Teaching practices are determining factors used to evaluate a teacher's effectiveness. Teachers who put into practice teaching strategies that reflect the behaviorist approach generate unfavorable feelings toward mathematics (Vinson, 2001). Students in behaviorist classrooms are passive learners who imitate demonstrations by the teacher and the textbook (Battista, 1999). Instructional strategies in behaviorist classrooms consist of students parroting what they have seen and heard, paper-and-pencil drills that lack emphasis on understanding of the content, and solving problems that are detached from real-life experiences (Vinson, 2001). The alternative is a constructivist approach.

A constructivist approach to teaching, which encourages a deep learning approach on the part of the learner, promotes self-efficacy. Teachers create an environment in which they and their students are encouraged to think and explore mathematics. Constructivism leads to new beliefs about excellence in teaching and learning and about the roles of both teachers and students in the process (Steffe & D'Ambrosio, 1995). In constructivist classrooms, students are active rather than passive. Teachers are facilitators of learning rather than transmitters of knowledge. This active role ignites excitement for both teaching and learning mathematics in addition to strengthening teacher self-efficacy.

The emphasis on learning encourages teachers to use manipulatives that depict authentic learning situations and mimic real-life situations involving mathematics. The

experiences of the in-service teachers must be about the nature of teaching, combining knowledge about mathematics with knowledge about children and how they learn mathematics. In-service teachers are typically more apprehensive about teaching mathematics than any other subject. These teachers need guidance to identify teaching practices that result in positive learning experiences such as (a) hands-on approaches using a variety of mathematics manipulatives, (b) small groups and partner pair-share groups to discuss learning strategies and reflect on solutions to problems, (c) connection to children's literature, (d) technology to enhance student learning, and (e) student-led activities to demonstrate effective teaching strategies. In addition to teaching pedagogy, students taught by teachers who practiced the constructivist approach were also able to review content taught in a different way other than direct instruction.

Professional Development

It is generally accepted that intensive, sustained, job-embedded, professional development focused on the content that teachers teach is more likely to improve teacher knowledge, classroom instruction, and student achievement (Darling-Hammond & Ball, 2004; Darling-Hammond et al., 2009; Garet et al., 2001; Guskey, 2003; 2009, Kennedy, 1999). Programs to improve mathematics education often attend to a number of specific goals for teachers, including developing a vision for reform, deepening content knowledge, promoting understanding of student thinking, and engaging in reflective practice. Teachers need the opportunity to “unpack” the mathematics content they are going to teach, struggle with important mathematics ideas, and explore the conceptual underpinnings and interconnections among topics. Situating teachers in a constructivist

learning environment, one in which their thinking is the focus of thoughtful discussion and reflection, promotes transfer of learning to teachers' practice (Schifter, 1998).

Weiss et al. (2003) argued that teachers need a clear vision of effective instruction and advocate specific interventions to assist the realization of this vision to effectively guide the design and implementation of their lessons. These interventions include (a) the opportunity to analyze high-quality lessons and identify effective elements, (b) textbooks and supplementary material designed to provide targeted professional development opportunities, and (c) high-quality professional learning opportunities for teachers with a focus on developing both content and pedagogical knowledge. Professional development programs designed to provide needed interventions by way of engaging teachers in addressing reform-based curriculum and assessments resulted in both teacher growth and increases in student achievement (Cohen & Hill, 1998).

According to Ball and Cohen (1999),

Teachers can certainly learn subject matter, as well as knowledge of children, learning and pedagogy, in a variety of courses and workshops. But the use of such knowledge to teach depends on knowledge that cannot be learned entirely either in advance or outside of practice. (p. 12)

Professional development of teachers should be situated in practice. When development training occurs in the practice setting, the everyday work of teaching becomes the object of ongoing investigation and thoughtful inquiry. Rather than learning theories and applying them to the practice of teaching, theories or general principles emerge from closely examining practice. Furthermore, providing teachers the opportunity to test these emerging practices through application with their students increased the likelihood that teachers will continue to use these reform-based practices (Franke & Kazemi, 2001; Schifter, 1998).

Teachers need collegial support as they transform their instructional practices and beliefs to align with the reform recommendations. Creating structures to provide teachers with the necessary support is critical to any initiative involving change. The opportunity to collaboratively plan, analyze and reflect on practice, and have the emotional support of colleagues promotes and sustains ongoing improvements in teachers' practices.

Consistent with the research literature on the benefits of creating high-performing professional learning communities is the value of aligning professional development with district goals and initiatives. Anderson's (2003) review of the literature on the district role in educational change concluded that district-wide improvements in teaching and learning were more likely to occur when professional development focused specifically on district learning goals and when districts worked to align school district policies and practices with the focus of professional development. Professional development standards promoted by the NSDC to produce stronger learning are outlined as a guide to ensure effective changes for teachers and students (Darling-Hammond et al., 2009). According to the NSDC, the design of any effective professional development program should include context standards, process standards, and content standards (Darling-Hammond et al., 2009).

Context standards. In an ideal world, the planning for contexts of learning takes place at the school or district level, where teachers and administrators can collaborate in designing relevant training experiences (Guskey, 1987). Some type of data collection should be used to establish the needs within that school or district and serve as the basis for planning decisions. If the process is implemented at the district level, then the district must conduct a needs assessment of teaching and learning mathematics in the elementary,

middle, and high school classrooms. A needs assessment entails convening a committee of district administrators, teachers, and mathematics leaders and consultants to collect and analyze the data and then develop an action plan.

Factors to be considered as part of the action plan include the schedule and location of the professional development program, as well as the required time away from day-to-day responsibilities. During this process, district administrators should begin to understand what is needed to nurture teacher capacity to teach reform-based mathematics instruction. District personnel and building principals will need to evaluate their teachers and support staff to assess individual and group competencies, as well as levels of knowledge regarding instruction in mathematics. Once the levels of knowledge have been identified, a plan for implementing an intensive, job-embedded, content-specific mathematics professional development program for elementary teachers can be designed.

Trainers in the program should consider the audience and ensure that the focus of instruction fits teachers' backgrounds. As in all good teaching, a variety of instructional methods should be used that allow participants to collaborate and contribute actively to their own learning. When teachers participate in professional learning with peers from their school or grade level, they become engaged in a powerful form of staff development that allows them to grapple with real issues related to the new content and instructional processes. Secondary to the knowledge gained from these activities, a strong working relationship is formed among the teachers at one school site and across one grade level in the district. Teachers have a more positive view of these in-service activities than traditional educational forums and regard them as effective learning opportunities when they are sustained over time (Garet et al., 2001).

Stiff (2000) recommended that high-quality mathematics professional development should include time: time for teachers to examine reform-based curricula, time to collaborate with colleagues, and time to integrate new mathematics content and teaching strategies in the classroom. Provision of this time requires resources to fund substitutes to cover the teachers' classes, thereby enabling teachers and other educators to attend professional development training programs to learn about leading-edge ideas and practices. NSDC suggested professional development resources be made available to provide support for many purposes (Darling-Hammond et al., 2009).

One component of professional development resources is trainers. Trainers should be paid to help teachers and administrators implement the new math standards as well as new instructional strategies. They may also provide support to assist schools and teams of teachers in planning and evaluating the professional program efforts (Darling-Hammond et al., 2009). The main goal and focus of the trainer is to increase teachers' mathematics content knowledge and uses of research-based pedagogy and develop the teachers to their fullest potential (Zambo & Zambo, 2008).

Process standards. All professional development sessions should be evaluated to determine if the goals of the session have been met. An assessment vehicle to measure the effect of the training on teachers and/or student performance over time should be used. This accountability measure encourages teachers to incorporate their learning into their daily classroom practices. As with all assessments, these appraisals should be realistic and fair. Disaggregated student data from various sources can be used to provide input on how effective the professional development goals are and provide insight into the efforts of the teachers to implement the goals. Student data also provides direction on

what content needs to be addressed, as determined by the teachers' professional learning in the areas of instruction, curriculum, and assessments. Professional development is most effective when it addresses the concrete, everyday challenges involved in teaching and learning specific academic subject matter, rather than focusing on abstract educational principles or teaching methods taken out of context (Garet et al., 2001).

Time is a precious commodity in the design and delivery of professional development programs. Time must be provided for teachers to internalize and accept the research that supports the claims made by advocates of a particular instructional improvement approach or reform movement established in a school or district (Guskey, 2003). Teachers who do not understand the meaning of the term *research-based* need time to investigate the implications of the research. Time should be available for teachers to discuss, ask questions, and obtain answers that will enable teachers to become informed consumers of educational research and to determine if the promise of improved teaching and higher student achievement can be achieved.

Research into effective mathematics teaching professional development echoes the same essential elements of professional development in general. Firestone et al. (2005) stated that successful content knowledge training consists of subject matter presented in a classroom-friendly form such as materials, examples, and activities to use with their students. Teachers are more likely to try classroom practices that have been modeled for them in professional development settings. Professional development has been judged by teachers to be most valuable when it provides opportunities to engage in hands-on work that builds their knowledge of academic content and how to teach that content to their students, and when it takes into account the local context (including the

specifics of local school resources, curriculum guidelines, and accountability systems) (Carpenter, Fennema, Peterson, Chang, & Loef, 1989; Cohen & Hill, 2000; Desimone et al., 2002; Garet et al., 2001; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Saxe, Gearhart, & Nasir, 2001).

Opportunities to incorporate the concepts and suggestions learned through in-service training into their everyday teaching are important to professional development (Firestone et al., 2005). Subject matter professional development should concentrate on pedagogical strategies focusing on methods that require students to manipulate materials and ideas that allow students to explore concepts and make connections between ideas. *Coherence* is a component of high-quality content instruction outlined by Firestone et al. (2005). It refers to addressing a few areas in depth with more intense follow-up. Teachers should be introduced to a set of activities, materials, or ideas and then be given opportunities to practice and reflect on them.

Learning opportunities for teachers should model the instructional strategies they are expected to use. To be effective, these activities and strategies should represent an integral part of teachers' daily practice rather than additional tasks. Other research-based recommendations indicate mathematics teachers should receive small to moderate levels of instruction in mathematics theory and applications of mathematics as well as content standards, the use of curriculum materials, the use of technology, and strategies for assessing student learning (Telese, 2008, Zambo & Zambo, 2008).

Content standards. The NCTM (1991, 2000) stressed the importance of focusing on high standards and in-depth learning opportunities for teachers. Professional development standards set by NCTM for teachers of mathematics recommend

professional development attend to (a) modeling good mathematics teaching, (b) knowing mathematics and school mathematics, (c) knowing students as learners of mathematics, (d) knowing mathematical pedagogy, (e) developing as a teacher of mathematics, and (f) defining teachers' roles in professional development. The type of professional development in which teachers engage must be challenging, authentic, collegial, and collaborative, as well as embedded in best practices, focusing on how students learn and the teaching process.

Professional development must provide teacher-centered, curriculum-specific, collaborative opportunities and long-term support targeted at developing teachers to teach high-quality mathematics education to every student (NCTM, 1991). To better address meeting the content standards when establishing and promoting effective professional development that will have a positive impact on math instruction, three guiding questions should be considered:

1. Do teachers lack the deep understandings of mathematics content that would allow them to teach concepts flexibly?

Knowledge about subject matter must come in a form that is useful in the classroom (Hawley & Valli, 1999). Teachers need examples from which to work, and materials and activities to use with students. Professional development must not only be rich in ideas and materials, but also provide teachers with the opportunity to engage with, modify, and incorporate those ideas into their own teaching (Little, 1993). This emphasis on subject knowledge is somewhat new, but it is one of the few areas in which there is a growing body of evidence linking job-embedded and subject-based professional

development to changed teaching practice and increased student achievement (Fennema, Peterson, & Carpenter, 1989).

2. Can teachers make appropriate connections between mathematics and real-life situations, and among mathematic concepts?

This connection requires a new focus on professional development content that addresses teaching methods. Increased emphasis on subject matter has de-emphasized generic teaching strategies in favor of subject-specific teaching practices. Constructivism makes this shift in emphasis to strategies that require children to explore ideas, often with peers, and to understand the connections between the five content strands in mathematics (Little, 1993). Thus, students can become fluent in different modes of representations and thinking patterns that are the basis for making connections in mathematics. This process of fluency development requires students to engage in activities in which they manipulate objects and ideas with less direct control by the teacher than occurred in the past (Lampert, 1990). Evidence for teaching these instructional approaches are the same as that for teaching content knowledge and suggest that their use has considerable benefit for students. Instruction on using instructional strategies needs to include opportunities for teachers to acquire formative classroom assessment techniques to be used in measuring student achievement in mathematics.

3. Are teachers being prepared to implement standards-based mathematics programs?

For the most part, teachers are challenged by the incomplete alignment of local curricula with state standards and national standards. Administrators and teachers are unsure of how to go about designing a document that includes both state and national

standards. The NCTM (2006) responded to this problem with *Curriculum Focal Points*. This publication presents itself as a starting point in a dialogue focusing on what is important at particular levels of instruction and an initial step toward a more coherent, focused curriculum. The recommended means by which to deliver this information to teachers is through professional development.

A trend first reported in 2002 by van den Berg as ongoing in schools across the United States involves the tailoring of teaching and learning to meet the different needs of all students. This trend is especially evident in the reform-based teaching practices of mathematics. Various methods of adaptive teaching can be utilized for the different aspects of differentiation and individualization. Implementation of different strategies of student monitoring and attempts at constructivist learning are central to address the differences in how students learn mathematics. Despite best efforts, it is difficult for teachers to put these forms of teaching and learning into actual practice. Such challenges are commonly experienced by regular education teachers or content-specific teachers whose classrooms include students with special needs.

When asked, teachers often respond they do not perceive themselves as having the skill for adapting their math instruction in ways that facilitate learning for students with special needs. Teachers report a lack of training to adapt the curriculum to individual students' special needs and are reluctant to adjust scoring and grading criteria for these individual students (Chester & Beaudin, 1996). It is important that professional development equip teachers with the know-how to act on what they know about students to provide various types of instructions based on individual differences. Professional development provides educators with opportunities to learn to recognize learning

strengths and how to differentiate learning activities within the classroom setting. A process to help teachers to assess student progress based on individual differences and needs must be included in professional development to help teachers design instructional to meet the needs of all students.

General education teachers may have received an introductory course during their preservice training focusing on descriptors of children with special needs. The preservice training teachers receive before entering the field provides limited information about special education students and few opportunities to practice teaching techniques effective in meeting the needs of special students (Hocutt, 1996). New skills and knowledge gained through professional development workshops or in-service programs that improve math performance and increase student learning for all students can provide a permanent boost in teacher efficacy (Tschannen-Moran et al., 1998).

A component of professional development that is often missed or intentionally excluded is how to involve families in the education of students. Boaler (1999) stated that the behaviors and practices of students in mathematical situations are not solely mathematical, nor individual, but are developing as part of the relationships formed between the student and the people in the student's environment. One way to initiate a proactive relationship with families and community members is by educating teachers on the different uses of technology. According to Epstein (1995), many reasons exist for developing school, family, and community partnerships. These reasons are why it is important for teachers to have opportunities to discuss and learn how establishing family involvement can improve school programs and school climate, provide family services

and support, increase parents' skills and leadership, and connect families with others in the school and community.

The reasons are worthwhile, but the main reason to create such partnerships is to help all youngsters succeed in school and in later life (Epstein, 1995). When parents, teachers, students, and others perceive one another as partners in education, a caring community forms around students and begins its work. The field of education has been strengthened by supporting federal, state, and local policies. For example, the Goals 2000 legislation sets partnerships as a voluntary national goal for all schools; Title I specifies and mandates programs and practices of partnership for schools to qualify for or maintain funding. Many states and districts have developed or are preparing policies to guide schools in creating more systematic connections with families and communities. These policies reflect research results and the prior successes of leading educators who have shown that these goals are attainable (Epstein, 1995).

Professional Development and Student Achievement

One essential characteristic of high-impact professional development is a focus on student learning (Reeves, 2010). The primary reason for conducting professional development is for student achievement (Guskey, 2003). Teaching teachers is the main route by which institutions increase student achievement, yet there exists little data to support the perception that professional development will increase the students' achievement levels (Killion, 2002). Research literature that has defined the characteristics required for professional development to be effective and that are connected with students' learning fail to support their claims with statistical data (Cohen & Hill, 2000; Desimone et al., 2002; North Carolina Professional Development Committee, 2003).

Despite the amount of literature on professional development, minimal documentation exists that explicitly compared the effects of professional development on teaching to student achievement (Desimone et al., 2002). Even though there is a logical and intuitive connection between professional development and student achievement (Borko, 2004; Loucks-Horsley & Matsumoto, 1999), most studies of professional development have not examined its effects in a quantitative and replicable manner (Desimone et al., 2002).

Yoon, Duncan, Lee, Scarloss, and Shapley (2007) reviewed more than 1,300 studies identified as addressing the impact of professional development on student achievement. The review identified nine studies that met the “what works” evidence standards, as well as a strong evaluation design and the development and use of valid and reliable instruments. Most of these nine studies investigated the effectiveness of professional development centered on a specific program (i.e., reading program) and the impact it had on student achievement (Yoon et al., 2007). The report’s recommendations for future research included a study design with strong internal validity, a study rigor and execution with high fidelity, an adequate psychometric measure, and a well-specified analytic model and appropriate statistics. Guskey (1986) pointed out the elimination of so many articles based on the absence of scientifically based research indicates a weak connection on the impact of professional development on student achievement. Thus, the research available indicates the need for creating a professional development model that allows for the collection of scientifically based evidence to provide quantifiable results on student achievement (Guskey, 1986, 2003).

Socioeconomic Status (SES)

SES is generally accepted as having an effect on academic achievement, which is measured by performance on achievement and IQ tests, success in school measured by grades, and higher education entrance rates. Children of lower SES perform lower in all areas than their counterparts from higher socioeconomic groups (Bond, 1981; Caldas & Bankston, 1997, Lee & Wong, 2004; Sirin, 2005).

Bond (1981) cautioned against overgeneralization in the use of SES as a cause for low educational achievement, noting many aspects of diversity have an effect on educational achievement. Opportunity exists to enhance understanding on the exact nature of the relationship between SES and educational achievement, considering different researchers have focused on one aspect of the relationship to the exclusion of the other (Dika & Singh, 2002, Gottfried, 1985). The tendency has been to credit everything to cultural deprivation, or to poor schools, or to attitudes of teachers, or to the students' low expectations, or the evils of the class system in general (Gottfried, 1985, White, 1982). All of these factors play a part, but how they are significant to one another is unclear.

Over the past 40 years, the three main indicators that have been used to identify the social and economic status of students are parental income, parental education, and parental occupation. Each of these socioeconomic background variables was found to have approximately equal effects on educational attainment and, taken together, accounted for 18% of the total variance in years of postsecondary educational attainment (Sewell, 1971).

Parental income as an indicator of SES reflects the potential for social and economic resources available to the student. The second traditional SES component, parental education, is considered one of the most stable aspects of SES because it is typically established at an early age and tends to remain the same over time. Parental education is an indicator of parents' income because income and education are highly correlated. The third traditional SES component, occupation, is ranked on the basis of the education and income required to have a particular occupation. Researchers have noted a fourth indicator of family SES background that is not used as commonly as the other three main indicators: home resources. Home resources include household possessions such as books, computers, and a study room, as well as the availability of educational services after school and in the summer (Eccles, Lord, & Midgley, 1991; Entwisle & Astone, 1994; McLoyd, 1998). For the purpose of this study, parental income was the indicator used because it determined free and reduced-price lunch status.

Socioeconomic Status (SES) and Student Achievement

The effect of social and economic circumstances on academic achievement may vary by students' grade level (Duncan, Brooks-Gunn, & Klebanov, 1994; Lerner, 1991). There has been a strong and growing effort to explain why different groups of students seem to receive different benefits from the school experience. Rossi (1961) found numerous explanations have been put forward, and, at the risk of oversimplifying, it would seem that most explanations for the SES/academic achievement correlation fall into four broad categories. Briefly, these are (a) a genetic argument, (b) a cultural argument, (c) an argument positing unequal educational treatment, and (d) an explanation of educational differences as part of class analysis.

Genetics. The first explanation reported by Rossi (1961) posits the genetic inferiority of lower socioeconomic groups. Supporters of this premise maintain certain groups have low status because they are genetically inferior. According to genetic theory, talent is believed to be inherited and society is believed to reward genetically inherited abilities. According to this argument, children from low socioeconomic groups who perform poorly in school do so largely because they lack the genetic ability to perform otherwise (Gottfried, 1985, Jenson, 1969).

Culture. Another set of explanations of the SES/achievement correlation concentrates on the different cultural environments of children from various socioeconomic groups and the effect these cultural factors may have on school performance. Proponents of this theory attribute school failure of lower class children to qualitative intellectual differences caused by deficiencies in the culture in which they are being raised. The culture of poverty (Dika & Singh, 2002; Zigler, 1970) argument assumes a deficiency exists in the intellectual environment of lower class children, coupled with the assumption that children in different socioeconomic groups are raised differently. Zigler (1970) concluded that family background was more decisive than school characteristic in determining success or failure among school children, and thus gave support to the belief that explanations of school failure should be given in cultural terms.

Unequal educational treatment/class disparities. The third set of explanations for the correlation between socioeconomic class position and educational achievement centers around the theory that lower class children receive substandard treatment from the educational establishment, they are more likely to have poorly trained teachers, to be

placed in classrooms with a high cap number, and to have less money spent on their education than are middle-class children. Lower class children fail to achieve in school because their teachers, consciously or unconsciously, project what amounts to a nonsupportive attitude toward them (Gottfried, 1985, Karabel & Halsey, 1977). Teachers expect less of lower class children than they do of middle-class children. Rist (1977) suggested research on the “self-fulfilling prophecy” (p. 292) be incorporated into the wider field of labeling theory. The poorest children enter school with more limited vocabularies and general knowledge than children from more affluent homes, but, according to Rist, it is not so much the inadequacies of the children but the indifference with which they are treated that is responsible for their poor academic performance.

Extensive literature can be found on the role teachers’ expectations and attitudes play on student achievement. Teachers’ attitudes on students’ aptitudes and whether students can achieve high levels of academic success are based on students’ SES (Lee & Wong, 2004; Sirin, 2005). The way in which teachers conduct their classrooms and their choices of actions serve as the means through which their attitudes affect students’ degree of academic achievement. A connection exists between the teacher’s expectations demonstrated through their choice of classroom processes and student achievement.

Summary

Despite the call for reforms and the plethora of knowledge and information informing this work, little has changed in the way teaching and learning of mathematics occur in U.S. classrooms. Students’ less-than-stellar performance in mathematics and the low numbers of students pursuing degrees in the disciplines of science, technology, engineering, and mathematics places the United States in a position of global

noncompetitiveness. The problem begins with the instruction of elementary students and the root cause is elementary mathematics teachers who are not adequately prepared to teach mathematics in a manner that will have a significant positive impact on students. The problem lies not only in the initial preparation of elementary teachers, but also and perhaps more importantly in the lack of ongoing, sustained, job-embedded, and content-specific professional development that practicing teachers receive.

CHAPTER THREE:
RESEARCH METHOD

Problem Statement

The review of literature indicated the need to refine and enhance teacher performance levels in teaching mathematics (Ball, 1990; Ball & Thames, 2008; Carpenter et al., 1989; Franke & Kazemi, 2001; Gerretson et al., 2008; Ma, 1999; NCTM, 1991; Schifter, 1998; Vinson, 2001). There is a negative impact on student achievement when teachers lack mathematics content knowledge (Ball, 1990, Battista, 1994, 1999; Boaler, 1999; Borko et al., 1992; Cohen & Hill, 1998, 2000; Franke & Kazemi, 2001; Goos, 2004; Newman, 2007; Schifter, 1998), do not know how to effectively strengthen their teaching abilities (Borko et al., 1992; Carpenter et al., 1989; Darling-Hammond & Ball, 2004; Darling-Hammond et al., 2009; Desimone et al., 2002; Steffe & D'Ambrosio, 1995; Stein et al., 1999; Telese, 2008), and lack personal and general efficacy (Bandura, 1977, 1993; Battista, 1994; Boaler, 1999; Czerniak & Shriver, 1994; Goddard, Hoy, & Woolfolk Hoy, 2000; Pajares & Miller, 1994; Smith, 1996). This study was designed to determine the effect a mathematics professional development had on teacher efficacy and whether there is a relationship between teacher efficacy and SES with student achievement.

The purpose of this quantitative study was twofold. The first objective of this study was to investigate the impact of a two-year professional development program on personal efficacy and general efficacy of mathematics teachers in 10 selected elementary schools in a southeastern state. The second focus of this study was to investigate the relationship between a teacher's personal efficacy and general efficacy, and student SES

relative to student achievement in mathematics. The first part of the study adds to the literature through an exploration of the effect the treatment (i.e., professional development program) had on the dependent variables (teachers' personal and general efficacy teaching mathematics). The second part of the study adds to the literature through an exploration of the relationship between the independent variables (personal efficacy, general efficacy, and student SES) and the criterion variable (student achievement in mathematics). The study's questions, information about participants and sample size, data collection procedures, instrumentation, and data analysis techniques are presented in this chapter.

Research Questions

The following questions were investigated:

1. What was the impact of a two-year professional development program focusing on conceptual understanding of mathematics content on teachers' personal and general efficacy teaching mathematics?
2. What is the relationship between teachers' personal and general efficacy teaching mathematics and students' SES with students' achievement in mathematics?

Hypotheses

The following hypotheses were tested:

Null Hypothesis 1: There will not be a relationship between a two-year professional development program focusing on conceptual understanding of mathematics content and teachers' mathematics efficacy.

Null Hypothesis 2: There will not be a relationship between teachers' perceived mathematics efficacy and students' test scores on a state-standardized mathematics test after controlling for student SES.

Variables

To examine the relationship between teacher efficacy and student SES with student achievement in mathematics, the selected characteristics of the teacher included his or her personal and general efficacy score. The student characteristics included mathematics test score from the KCCT and SES as evidenced by eligibility for free or reduced-price lunch. The selected sample of students included all third-grade students without disabilities, as identified in accordance with the district's information system (Infinite Campus). Student achievement included student scores on the state criterion-referenced KCCT in mathematics.

Conceptual Framework

This study examined the effect of mathematics professional development on teachers' efficacy, and the relationship between teacher efficacy and student SES and student achievement in mathematics. The primary intent of the study was to gain new insights into understanding the impact of well-designed, mathematics professional development on teachers' perceived efficacy on improving student achievement. A secondary intent of the study was to add to the existing literature that guides important local, state, and national guidelines intended to address issues related to designing mathematics professional development to better meet the needs of students, regardless of their SES. As shown in Figure 3.1, the conceptual framework underpinning this study is

directly related to the elements needed by teachers to help students achieve high levels of learning in mathematics.

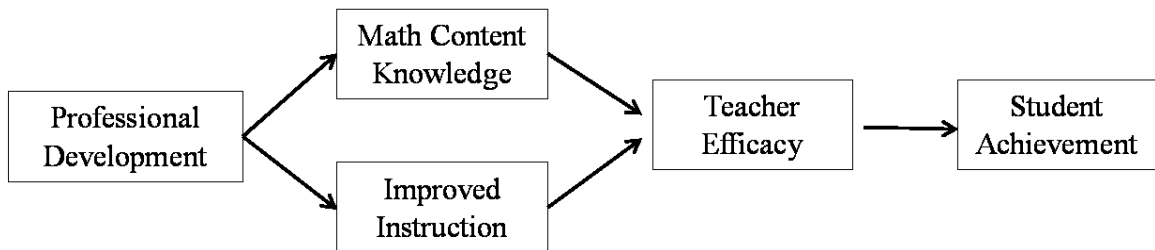


Figure 3.1. Conceptual framework of the elements of professional development, teacher efficacy, and their relationship with student achievement.

Change in how mathematics content is taught occurs as the nature of a teacher’s mathematical knowledge evolves (Ball, 1996; McDiarmid, & Wilson, 1991; Shulman, 1986, 1987). If teachers implemented the instructional practices learned in professional development programs into their classrooms, they would be expected to observe positive changes in their students’ achievement and attitudes toward mathematics. After teachers reflect on the positive changes that occurred in the teaching and learning of mathematics, the perceptions they developed about their personal and general efficacy changed.

Teachers’ personal and general efficacies increase when students become more successful and enthusiastic about learning mathematics. Elementary school mathematics teachers must possess beliefs and knowledge, and engage in classroom practices that relate to mathematical content, pedagogy, child development, and student thinking in an integrated way to promote high levels of student achievement.

Purpose of the Study

Research studies suggest that well-designed professional development has a positive impact on teacher practice and influences student achievement (Darling-

Hammond et al., 2009; Stein et al., 1999). A high-quality professional development program should focus on increasing mathematics content knowledge and the use of research-based pedagogy. The design needed to support an intensive, ongoing, job-embedded, professional development is connected to practice. There has been limited research on the impact of professional development on teacher efficacy, especially in specific subject areas. Similarly, there has been limited research on the relationships between math teacher efficacy and SES with student achievement. Considerable research exists on each variable independently, but the relationship between teacher efficacy and student achievement with consideration given to socioeconomic status is limited, especially in mathematics.

The outcome of student achievement was selected because the ultimate goal of effective instruction is increased student achievement. To accomplish this goal, a well-designed professional development program was created to help teachers master math content, work on strengthening their math teaching skills, evaluate their own and their students' performance, and address changes needed in teaching and learning.

Mathematics scores from the KCCT were used for this study. To meet state requirements for NCLB (2002), all students enrolled for at least one year in grades 3-5 participated in the testing.

In an elementary school third-grade setting, one homeroom teacher provides all instruction in mathematics. Therefore, this study included students in third grade. Students participating in special education services, as identified through an individual education plan, were excluded from the sample because of the variance in the severity of their disability, level of service provided, and accommodations in testing.

Context of the Study

The school district in which this study was conducted is located in a nonmetropolitan community setting with a total population of 113,436 encompassing over 446 square miles. According to the latest census data, the county has a population of 81,103 (U.S. Census Bureau, 2003). Residents living within the city limits experienced an increase in population to 32,333 in 2008 (U.S. Census Bureau, 2009). Summing the population of those living in what is defined as the county area ($n = 81,103$) and residents living within the city limits ($n = 32,333$), equals the total population ($N = 113,436$).

The U.S. Census Bureau (1995) defined rural areas as all territory outside of the urbanized areas and clusters. Using information from the 2000 census (U.S. Census Bureau, 2000), rural population was defined as regions where fewer than 2,500 residents live in areas composed of open country. Urban area was defined as a central city and surrounding areas whose population (“urban nucleus”) is greater than 50,000. These areas may or may not contain individual cities with 50,000 or more residents; rather, they must have a core with a population density generally exceeding 1,000 persons per square mile and may contain adjoining territory with at least 500 persons per square mile (other towns outside of an urbanized area whose population exceeds 2,500) (U.S. Census Bureau, 2000).

The median cost of a home in the city is approximately \$94,000. While 22.3% of the population is under 18 years of age, only 10.8% of the population is over 65 years of age. According to the census (U.S. Census Bureau, 2009), the reported majority ethnic background of the population is Caucasian (93.4%). Minority populations include

Black/African American (4.3%), American Indian and Alaskan Native (0.3%), Asian (0.8%), and Hispanic (1.4%), with some people reporting two or more races (1.2%).

The School District

As reported on the 2008-2009 district’s report card (U.S. Chamber of Commerce, 2009), the school district had an enrollment of over 10,500 students. These students were enrolled in grades K through 12 in 16 schools, 10 of which were elementary schools. The district employs more than 600 certified teachers. The student teacher ratio was 17:1. The per-pupil expenditure in 2008 was \$9,386.

An overview of student demographics for the district during the 2008-2009 school year is provided in tables 3.1, 3.2, 3.3, and 3.4. Demographics indicate that students were distributed nearly evenly between males and females. The percentage of students who were economically disadvantaged was 46.8%, as identified through eligibility for free or reduced-price lunch. Approximately 11.2% of the students represented an ethnic minority population, and 19% of the students participated in special education programs, as identified by their individual education plan.

Table 3.1. District-wide Student Gender Demographics (2008-2009)

Gender	Frequency	Valid (%)
Male	6,177	51.7
Female	5,769	48.3
Total	11,946	100.0

Note. Data from P. Baker, personal communication, May 7, 2010.

Table 3.2. District-wide Student Economic Status (2008-2009)

Lunch price	Frequency	Valid (%)
Valid free	4,700	38.3
Reduced-price	898	7.5
Full price	6,348	53.1
Total	11,946	100.0

Note. Data from P. Baker, personal communication, May 7, 2010.

Table 3.3. District-wide Student Race/Ethnicity Status (2008-2009)

Ethnicity	Frequency	Valid (%)
White	10,614	88.8
Black/not Hispanic	697	5.8
Hispanic	223	1.9
Asian or Pacific Islander	121	1.0
American Indian or Alaskan Native	21	0.2
Other	270	2.3
Total	11,946	100.0

Note. Data from P. Baker, personal communication, May 7, 2010.

Table 3.4. District-wide Student Special Education Status (2008-2009)

Educational program	Frequency	Valid (%)
Valid special education	2,265	19.0
Regular education	9,681	81.0
Total	11,946	100.0

Note. Data from P. Baker, personal communication, May 7, 2010.

Professional Development Program

Based on NCTM (2000, 2006) recommendations, the type of professional development designed for this study included teachers being engaged in challenging, authentic, collegial, and collaborative activities, as well as embedded in best practices, focusing on how students learn and the teaching process. It provided teacher-centered, curriculum-specific, collaborative opportunities, and long-term support targeted at developing teachers to provide high-quality mathematics education to every student (Darling-Hammond & Ball, 2004; Darling-Hammond et al., 2009; Garet et al., 2001; Guskey, 2003; Kennedy, 1999; NCTM, 1991).

Professional Development Design

Element 1: Planning

Various sources of information from the school district were used to determine the need for mathematics professional development. The district's mathematics test scores from the KCCT assessment, especially at the middle school level, had continued to decline for a number of years despite the adoption of various mathematics programs and textbooks. Middle school teachers in faculty meetings, district math meetings, and informal interviews claimed that a significant factor in the low scores of middle school

mathematics students was the quality of mathematics teaching in the elementary and intermediate grades of the feeder schools. An explanation as to why the quality of mathematics teaching in the elementary schools was a significant factor for low math scores, as anecdotally voiced by middle school teachers, was the degree to which elementary teachers understood the mathematics content they taught.

Important findings in the 1980s initiated a new wave of interest in the conceptualization of teacher content knowledge of mathematics (Shulman, 1986). *Content knowledge* was defined as the knowledge of the subject and its organizing structures (Shulman, 1986). As noted in the Review of Related Literature, even in the 21st century, many teachers reported that they do not have sufficient conceptual understanding of mathematics and rely on rote computations and algorithms for instruction (Gerretson et al., 2008).

Ball et al. (2008) further defined the domain of teacher knowledge as pedagogical content knowledge. Shulman (1986) suggested that there is content knowledge unique to teaching, which he defined as a kind of subject-matter-specific professional knowledge. Pedagogical content knowledge bridges content knowledge and the practice of teaching (Ball et al., 2008).

Shulman (1986) argued that knowing a subject for teaching requires more than knowing its facts and concepts. Teachers must also understand the organizing principles, structures, and rules for establishing what is logical to do and say in mathematics. The teacher need not only understand that something is so; he or she must further understand why it is so, and how it works the way it does. To better emphasize the difference, Ball (1990) introduced the phrase *knowledge about mathematics* to contrast with *knowledge of*

mathematics. In particular, a focus on student conceptions and, in many cases, student misconceptions acknowledges that accounting for how students understand a content domain is a key feature of the work of teaching that content.

Borko et al.(1992) described a classroom teaching experience for evidence of conceptual and procedural knowledge of the topics taught, the teacher's knowledge of student understanding, and the teacher's ability to generate appropriate representations for teaching procedures and concepts. A teacher was asked by a student to explain why the invert-and-multiply algorithm for dividing fractions works. Despite having taken several math classes in college and having a mathematics content background, the teacher was unable to provide a correct representation for division of fractions or to explain why and how the invert-and-multiply algorithm works.

This lack of understanding mathematical concepts contributes to a low sense of teacher self-efficacy, which contributes to difficulties with novice teaching. In addition to coming to see themselves as teachers, individuals must develop confidence and see themselves as effective practitioners in the classroom (Tschannen-Moran et al., 1998). Teachers' expectations, attributions, and goals are influenced by a strong sense of efficacy. A strong sense of self-efficacy makes a difference in teacher motivation, which in turn, affects how well their students achieve (Bandura, 1997; Goddard et al., 2000). Teachers with low self-efficacy frequently blamed others for their failures, chose activities emphasizing rote memorization and drill, and focused on student behavior rather than student learning (Czerniak & Shriver, 1994).

Given the perspectives of middle school teachers on the quality of elementary math instruction, as well as pedagogical requirements articulated by Shulman (1986),

Ball (1990), and others in this study, the elementary grade levels were identified as the primary target for intensive professional development. A committee consisting of district personnel, administrators, principals, teachers, mathematics specialists, and state department consultants was convened to help guide the planning. Additional data were also collected through grade-level meetings and classroom observations in each school. This information gave insight about the degree to which teachers tie their instruction to textbooks and how much understanding they have on how the state and national content standards relate to everyday mathematics instruction.

The committee developed goals and objectives for the two-year mathematics professional development program. According to the NSDC, the design of any effective professional development program should include context standards, process standards, and content standards (Darling-Hammond et al., 2009). Therefore, goals and objectives included the following items:

1. alignment of district mathematics curriculum with state and national content standards,
2. clarification of what the process standards look like in the classroom,
3. conceptual understanding of the mathematics content,
4. effective instructional strategies for implementing the process standards including the use of technology, and
5. effective use of formative assessment strategies.

Element 2: Implementing

This professional development program consisted of full-day grade-level meetings in the schools, four times a year. The first year focused on curriculum alignment

and formative assessment. At the first session, the teachers, with the help of the trainer, examined the NCTM (2000) content and process standards, the NCTM (2006) focal point, program of studies, and core content for assessment, and identified the specific standards relevant to their grade level. Next, they used these standards to build their grade-level mathematics curriculum.

Developmentally appropriate formative assessment strategies that aligned with the standards were modeled and practiced with the teachers. For example, a think-pair-share exercise was modeled as a formative assessment highlighting the difference between using open and closed questioning to initiate meaningful student conversation. When fifth graders learning about means are instructed to turn to their partner, the request to “*Find the mean of 15, 18, 22, 24, and 31*” is less effective than requesting the partner to “*Find five numbers whose mean is equal to 22.*” Because the second request has a variety of answers, teachers listening to students solving the problem gain more insight into the students’ thinking processes.

After teachers developed their curriculum and practiced appropriate formative assessment, they entered the next cycle of training. The next cycle of training consisted of disaggregating test data and analyzing student responses from their common assessments. This information was used to determine which instructional strategies should be addressed in the next training.

To model the instructional practice of using a variety of strategies, each training cycle was broken down into several sessions. In the morning, teachers worked on alignment and appropriate formative assessments. In the afternoon, they were engaged in actual teaching episodes that targeted the mathematics standards or modeled the

formative assessment strategies discussed in the morning. Each of the four training sessions focused on different mathematics content standards (number operations, geometry, measurement, data analysis and probability, and algebraic thinking).

At the conclusion of each day's training session, the teachers were given all of the supplies and materials they needed to implement the specific activities the next day. For example, fraction kits were demonstrated and the teachers received all the supplies necessary for each student to make a fraction kit. These kits allowed the students to explore the idea of equivalent fractions.

A crucial element of each day's training session was free time. The sessions were set up to give the teachers time to talk, share their reflections, and discuss different strategies to teach difficult concepts. It was often during this time that teachers would recognize the relevance of the training as well as how to differentiate activities to meet the needs of all students.

During the second year, the training included activities that engaged teachers in re-examining and deconstructing the standards on their curriculum map to better equip them to implement the math standards as well as new instructional strategies. According to the NSDC, the design of any effective professional development program should include working with content standards (Darling-Hammond et al., 2009). In order for teachers to teach mathematics for high standards, they need to not only know what the standards are, but they must also understand what the standards mean (Ball, 1996; Darling-Hammond & Ball, 2004; Guskey, 1981). They learned how to write the standards in teacher-friendly terms. They were encouraged to use "I can" statements to translate them into student-friendly terms. In addition to learning about the standards,

another goal and focus would be to increase their mathematics content knowledge, uses of research-based pedagogy, and effective use of formative assessment strategies to develop the teachers to their fullest potential (Zambo & Zambo, 2008).

The intentional use of technology to enhance instruction of the standards was also targeted the second year. For example, one session focused on how to integrate web resources, the student response system, and eInstruction Corporation's Interwrite® Pad. Allowing teachers to practice individually helped to ensure that the technology resources were used appropriately in the classrooms.

A literature connection was made with the mathematics standards in the second year. Suggestions for lessons incorporating various children's trade books were given and examples of lessons were demonstrated. Some of the books highlighted included *Martha Blah Blah* by Susan Meddaugh, which targets data analysis and probability; *When a Line Bends, A Shape Begins* by Rhonda Gowler Greene, which focuses on geometry and measurement; *The Warlord's Beads* by Virginia Walton Pilegard, which focuses on place value; and *How Big is a Foot?* by Rolf Myller, this focuses on nonstandard measurement.

Other areas of integration included science and the use of the environment with mathematics content. The science and mathematics integration centered on measurement through the use of the Full Option Science System module (FOSSweb, n.d.), and each school received a measurement kit. The environment-based education training focused on taking teachers outside to participate in a tree measuring unit. This activity helped them understand the academic benefits of taking students outside. Content-specific instructional strategies continued to be demonstrated for teachers to further strengthen their mathematics content knowledge and pedagogical skills.

Element 3: Monitoring

The professional development was monitored by the Title I coordinator and the district elementary curriculum specialist, with support from the 10 math interventionists who represented each elementary school in the district. The Title I coordinator communicated with the building principals to obtain feedback on what was being seen as significant changes in math instruction in the classrooms and the impact these changes had on student achievement. The district elementary curriculum specialist made school visits to observe math instruction in classrooms, assisted teachers with developing math lessons, and met with math interventionists in each elementary school. The work of the math interventionists in the elementary schools was the essential element in monitoring what changes were occurring in the classrooms with the more developed instruction of mathematics.

The math interventionists provided support following each professional development session. They established themselves as partners with the teachers in the learning process and attended the grade-level meetings in their assigned schools to listen to the teachers' concerns regarding changes in the classrooms concerning math instruction. Following their meetings with the teachers, the interventionists discussed the teachers' concerns with the district elementary curriculum specialist to develop ways to provide instructional support for the teachers in their individual classrooms.

Instructional support was provided by working with the teachers to remind them of activities and ideas that were shared during the professional development sessions. In addition, the interventionists conducted after-school make-and-take sessions to construct

additional math materials used in the professional development session. They also modeled additional instructional methods using the manipulative in the classrooms.

Element 4: Assessing

All teachers participating in the training completed a teacher efficacy survey indicating their mathematics teaching success after completing the training program. This data source, used as the culminating assessment, indicated whether teachers believed their mathematics teaching effectiveness had improved over the two years during which the professional development was provided.

Research Design

Creswell (2009) indicated that quantitative methods are appropriate when identifying those factors that might influence a specific outcome or when testing a particular theory. In contrast, qualitative studies are appropriate when the researcher is exploring and is not necessarily able to quantify the existing variables (Creswell, 2009). Because specific factors have been identified through the literature review as key variables to raising student achievement through high-quality professional development and enhanced teacher efficacy, quantitative methods were chosen for this study. The first question represented a causal comparative design, and the second question represented a correlation design.

Data Collection

Data collected for this study was retrieved using the questions posed in survey form (see Appendix A) with permission from the elementary teachers participating in the professional development, the district assessment coordinator, and the director of pupil personnel in the school district. Participants could choose to opt out of this study at any

time without penalty (a principle of ethical research). The data obtained from the school district and used for the study were gathered and analyzed via procedures that strictly adhere to the principles of ethical research, as approved by the Institutional Review Board ([IRB] see Appendix B and Appendix C). With that in mind, the researcher took several steps to make certain to protect the privacy of study participants (Locke, Spirduso, & Silverman, 2000).

The researcher had the responsibility to inform and protect the participants. The research process involved voluntary cooperation, and the researcher informed the participants about the study's purpose. The researcher respected the information the participants provided on the survey and protected that information. Each teacher participant was assigned a number. This information was kept locked in the researcher's office, as explained in the IRB approvals.

The participants' rights and interests are considered of primary importance when reporting and analyzing the data. The researcher was committed to keeping identifying characteristics of the sample confidential. The code assigned to each participant identified his or her name and the grade the participant taught. The codes were used to link teacher survey data to his or her respective students' achievement results. After this linkage was made, all personally identifiable information was deleted from the files.

Data Analysis

Descriptive statistical analyses were conducted to generate means, standard deviations, and ranges for the dependent and independent variables (teacher efficacy, student achievement, and SES). To respond to Question 1, the study employed a paired-samples *t* test to compare the means of the two dimensions of teacher efficacy, as

perceived before and after the professional development from the MTEBI. A paired-samples *t* test is used when the same individual needs to be measured twice, usually in a before-after or pretest-posttest design (Harris, 1997).

To respond to Question 2, a multiple regression was performed to analyze the relationship between the students' mathematics scores from the KCCT mathematics test, the teachers' personal efficacy and general efficacy scores, and student SES, as determined by eligibility for the free and reduced-price lunch program. A multiple regression is used to predict the score on the criterion variable from the scores on several independent variables. Emphasis is on the prediction of the criterion variable from the independent variables (Harris, 1997). For all tests, an alpha level of .05 was used to determine statistical significance (Jackson, 2009). SPSS's Predictive Analytics SoftWare (Version 18.0) was used to analyze the data for both questions.

Sample

The focus of this study was the effect a mathematics professional development program has on teacher efficacy and the relationship between teacher efficacy, student SES, and student achievement. The study sample included 10 elementary schools in one school district in the southeastern United States. The resulting sample size consisted of 35 third-grade elementary school teachers. All of the participants involved in this study were employed in one of the 10 elementary schools in this school district as a full-time certified teacher.

Participants in the study were regular classroom teachers who teach mathematics at their assigned grade level in a collaborative classroom. Special education teachers and special education students were excluded from this study. Configurations of the grade

levels in all 10 schools consisted of kindergarten through fifth grade. All of the teachers participated in a job-embedded, mathematics professional development program four times a year over a two-year period.

Instrumentation

The MTEBI was used to gather data relevant to the research questions. The MTEBI was constructed using the STEBI survey. Statements/items were prepared primarily upon the conclusions and theories presented in the literature review on teacher efficacy (Hoy & Woolfolk, 1993; Pajares & Miller, 1994; Vinson, 2001; Ware & Kitsantas, 2007). The survey is included as Appendix A and described in detail below.

Math Teaching Efficacy Beliefs Instrument (MTEBI) Survey

This instrument was adapted from the STEBI, which was developed and validated by Riggs (1988) and modified by Riggs and Enochs (1990) to measure teachers' personal self-efficacy and general efficacy beliefs for science teaching and learning. It is a 25-item survey that uses a 6-point Likert-type scale (1 = *Strongly disagree*, 6 = *Strongly agree*). Thirteen of the statement items are written in the affirmative/positive, and 12 are written in the negative. Items written in the negative were reverse-coded to produce consistent values between positively and negatively worded items.

The coefficient alpha for the STEBI was 0.77 (Enochs & Riggs, 1990). An alpha coefficient of .90 was produced from the Personal Science Teaching Efficacy Scale, and an alpha coefficient of .76 resulted for the Science Teaching Outcome Expectancy Scale. An item-total item correlation of .49 and above was determined for all 13 items on the Personal Science Teaching Efficacy Scale. The lowest correlated item-total item from the Science Teaching Outcome Expectancy Scale was .30. Construct validity was determined

by way of factor analysis (Enochs & Riggs, 1990).

A comparable instrument for mathematics was not found. The researcher replaced any reference to *science* with *mathematics* to reflect mathematics teaching beliefs. An item analysis was conducted for the 25-item survey. Teacher participants completed the survey at the end of the second year of the professional development training.

Reliability and Validity of the MTEBI

Internal consistency, which is an indicator of reliability, is an essential requirement of any survey (Harris, 1997). If a survey lacks reliability, the results are futile. Using Cronbach's alpha, a measure of internal consistency, the reliability of the instrument was tested in one administration. The administration involved 35 third-grade teachers in a single school district. Results are presented in Table 3.5.

Table 3.5. Math Teaching Efficacy Beliefs Instrument, Cronbach's Alpha

Variable (Pre-/posttraining)	Number of items	Cronbach's alpha
Efficacy		
Pretraining	25	.90
Posttraining	25	.82
General efficacy		
Pretraining	12	.74
Posttraining	12	.69
Personal efficacy		
Pretraining	13	.90
Posttraining	13	.79

To establish the validity of the personal and general efficacy statements, face validity, content validity, and construct validity were determined for both sets of statements. Validity refers to whether a survey measures what it purports to measure (Jackson, 2009). One form of validity is content validity. Jackson (2009) defined *content validity* as “a systematic examination of the test content to determine whether it covers a representative sample of the domain of behaviors to be measured” (p. 70). Content validity was determined by generating items from a credible study and by asking five experts (postsecondary mathematics educators from several universities) to judge whether the items met their understanding of the standards. Results from this test indicated that the survey had content validity. All five postsecondary educators scored the statements correctly according to the type of efficacy (general or personal) the statement was rating. Statements 1, 4, 7, 9, 10, 11, 13, 14, 15, 16, 20, and 25 address general efficacy and statements 2, 3, 5, 6, 8, 12, 17, 18, 19, 21, 22, 23, and 24 address personal efficacy.

To address whether a test looks valid on its surface, the researcher needed to simply establish face validity. “Face validity relates to whether or not the test looks valid to those who selected it and those who take it” (Jackson, 2009, p. 70). Face validity was determined by asking the participants to indicate if the items on the survey measured what they were intended to measure. The participants reported their opinions on whether the items did measure what the participants were instructed the items would measure. The percentage of those who agreed that the survey items measured what they were instructed would be measured was 100%. Therefore, the face validity of the survey was established.

The most important type of validity considered by many is construct validity.

According to Jackson (2009), “the construct validity of a test assesses the extent to which a measuring instrument accurately measures a theoretical construct or trait that it is designed to measure” (p. 71). The construct validity of the MTEBI is likely because the words on the STEBI survey were changed only minimally. The STEBI is valid, therefore, it is likely that the MTEBI is valid based on only changing the content word in each item from *science* to *math*. The items are not influenced by the difference in science and math as a content area.

Commonwealth Accountability Testing System (CATS)

Student achievement was measured using the state’s KCCT, part of the CATS assessment, which was administered in April 2009. This test included both multiple-choice and open-response items and measured the students’ achievement of grade-specific state standards in mathematics. Kentucky Department of Education contracted trained scorers who assigned every third grader a holistic score of novice, apprentice, proficient, or distinguished on statewide assessment measures in mathematics. No points are given for a novice score. For apprentice, proficient, and distinguished scores, .4, 1, and 1.4 were the values assigned, respectively.

The values resulting from the holistic scores are applied to calculate an index score used for state and federal accountability models. Individual student scores also are reported as percentage correct and scale scores. Mean scale scores were used in this study. The researcher obtained all achievement data directly from the school district and aggregated the data.

Socioeconomic Status (SES)

The SES of each student was measured by use of the state district factor groups. School and district report cards provided information about each school and district, including the percentage of children who qualify for free and reduced-price lunch. The researcher issued a request to the district's director of pupil personnel for the SES information of each student in the individual classrooms of those teachers participating in the research study. Each student was coded as 0 for paid lunch or 1 for free and reduced-price lunch.

Data Collection Procedure

The MTEBI, which includes one survey indicating reported efficacy levels before the training and after the training, was administered to all of the teachers following the mathematics professional development. The teacher participants completed the survey at the end of the professional development training. The survey was used as a reflective tool to assess teachers' perceived growth from the beginning of the professional development through the end.

Justification of using the MTEBI as a reflective tool was based on the work of Dewey (1933), who defined reflective thinking as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends" (p. 9). According to Dewey, a teacher can "transform a situation in which there is experienced obscurity, doubt, conflict, disturbance of some sort, into a situation that is clear, coherent, settled, harmonious" (pp. 100-101) by thinking reflectively. Dewey made central in his approach to schooling that the natural form of learning from experience is by doing first and then

reflecting on what happened. The professional development design reflected the elements of Dewey's theoretical description of reflective thinking: A real problem arises out of present experiences, suggestions for a solution come to mind, relevant data are observed, and a hypothesis is formed, acted upon, and finally tested.

Dewey (1933) argued that teachers who are distinguished in the teaching arena but lack an inquiring mind will have their professional growth reduced. Those teachers who lack reflective thinking will lead to intellectual dependency on "those persons who give them clear-cut and definite instructions as to just how to teach this and or that" (Dewey, 1933, p. 152). In addition, by emphasizing the MTEBI as a reflective tool as opposed to an evaluative one, use of the MTEBI enhanced the reliability of teachers' reporting and minimized confounding issues of bias and inflated scores.

At the beginning of the professional development program, teachers' self-reporting of their instructional practices and beliefs on the survey instrument indicated that, collectively, the teachers thought that they were very effective mathematics teachers. However, their understanding of what constituted effective mathematics teaching was consistent with traditional teaching practices, which are not substantiated by research and are in direct opposition to the recommendations of the NCTM (1991, 2000, 2006), the National Research Council, and the Math Advisory Panel.

When all of the participants score about the same, such as the case for this study in which all of the scores were high, the results of the pretest indicated that a ceiling effect was present. For this reason, a pre- and posttest reflections survey instrument was used at the conclusion of the professional development. The teachers were asked to reflect on their teaching of mathematics before and after the professional development.

They completed the survey designed to assess their change from the start of the professional development to the end of the professional development. One limitation to this study might be having asked the teachers to reconstruct the past.

Reliability and Validity of the Research Design

A sample size of 35 participants was used for this study. The appropriate data taken from the MTEBI survey, KCCT assessment, and the SES of each student was collected and analyzed. Efforts were made to establish reliability and validity of the study design.

Internal Validity

Internal validity is explained by Jackson (2009) as the “extent to which the result of an experiment can be attributed to the manipulation of the independent variable rather than to some confounding variable” (p. 207). The following precautions were implemented to control for threats to internal validity in reference to maturation and participant mortality.

Maturation. Participants may mature cognitively over the period of time the professional development was being conducted. To control for maturation, the number of years of experience was considered for the group of teachers who participated in the professional development. The majority of teachers in the district who teach third grade are veteran teachers. Therefore, minimal increases in maturation were expected.

Participant mortality. A certain amount of dropout or mortality may occur during the course of time over which a research study is conducted. To control for participant mortality, the district administration committed two years to the professional development program and pledged that all teachers would remain in the professional

development program for the two years planned. This commitment included classroom teachers as well as special education teachers. Teacher turnover during the two year of the professional development was exceptionally low.

External Validity

The extent to which this study can be generalized is limited to nonmetropolitan areas. This study needs to be generalized to similar contexts and would need replication in multiple sites prior to generalization to other contexts.

Data Analysis

The survey instrument gathered data on 25 individual items related to teacher efficacy in teaching mathematics. Items were assigned into two groups to facilitate analysis. Specifically, individual items were combined into two groups describing the constructs for general efficacy and personal efficacy. Two paired-samples t tests were conducted to compare the means from the MTEBI before and after the professional development.

The first t test compared personal efficacy, while the second compared general efficacy. The null hypotheses were there are no differences between the pretraining survey and posttraining survey scores. In other words, the professional development does not have an effect on the teachers' mathematics efficacy beliefs scores. The alternative hypotheses stated there are differences between the paired means; therefore, the elementary mathematics professional development *does* have an effect on the teachers' mathematics efficacy beliefs scores (i.e., personal and general efficacy).

A negative difference score indicates the subjects' mathematics efficacy increased during the course of the study. A positive difference indicates the subjects' mathematics

efficacy decreased during the course of the study. Reliability for both the pretraining survey and posttraining survey was measured by Cronbach's alpha. A reliability coefficient of .70 was used as the minimum level to determine if the survey scales are reliable. The scale variables include (a) efficacy pretraining ($\alpha = .90$) and efficacy posttraining ($\alpha = .82$), (b) general efficacy pretraining ($\alpha = .74$) and general efficacy posttraining ($\alpha = .69$), and (c) personal efficacy pretraining ($\alpha = .90$) and personal efficacy posttraining ($\alpha = .79$)

Limitations

Although the results of this study are enlightening, there are limitations. The findings of this study provide promising practices to increase teachers' perceptions of their efficacy, their attitudes towards teaching mathematics, and their students' achievement. However, the findings are limited to the teachers and district in the study. The study's generalizability is limited to a comparable district.

Self-reporting of efficacy is a limitation, particularly when administered in the context of a specific professional development program. When the survey was administered following the professional development, a limitation may be that the teachers do not remember the level of their efficacy with teaching of mathematics prior to the professional development. In the future, teachers will complete the efficacy survey prior to and outside the context of professional development. Using the survey only at the end may cause them to reflect inaccurately on their efficacy two years prior. Finally, the sample included 35 third-grade teachers. Such a sample may limit the power to find statistical differences that actually exist.

Summary

To analyze the effect a mathematics professional development has on teacher efficacy and the relationship between teacher efficacy and student SES with student achievement, an efficacy survey was administered to the teachers ($N = 35$) of third-grade students in one school district in the southeastern United States following the teachers' participation in a two-year professional development program focusing on mathematics instruction. The survey consisted of 25 6-point Likert-scaled statements (1 = *Strongly disagree*, 6 = *Strongly agree*). SPSS Predictive Analytics SoftWare (Version 18.0) was the statistical program used for analysis. Analyses included Cronbach's alpha, descriptive statistics, paired-samples t tests, and multiple regression.

CHAPTER FOUR:

RESULTS

Introduction

The purpose of this chapter is to report the results of the statistical analysis of the data collected in this study. Chapter 4 begins with an overview of the variables and measurements used in this study as well as a restatement of the purpose of the study, followed by the results in narrative and tabular format. The summaries of the frequencies of responses for the teacher survey items, descriptive statistics on scales formed from these items, which include general and personal efficacy, and results of the paired-samples *t* tests used to compare the means of the two dimensions of teacher efficacy, as perceived before and after the professional development, as measured by the MTEBI, are included in the findings.

Student eligibility for free or reduced-price lunch status and their scale score on the KCCT math assessment are also included in this study. Specifically, they are used in a multiple regression on the index score as the criterion variable and with personal or general efficacy with free/reduced-price lunch rates as the predictor variables. For all tests, an alpha level of .05 was used to determine statistical significance; the effect sizes are reported. The total population of third-grade teachers in the district was 40. Of the total population of full-time third-grade teachers, 35 (88%) were included in this study. The sample of teachers represents the population of teachers in the district by race and gender, which supports the population validity of the sample.

Variables and Measures

For Question 1 (What was the impact of a two-year professional development program focusing on conceptual understanding of mathematics content on teachers' personal and general efficacy to teach mathematics?), the independent variable was the professional development program and the dependent variable was teacher efficacy (general and personal). Teacher efficacy variables were assessed on the MTEBI survey (see Appendix A). The MTEBI consisted of 25 items on a 6-point Likert scale ranging from 1 = *Strongly disagree* to 6 = *Strongly agree*. Cronbach's alpha was used to measure the internal consistency of the MTEBI. The scale variables include (a) efficacy pretraining ($\alpha = .90$) and posttraining ($\alpha = .82$), (b) general efficacy for pretraining ($\alpha = .74$) and posttraining ($\alpha = .69$), and (c) personal efficacy pretraining ($\alpha = .90$) and posttraining ($\alpha = .79$).

For Question 2 (What is the relationship between teachers' personal and general efficacy teaching mathematics and students' SES with students' achievement in mathematics?), the predictor variables were the teacher efficacy scores and the students' SES. The criterion variable was student achievement on a state-mandated mathematics test. Student achievement scale scores were assessed on the KCCT, a state-administered test.

The professional development program focused on increasing mathematics content knowledge and the use of research-based pedagogy. The design supported research findings that indicate intensive, ongoing; job-embedded, professional development that is connected to practice was most beneficial to teachers. Teacher

efficacy scores resulted in two categories: general efficacy score and personal efficacy score. Students' SES included data on free and reduced-price lunch percentages.

Purpose

The purpose of this study was twofold. The first part of this study investigated the impact of a two-year professional development program on personal efficacy and general efficacy of mathematics teachers in 10 selected elementary schools in a southeastern state in the United States. Developing teachers' grade-specific knowledge of mathematics content and pedagogy was the focus of the professional development. The second part of this study investigated the relationship between a teacher's personal efficacy, general efficacy, and students' SES (based on free or reduced-price lunch program eligibility) with student achievement in mathematics. A multiple regression was used to analyze the relationship between teachers' efficacy and students' SES, with the students' mathematics achievement from KCCT. This analysis was conducted to help guide the focus of professional development programs in school districts and advance the knowledge base of literature on professional development models and the influence on student achievement.

Teacher Efficacy

Hoy and Woolfolk (1990) argued that it is misleading to combine the two teacher efficacy categories (personal and general) into a single score and, in most studies, there was a weak positive correlation between the two scores. The two aspects were general efficacy, a reflection of the teachers' beliefs about the general factors associated with how students learn mathematics, and personal efficacy, the individual teacher's perception of his or her effectiveness to teach math. Hoy and Woolfolk stated that

personal efficacy describes the individual teacher’s perception of his or her effectiveness, whereas general efficacy describes the teacher’s beliefs about the general factors associated with how students learn mathematics.

Third-grade students in this study were identified from the district’s information system (Infinite Campus). Student achievement was the student scale scores on the state criterion-referenced KCCT in mathematics.

Research Question 1

General Efficacy

Mean ratings. The means and standard deviations for the individual items comprising general efficacy on the survey are presented in Table 4.1. The items are listed in order of descending means on the posttraining survey to provide a picture of the importance of each survey item.

Table 4.1. General Efficacy Means and Standard Deviations

Item	General efficacy statements	Pre/ post- train	Mean	SD	Mean Diff.	Rank of Diff.
4	When the math grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	Pre	4.37	.808	1.06	2
		Post	5.43	.778		
11	When a low achieving child progresses in math, it is usually due to extra attention given by the teacher.	Pre	4.57	.655	0.74	5
		Post	5.31	.718		
9	The inadequacy of a student’s math background can be overcome by good teaching.	Pre	4.06	1.083	1.17	1
		Post	5.23	.808		

Table 4.1 (continued)

Item	General efficacy statements	Pre-/ post- train	Mean	<i>SD</i>	Mean Diff.	Rank of Diff.
14	The teacher is generally responsible for the achievement of students in math.	Pre	4.80	.759	0.40	9
		Post	5.20	.868		
15	Students' achievement in math is directly related to their teacher's effectiveness in math teaching.	Pre	4.63	.731	0.51	8
		Post	5.14	.845		
16	If parents comment that their child is showing more interest in math at school, it is probably due to the performance of the child's teacher.	Pre	4.34	.938	0.77	4
		Post	5.11	1.105		
20	Effectiveness in math teaching has little influence on the achievement of students with low motivation.	Pre	4.54	1.245	0.23	10
		Post	4.77	1.592		
1	When a student does better than usual in math, it is often because the teacher exerted a little extra effort.	Pre	4.23	.910	0.51	8
		Post	4.74	1.268		
13	Increased effort in math teaching produces little change in some students' math achievement.	Pre	4.03	1.200	0.60	7
		Post	4.63	1.536		
25	Even teachers with good math teaching abilities cannot help some kids learn math.	Pre	3.80	1.549	0.69	6
		Post	4.49	1.579		
7	If students are underachieving in math, it is most likely due to ineffective math teaching.	Pre	3.49	1.147	0.82	3
		Post	4.31	1.183		
10	The low math achievement of some students cannot generally be blamed on their teachers.	Pre	3.31	1.051	0	11
		Post	3.31	1.345		

As shown in Table 4.1, the pretraining response to Question 14 had the highest mean, indicating the teacher is generally responsible for the achievement of students in

math ($M = 4.80$, $SD = .759$). Question 4 had the highest mean for the posttraining response, indicating that when students' math grades improve, it is due to the teacher's approach to teaching ($M = 5.43$, $SD = .778$). These survey questions have a common theme of teachers being able to improve student achievement. Conversely, the pretraining response to Question 10 had the lowest mean, which indicates the teacher was responsible for student underachievement ($M = 3.31$, $SD = 1.051$). The posttraining response to Question 10 was also the lowest mean ($M = 3.31$, $SD = 1.345$), which indicates low achievement in math cannot generally be blamed on teachers.

The six posttraining statements ranking the highest had a mean above 5.0, indicating agreement. For all of the remaining statements except for the final one, the mean was above 4.0, indicating responders barely agreed to agreed. The final statement item reported the lowest mean of 3.31, which indicated the responders barely disagreed.

There was an increase in the teachers' general efficacy following participation in the professional development program. For example, teachers' responses representing their experience prior to the professional development program indicated the teachers barely agreed with most of the statement items with the exception of the last three statements, results of which indicated the responders barely disagreed. Because a score of 3.5 would indicate neutrality, a mean of 4.0 indicated agreement.

Item Frequencies

Frequencies reported as percentages of the individual items on the MTEBI survey for general efficacy are presented in Table 4.2. The items are listed in the same order as presented in Table 4.1 to provide a clearer picture of the ratings of the importance of each item.

General efficacy included the statements designed to reflect the teachers' beliefs about the general factors associated with how students learn mathematics. The teachers indicated their agreement with these items using a 6-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3= Barely disagree, 4= Barely agree, 5= Agree, and 6 = Strongly agree.). The majority of the items (4, 11, 9, 14, 15, 16, 1, and 7) were written in the positive. Items 10, 13, 20, and 25 were written in the negative and have been reverse-coded to increase survey validity (Jackson, 2009).

Table 4.2. Percentage of Participants Responding to Each Indicator Within General Efficacy

Item	General efficacy statements	Pre- /Post- train	Teachers' % Responses					
			SD	D	BD	BA	A	SA
4	When the math grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	Pre	0	0	11.4	48.6	31.4	8.6
		Post	0	0	2.9	8.6	31.4	57.1
11	When a low achieving child progresses in math, it is usually due to extra attention given by the teacher.	Pre	0	0	5.7	34.3	57.1	2.9
		Post	0	0	14.3	0	40.0	45.7
9	The inadequacy of a student's math background can be overcome by good teaching.	Pre	2.9	8.6	11.4	34.3	42.9	0
		Post	0	0	2.9	14.3	40.0	42.9
14	The teacher is generally responsible for the achievement of students in math.	Pre	0	0	2.9	31.4	48.6	17.1
		Post	0	0	2.9	11.4	45.7	40.0

Table 4.2 (continued)

Item	General efficacy statements	Pre- /Post- train	Teachers' % Responses					
			SD	D	BD	BA	A	SA
15	Students' achievement in math is directly related to their teacher's effectiveness in math teaching.	Pre	0	0	8.6	25.7	60.0	5.7
		Post	0	0	5.7	11.4	45.7	37.1
16	If parents comment that their child is showing more interest in math at school, it is probably due to the performance of the child's teacher.	Pre	2.9	2.9	5.7	34.3	54.3	0
		Post	2.9	2.9	0	8.6	45.7	40.0
20	Effectiveness in math teaching has little influence on the achievement of students with low motivation.	Pre	20.0	45.7	14.3	8.6	11.4	0
		Post	42.9	31.4	8.6	2.9	5.7	8.6
1	When a student does better than usual in math, it is often because the teacher exerted a little extra effort.	Pre	0	2.9	17.1	40.0	34.3	5.7
		Post	0	8.6	5.7	25.7	22.9	37.1
13	Increased effort in math teaching produces little change in some students' math achievement.	Pre	5.7	42.9	11.4	28.6	11.4	0
		Post	37.1	28.6	14.3	5.7	8.6	5.7
25	Even teachers with good math teaching abilities cannot help some kids learn math.	Pre	20.0	14.3	20.0	22.9	17.1	5.7
		Post	34.3	28.6	8.6	14.3	8.6	5.7
7	If students are underachieving in math, it is most likely due to ineffective math teaching.	Pre	8.6	5.7	34.3	31.4	20.0	0
		Post	11.4	5.7	40.0	25.7	17.1	0

Table 4.2 (continued)

Item	General efficacy statements	Pre- /Post- train	Teachers' % Responses					
			SD	D	BD	BA	A	SA
10	The low math achievement of some students cannot generally be blamed on their teachers.	Pre	0	14.3	31.4	25.7	28.6	0
		Post	0	25.7	20.0	25.7	17.1	11.4

Note. SD = Strongly disagree. D = Disagree. BD = Barely disagree. BA = Barely agree. A = Agree. SA = Strongly agree. Shaded items were reverse-scored.

Upon viewing the ranking of responses presented in Table 4.1 and Table 4.2, two common themes evolve. The highest mean survey items (4, 11, 9, 14, 15, and 16) are indicative of teachers' beliefs that teachers get the credit for student achievement collectively. The lowest mean survey items (20, 1, 13, 25, 7, and 10) are indicative of teachers' beliefs that they are not accountable for the achievement of all students. Using the results of the percentages found in Table 4.2, the researcher combined the three levels of agreement (barely agree, agree, and strongly agree) and the three levels of disagreement (barely disagree, disagree, and strongly disagree) to assess how the responses shifted on the scale. The total percentage for agreement and disagreement was used to predict if there was an increase or decrease between the pretraining survey and the posttraining survey without a statistical test. The questions were grouped according to common themes determined by the researcher.

Results of the percentages for questions 9, 16, and 25 indicated that there was an increase in agreement between the pretraining survey and the posttraining survey. The common theme determined was that the professional development led to a substantial increase in the teachers' beliefs that they could influence the students' math achievement.

For questions 1 and 13, the common theme found was effort. Agreement with these questions increased after the professional development experience. In contrast, Item 11, which mentioned only *attention*, actually yielded a decrease in agreement. The assumption is that, through the professional development, the teachers concluded that putting more effort into assisting the students did correlate with student achievement, but that simply giving the students more attention did not.

Responses to statements 4, 15, and 20 indicated small increases in agreement. In contrast, the response to Item 7 indicated a decrease in agreement. Interestingly, the common theme for this set of questions is while the teachers did believe that teacher effectiveness could increase student achievement, they did not believe that teacher *ineffectiveness* could cause students to underachieve in mathematics.

Two statements (10 and 14) related to the teachers' responsibility for math achievement. Item 14 stated that the teacher is generally responsible for achievement of students in math. This statement yielded a 97.1% agreement rate on both the pretraining and posttraining surveys. No change in agreement was noted in response to Item 10, but less than half of the teachers reported believing that students' low math achievement could be blamed on their teachers.

Personal Efficacy

Mean ratings. The means and standard deviations for the individual questions on teachers' personal efficacy are presented in Table 4.3. To provide a clearer picture of the ratings of importance of each item, the individual items are presented in order of descending means on the posttraining survey.

Table 4.3. Descending Means and Standard Deviations, Personal Efficacy Items

Item	Personal efficacy statements	Pre-/ Post- train	Mean	<i>SD</i>	Mean Diff.	Rank of Diff.
18	I am typically able to answer students' math questions.	Pre	4.80	.833	0.80	8
		Post	5.60	.497		
12	I understand math concepts well enough to be effective in teaching elementary math.	Pre	4.57	.948	1.00	3
		Post	5.57	.558		
2	I am continually finding better ways to teach math.	Pre	4.03	1.098	1.51	1
		Post	5.54	.611		
22	When a student has difficulty understanding a math concept, I am usually at a loss as to how to help the student understand it better.	Pre	4.54	1.268	0.97	4
		Post	5.51	.853		
23	When teaching math, I usually welcome student questions.	Pre	4.97	1.248	0.43	10
		Post	5.40	1.090		
19	I wonder if I have the necessary skills to teach math.	Pre	4.43	1.378	0.94	5
		Post	5.37	.942		
5	I know the steps necessary to teach math concepts effectively.	Pre	3.97	1.098	1.32	2
		Post	5.29	.789		
8	I generally teach math ineffectively.	Pre	4.83	1.248	0.40	11
		Post	5.23	1.165		
21	Given a choice, I would not invite the principal to evaluate my math teaching.	Pre	4.51	1.579	0.63	9
		Post	5.14	1.396		
17	I find it difficult to explain to students why and how mathematics works.	Pre	4.20	1.346	0.86	6
		Post	5.06	1.282		
24	I know what to do to turn students on to math.	Pre	4.14	1.353	0.83	7
		Post	4.97	1.294		

Table 4.3 (continued)

Item	Personal efficacy statements	Pre-/Post-train	Mean	SD	Mean Diff.	Rank of Diff.
3	Even when I try very hard, I don't teach math as well as I do most subjects.	Pre	4.29	1.250	0.40	11
		Post	4.69	1.491		
6	I am not very effective in monitoring math achievement through hands-on activities	Pre	3.83	1.124	0.003	12
		Post	3.86	1.768		

As indicated in Table 4.3, the personal efficacy statement that had the highest mean on the pretraining survey was Question 23, which indicated teachers' willingness to answer students' questions ($M = 4.97$, $SD = 1.248$). The personal efficacy statement on the posttraining survey that evoked the highest mean involved the teachers' ability to answer students' math questions ($M = 5.60$, $SD = .778$). Because these statistics were gauged on a 6-point scale, the statistics indicate extreme agreement. Both survey questions have a common theme of teachers' comfort to answer students' questions. Conversely, the question that had the lowest mean on both the pretraining survey ($M = 3.83$, $SD = 1.124$) and the posttraining survey ($M = 3.86$, $SD = 1.768$). Specifically, they reported *I am not very effective in monitoring math achievement through hands-on activities*. Because 3.5 on a 6-point scale indicates neutrality, teachers' responses indicated slight agreement with this statement.

Results indicate the professional development program contributed to an overall increase in the teachers' personal efficacy. According to the teachers' responses, prior to their participation in the professional development program, the teachers indicated greater personal efficacy than general efficacy, although agreement ranged in the mid-4 area on a 6-point scale. Following the training, as reported on the posttraining survey,

most of the means of statement responses moved up to between 5 and 6. However, the one item for which agreement remained below 4 concerned the instruction of students working with math manipulatives. In summary, teachers reported believing they do an effective job teaching mathematics, but instruction requiring conceptual understanding, such as constructing meaning with manipulatives, is a weak area.

Item Frequencies

The percentages of responses to the individual items on the MTEBI survey for personal efficacy are presented in Table 4.4. Personal efficacy statements were designed to reflect the teachers' perception of their individual effectiveness to teach mathematics. These items could be distinguished from the general efficacy statements because they are written in first person. Thirteen of the items on the survey were personal efficacy statements. Five were written in the positive and eight were written in the negative. The items written in the negative were reverse-coded. The items are presented in identical order as shown in Table 4.3 to provide a clearer picture of the rated relative importance of each item.

Table 4.4. Percentage of Participants Responding to Each Indicator within Personal Efficacy

Item	Personal efficacy statements	Pre-/ Post- train	Teachers' % Responses					
			<i>SD</i>	D	BD	BA	A	SA
18	I am typically able to answer students' math questions.	Pre	0	2.9	2.9	20.0	60.0	14.3
		Post	0	0	0	0	40.0	60.0
12	I understand math concepts well enough to be effective in teaching elementary math.	Pre	0	2.9	8.6	31.4	42.9	14.3
		Post	0	0	0	2.9	37.1	60.0

Table 4.4 (continued)

Item	Personal efficacy statements	Pre-/Post-train	Teachers' % Responses					
			<i>SD</i>	D	BD	BA	A	SA
2	I am continually finding better ways to teach math.	Pre	0	11.4	20.0	25.7	40.0	2.9
		Post	0	0	0	5.7	34.3	60.0
22	When a student has difficulty understanding a math concept, I am usually at a loss as to how to help the student understand it better.	Pre	22.9	37.1	22.9	8.6	5.7	2.9
		Post	65.7	25.7	5.7	0	2.9	0
23	When teaching math, I usually welcome student questions.	Pre	2.9	2.9	5.7	14.3	31.4	42.9
		Post	2.9	2.9	0	0	34.3	60.0
19	I wonder if I have the necessary skills to teach math.	Pre	28.6	25.7	14.3	25.7	2.9	2.9
		Post	57.1	31.4	5.7	2.9	2.9	0
5	I know the steps necessary to teach math concepts effectively.	Pre	0	11.4	20.0	34.3	28.6	5.7
		Post	0	2.9	0	2.9	54.3	40.0
8	I generally teach math ineffectively.	Pre	34.3	40.0	8.6	8.6	8.6	0
		Post	57.1	25.7	5.7	5.7	5.7	0
21	Given a choice, I would not invite the principal to evaluate my math teaching.	Pre	37.1	17.1	28.6	2.9	5.7	8.6
		Post	60.0	22.9	2.0	0	14.3	0
17	I find it difficult to explain to students why and how mathematics works.	Pre	11.4	42.9	20.0	8.6	14.3	2.9
		Post	51.4	25.7	8.6	5.7	8.6	0
24	I know what to do to turn students on to math.	Pre	14.3	31.4	28.6	8.6	14.3	2.9
		Post	42.9	34.3	11.4	2.9	5.7	2.9

Table 4.4 (continued)

Item	Personal efficacy statements	Pre-/Post-train	Teachers' % Responses					
			SD	D	BD	BA	A	SA
3	When I try very hard, I don't	Pre	11.4	40.0	28.6	11.4	2.9	5.7
	teach math as well as I do most subjects.	Post	34.3	40.0	5.7	2.9	14.3	2.9
6	I am not very effective in	Pre	5.7	20.0	40.0	22.9	8.6	2.9
	monitoring math achievement through hands-on activities	Post	14.3	42.9	2.9	8.6	17.1	14.3

Note. SD =Strongly disagree. D = Disagree. BD = Barely disagree. BA = Barely agree. A = Agree. SA =Strongly agree. Shaded items were reverse-scored.

Upon viewing the ranking of responses presented in Table 4.4, two common themes evolve. The highest ranked questions (18, 12, 2, 22, 23, and 19), indicate that the teachers credited student achievement to their general knowledge of mathematics content. The lowest ranked survey items (5, 8, 21, 17, 24, and 3) indicate that teachers believed their conceptual understanding of mathematics and their ability to use pedagogy strategies in their instruction contributed to student achievement.

Using the results of the percentages found in Table 4.4, the researcher combined the three levels of agreement (barely agree, agree, and strongly agree) and the three levels of disagreement (barely disagree, disagree, and strongly disagree) to assess how the responses varied in the scale. The total percentage for agreement and disagreement was used to predict if there was an increase or decrease between the pretraining survey and the posttraining survey. The questions were grouped according to common themes determined by the researcher.

Teaching mathematics was the common theme for questions 2, 3, 5, and 19. Item 2 increased in percentage of agreement. The statement related to seeking better ways to teach increased from 68.6% prior to training to 100% after training, according to the surveys. Questions 5 and 19 related to knowing the steps necessary to teach math and having the requisite skills. Agreement with both questions increased from 68.2% in the pretraining survey to over 90% in the posttraining survey. The item to which no change in agreement was reported was Question 3. It related to the teachers' comparisons of their math knowledge relative to other subjects. Even after the professional development sessions, only 20% of the teachers reported believing they taught mathematics as well as they did other subjects.

The two statements for which extent of agreement decreased were items 24 and 6, having a common theme of engaging and assessing students. Item 24 stated *I know what to do to turn students on to math* and showed a substantial decrease, from 30.8% agreement in the pretraining survey to 11.5% agreement in the posttraining survey. It is possible the low percentages of agreement may have been due to the wording of the item. Perhaps if the phrase *to turn students on* had been replaced with *to engage students*, the responses might have been different. On Item 6, related to effectively monitoring math achievement during mathematics activities, the percentage of agreement decreased from 65.7% in the pretraining survey to 60.1% in the posttraining survey.

Comparisons of Pre- and Posttraining General and Personal Efficacy

Previous sections of this chapter have offered a review of the individual means along a descriptive continuum. The means of the scales as a whole have not been

compared. In this section, the pre- and posttraining means of the scales are reported and compared for differences.

General Efficacy

The means and standard deviations of general efficacy, disaggregated by pretraining and posttraining survey data, are presented in Table 4.5.

Table 4.5. Means and Standard Deviations, General Efficacy Scales

Mathematics efficacy beliefs test	Mean	<i>SD</i>
General efficacy—pretraining	4.18	.532
General efficacy—posttraining	4.80	.563
Change in general efficacy	.63	.421

On a 6-point scale, where 3.5 would indicate neutrality, the teachers reported slight agreement of 4.18 prior to the training. This value increased to 4.80 on the posttraining survey, which indicated an increase in agreement. Thus, a positive change of 0.63 occurred. A paired-sample *t* test is reported later in this study to determine if this difference is statistically significant.

Personal Efficacy

The means and standard deviations of the scale for personal efficacy, disaggregated by pretraining and posttraining survey data, are presented in Table 4.6.

Table 4.6. Means and Standard Deviations, Personal Efficacy Scales

Mathematics efficacy beliefs test	Mean	<i>SD</i>
Personal efficacy—pre-training	4.39	.839
Personal efficacy—post-training	5.17	.598
Change in personal efficacy	.77	.645

A comparison of the information presented in Table 4.5 and Table 4.6 indicates the teachers had higher personal efficacy than general efficacy prior to and after participating in the professional development program. Even so, the differences were only .21 and .37 for personal and general efficacy, respectively. Personal efficacy posttraining increased to 5.17, indicating strong agreement after completing the professional development. This increased agreement represented a positive change of 0.78.

Paired-Samples *t* Tests

To answer Research Question 1, a paired-samples *t* test was conducted to determine the effect the independent variable (two-year professional development program) had on the dependent variables (teachers' general and personal efficacy for teaching mathematics). Results from the paired-samples *t* test comparing the means of the pair of scales for teachers' general efficacy are presented in Table 4.7.

Table 4.7. Paired-Samples *t* Tests, General Efficacy

		Paired differences		<i>t</i>	<i>df</i>	Mean difference	Sig. (2-tailed)
		95% Confidence interval of the difference					
		Lower	Upper				
Pair 1	General efficacy (mean pretraining) - general efficacy (mean posttraining)	-.7711	-.4813	-8.784	34	-.6262	.000

As indicated in Table 4.7, results of the *t* test revealed a significant difference between teachers' general efficacy before and after the professional development program, $t(34) = -8.784, p < .05$. The general efficacy mean was higher after the professional development. Therefore, Null Hypothesis 1 is rejected.

Results from the paired-samples *t* tests comparing the means of the pair of scales for teachers' personal efficacy are presented in Table 4.8.

Table 4.8. Paired-Samples *t* Tests, Personal Efficacy

		Paired differences		<i>t</i>	<i>df</i>	Mean difference	Sig. (2-tailed)
		95% Confidence interval of the difference					
		Lower	Upper				
Pair 1	Personal efficacy (mean pretraining) - personal efficacy (mean posttraining)	-.9996	-.5564	-7.135	34	-.7780	.000

As indicated in Table 4.8, results of the *t* test revealed a significant difference between teachers' personal efficacy before and after the professional development

program, $t(34) = -7.135, p < .05$. The personal efficacy mean was higher after the professional development. Therefore, Null Hypothesis 2 is rejected.

Relationship Between Student Achievement with Teacher Efficacy and Student SES

To answer Question 2, a multiple regression analysis was performed with the criterion variable (student achievement) and the predictor variables (teachers' general efficacy in teaching mathematics, teachers' personal efficacy in teaching mathematics, and students' SES). Students' SES was determined using the students' eligibility for the free and reduced-price lunch program, as determined by income. The population of third-grade students in the district who qualified for free and reduced-price lunch was 52.2%. Student achievement was determined by their scale score on the Math KCCT. The percentage of students scoring proficient or distinguished on the KCCT assessment can be calculated by cuts in the range of these scale scores. The population of proficient and distinguished scores on the mathematics section of the KCCT for the third-grade population in the district was 79.4%.

The regression analysis revealed that the model significantly predicted student achievement, $F(2,705) = 49.78, p < .05$, and R^2 for the model was .12. These results indicated that the predictor variables collectively explained 12.4% of the variance on the KCCT index score in math. General efficacy and students' SES (determined by lunch program status) had a significant relationship with students' achievement in mathematics (see Table 4.9).

Table 4.9. Regression on General Efficacy

Model ^a	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>Sig.</i>	
	<i>B</i>	<i>SE</i>	Beta			
1	(Constant)	329.125	6.410		51.350	.000
	Lunch status	7.234	.747	.341	9.679	.000
	General efficacy (mean posttraining)	2.774	1.295	.076	2.141	.033

Note. ^aDependent variable = Scale score.

In terms of individual relationships between the predictor variables and student achievement in mathematics, students' SES ($t = 9.679, p < .05$) and teachers' general efficacy with teaching mathematics ($t = 2.141, p < .05$) significantly predicted student achievement. The most powerful predictor, according to the standardized coefficients, was students' SES (lunch program status) ($\beta = .341$). The standardized coefficient was positive; thus, a direct relationship exists between students' SES and student achievement. The second most powerful predictor was teachers' general efficacy in teaching mathematics ($\beta = .076$). This standardized coefficient is positive; thus, a direct relationship exists between teachers' general efficacy and student achievement. Lunch status was almost 5 times more powerful than general efficacy as a predictor of math test scores.

A simple linear regression was performed with teachers' personal efficacy teaching mathematics and students' SES (as determined by lunch program status), on student achievement. The results are presented in Table 4.10.

Table 4.10. Regression on Personal Efficacy

Model ^a	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>Sig.</i>
	<i>B</i>	<i>SE</i>	Beta		
1 (Constant)	332.264	6.487		51.223	.000
Lunch status	7.231	.749	.341	9.657	.000
Personal efficacy (mean posttraining)	1.971	1.222	.057	1.613	.107

Note. ^aDependent variable = Scale score.

Results of the multiple linear regression indicate teachers' personal efficacy and students' SES significantly predict student achievement are not significant $F(2,705) = 48.656, p < .05$, and R^2 for the model was .121. The model explains 12.1% of the variable in math achievement scores. The predictor variable, students' SES ($t = 9.679, p < .05$) is significant. The standardized beta of .341 indicates that it is a powerful predictor of student achievement with a positive relationship. Personal efficacy ($p = .107$) is not a significant predictor.

Summary

The purpose of this chapter was twofold. The first purpose was to report the findings of the teacher efficacy survey in regards to the impact of a two-year professional development program on teachers' general and personal efficacy in teaching mathematics. The majority of teachers agreed with general and personal efficacy statements relative to their performance prior to participating in the professional development program, but the mean increased after the professional development program. Teachers ranked their ability to answer students' math questions the highest ($M = 5.60$), indicating they have higher confidence with this personal efficacy variable.

The lowest ranked statement in general efficacy had to do with the blame for students' low math achievement generally being placed on their teachers ($M = 3.31$). Teachers' responses indicated they believed that they could have an effect on student achievement in mathematics but should not be blamed for the underachievement of students. Data indicated that participation in the professional development program had a significant effect on teachers' general and personal efficacy for teaching mathematics.

The second purpose of this chapter was to report the findings of the relationship between the teachers' personal efficacy and general efficacy with student SES (determined by lunch program status) and students' achievement in mathematics. Data indicated that teachers' general efficacy and students' SES were significant predictors of student achievement. However, teachers' personal efficacy was not.

CHAPTER 5:

FINDINGS, IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSION

A considerable amount of research exists on the design of professional development, teacher efficacy, how teachers learn during professional development (Borko, 2004; Ross & Bruce, 2007; Stein et al., 1999), and teacher change in classroom instruction as a result of professional development (Ball & Cohen, 1999; Desimone et al., 2002; Penuel et al., 2007). Policy makers and school district leaders have sought to improve the quality of professional development to effectively raise student achievement. However, despite the plethora of research conducted to date on professional development, relatively little systematic research has been conducted on the effect it has on student achievement (Loucks-Horsley & Matsumoto, 1999).

Since the late 1990s, a considerable body of literature has emerged on teachers' perceived efficacy, identifying it as a powerful variable in determining instructional effectiveness leading itself to student achievement (Ashton & Webb, 1986). Teacher efficacy is a teacher's expectation that he or she will be a change agent for instructional strategies resulting in student achievement (Bandura, 1993). Effective change contributes to enhanced achievement when teachers with high efficacy try new instructional strategies and classroom management approaches, attend more closely to the needs of struggling students, and enable students to have a positive perception of their academic abilities (Guskey, 1988).

This study investigated the impact of a two-year professional development program on personal efficacy and general efficacy of third-grade mathematics teachers

and examined the relationship between teaching efficacy, student SES, and student achievement in mathematics. The following questions were addressed:

1. What was the impact of a two-year professional development program focusing on conceptual understanding of mathematics content on teachers' personal and general efficacy teaching mathematics?
2. What is the relationship between teachers' personal and general efficacy teaching mathematics and students' SES with students' achievement in mathematics?

Question 1 was measured using a paired-samples *t* test to determine the effect the independent variable (two-year professional development program) had on the dependent variables (teachers' general and personal efficacy for teaching mathematics). For Question 2, a multiple regression was used to investigate the relationship between teacher efficacy and students' SES with student achievement. The implications, recommendations, and conclusions drawn from the findings of this study are presented in this chapter. Recommendations are included for practitioners and policy makers, as well as options for future study in the areas of professional development, teacher efficacy, and student achievement.

Findings

Professional Development and Teacher Efficacy

Research Question 1 focused on the effect a two-year professional development program had on teachers' general and personal efficacy in teaching mathematics. The professional development program emphasized conceptual understanding of mathematics content. Empirical evidence of the findings indicated the professional development

program did increase the teachers' general and personal efficacy. A paired-samples *t* test was conducted and revealed a significant difference in both teachers' general and personal efficacy before and after the professional development program.

Findings of this study were consistent with the research findings of Ross (1995), supporting the theory that teachers' general efficacy does predict student achievement (see Table 4.9). The development of teacher efficacy is a cyclical and iterative process. Based on research conducted by Bandura (1977, 1982), four types of experiences play a role in the formation of teacher efficacy: mastery experience, physiological arousal, vicarious experience, and verbal persuasion.

Based on Bandura's research (1977, 1982), mastery experience is based on the number of successes and failures a person has had. Successes raise mastery experience, failures lower it, and repeated successes strengthen efficacy, resulting in reducing the negative effect of occasional failures. Physiological or emotional arousal can occur in response to stressful and taxing situations. Debilitated performance and reduced efficacy may result from physiological or emotional arousal. Diminishing emotional arousal can increase efficacy.

Vicarious experience involves seeing others perform challenging activities without experiencing negative feelings. Bandura (1977, 1982) explains how this exposure can generate self-expectations similar to ability and competency. Verbal persuasion is experienced when a person is led, through suggestion, into believing he or she can cope successfully with something that had previously overwhelmed him or her.

In this study, teachers learned new and more effective approaches to teaching mathematics through active and collaborative job-embedded professional development

sessions. Teachers had opportunities to develop their knowledge of mathematics standards and curriculum, mathematics content knowledge, constructivist pedagogy, and formative assessment strategies. They were able to witness and demonstrate these skills, and were coached to apply these skills to the education of their students. Attempting to teach in an unfamiliar way and to test new instructional strategies in the classroom can be stressful. Opportunities to develop strategies and overcome or manage stress are important factors for developing teacher efficacy. This study showed that, by providing a mastery experience for teachers, including participation in content-related professional development that was job-embedded and focused on improving conceptual learning and teaching strategies, teacher efficacy was increased.

Professional development and general efficacy. General efficacy describes teachers' beliefs about the general factors associated with how students learn mathematics. These are factors that relate to a belief of what teachers in general can accomplish, extending beyond individual capabilities of a specific individual or person. The statements on the survey reflected the four general categories of teacher influence, effort and attention, effective teaching, and teacher responsibility.

The reform movement for mathematics is based on teaching for conceptual understanding and tailoring teaching strategies to meet the different needs of all students—especially those who have special needs (van de Berg, 2002). The two-year professional development program embedded teaching strategies as well as skills and knowledge to improve student learning with the goal being to increase student achievement in mathematics. Strategies and skills were introduced and modeled, and opportunities to practice were provided for individual teachers. They were then

encouraged to return to their schools and use their newfound competencies in their classrooms.

Minimal emphasis was put on collaboration and ways to work with other teachers who share in the responsibility of teaching students with learning needs (i.e., special education teachers). When teachers work together to find ways to address the learning, motivation, and behavior problems of their students, their feelings of efficacy are likely to increase (Tschannen-Moran et al., 1998). High-efficacy teachers experience higher degrees of success than low-efficacy teachers because they attend more closely to the needs of lower ability students, resulting in higher levels of student achievement overall. For teachers to feel a deeper sense of responsibility for students who achieve at low levels in mathematics, a component on how to effectively collaborate with other teachers to better address student achievement needs to be included in a professional development program.

The findings in response to the general efficacy statements, as a result of the professional development, showed a 0.626 increase overall in teachers' belief about the general factors associated with how students learn mathematics. Teachers believe there is a connection between student improvement and teachers having found a more effective approach to teaching. A student's increased interest in math could be a result of an effective teaching approach practiced by the teacher.

Developing effective teaching strategies for all students can be a challenge for many teachers. This difficulty was reflected in the analysis of responses to Item 10, in which teachers indicated that the low achievement of some students could not generally be blamed on their teachers. As previously reported, implementing different teaching

strategies and monitoring student learning is difficult for regular education teachers whose classroom includes special needs students or students who struggle.

The quarterly professional development sessions were designed to bring together in a collaborative and positive environment teachers from the same grade level, teaching the same content, and attempting the same instructional strategies. New instructional strategies along with new formative assessment strategies to evaluate student learning were shared at previous professional development sessions. The teachers were expected to return to their classrooms and implement these instructional and assessment strategies into their lessons before the next scheduled professional development session. A collaborative and positive type of environment enabled the teachers to process their stress of implementing the previously learned strategies in a productive manner, resulting in positive attitudes towards trying new instructional strategies, as demonstrated in the analysis of Item 4, which stated students improve as a result of a more effective teaching approach. These experiences increased teachers' ability to develop efficacy through physiological arousal.

Teachers had the opportunity to gain vicarious experience as they observed master teachers modeling constructivist pedagogy and mathematics lessons and activities in the professional development sessions. A valuable component for the professional development was that all of the content modeled was situated in practice. The analysis of Item 15 showed an increase in the pre- and posttraining mean, stating the teachers agreed that students' achievement in math was directly related to their teacher's effectiveness in math teaching.

The professional development program was deemed successful because the teachers could see a positive change in their instructional practice resulting in student achievement. Opportunities to conduct hands-on work focused on developing the teachers' knowledge of academic content and ways to teach it to their students, taking into account the specifics of their school resources, district curriculum guidelines, and accountability systems. This vicarious experience contributed to the increase in the teachers' efficacy.

Teachers received emotional support, feedback, and encouragement throughout the two-year initiative from master teachers, mathematics intervention specialists, principals, and peers. A large support network was fostered, which provided teachers with advice, moral support, and enthusiasm. All of the participants were allotted time to work with their peers to provide and receive advice, moral support, and encouragement on working with struggling students or those involved in intervention during the professional development. This verbal persuasion contributed to increased teacher efficacy.

Professional development and personal efficacy. Personal efficacy is defined as the individual teacher's perception of his or her effectiveness to teach mathematics (Hoy & Woolfolk, 1990). These factors are more specific to an individual or person's capabilities rather than a belief about what teachers in general can accomplish. Items on the survey of personal efficacy were categorized as either related to knowledge content or mathematical pedagogy related to teaching strategies.

The item analysis for statements reflecting personal efficacy showed a 0.78 mean increase. This was a larger increase (0.15) than that for general efficacy. This difference

indicated the teachers' perception of their effectiveness to teach math grew stronger on a personal basis. Evidence from the study to support the strength of personal efficacy was found in the answer to Item 2 relating to the idea that the teachers were continually finding better ways to teach math. Based on the posttraining survey analysis, 100% of the teachers agreed with this question—the highest percentage of agreement of all questions on the survey, including those directly related to general efficacy.

These results indicated that teachers in this study changed the way they were teaching mathematics to their students. These changes can be attributed to the focus and quality of the professional development experiences. Analysis of the quantitative data indicated that the lessons teachers learned during the professional development sessions have become common classroom practices. The structure of the professional development experiences were aligned with the research literature defining high-quality professional development. The professional development was sustained for a two-year period, with ongoing quarterly professional development sessions. Additionally, teachers received ongoing collaborative support from the mathematics intervention specialist in each of the 10 schools, which provided the teachers with verbal persuasion to support the formation of teacher efficacy.

Professional development was embedded in the teachers' authentic and daily work, and was grade-level and content-specific. The foci of the sessions were on the development of teachers' content and pedagogical content knowledge and on providing a mastery experience to promote teacher efficacy. Time was allowed for the teachers to unpack the standards, plan their curriculum, and learn instructional practices to address the specific content and pedagogical demands of their grade level. The mean posttraining

score indicated teachers agreed with Item 12, which stated that the teachers understood math concepts well enough to be effective in teaching elementary mathematics.

Teachers witnessed instructional strategies modeled by master teachers, had opportunities to wrestle with the mathematics concepts addressed in challenging mathematics problems, and returned to their classrooms prepared with the resources needed to implement these strategies and activities. Teachers participated in unexpected experiences when they tested these new strategies with their students and gained personal and professional value and relevance for transforming instructional practices resulting in student achievement. This improved performance was reflected in the mean difference between pre- and posttraining responses to Item 5, which stated that teachers knew the steps necessary to teach math concepts effectively.

Given the nature of open-ended activities and more effective questioning strategies, teachers had opportunities to develop knowledge of their students' understanding or misunderstanding of important mathematics ideas. Coupled with their developing knowledge of formative assessment strategies, teachers had a doorway opened to understand student thinking. Despite this newfound awareness, teachers showed a minimal increase from pretraining to posttraining responses to Item 6, indicating very little growth in their efficacy of monitoring math achievement through hands-on activities. Both formative assessment strategies and effective questioning strategies are crucial to promote student achievement through active learning using hands-on activities. This shortcoming represents an area that professional development needs to stress in the future.

The two-year professional development program in which elementary school

teachers participated was job-embedded and periodical; sessions were conducted quarterly. Teachers were given time to return to their classrooms to practice strategies and teach specific content before the next professional development session. At the following professional development session, teachers were afforded the opportunity to reflect and share their experiences within a context of collegiality and collaboration. The professional development structure provided physiological arousal in addition to opportunities for teachers to develop their necessary mathematical knowledge for teaching within a context of collegial support.

Relationship Between Teacher Efficacy and SES with Student Achievement

Research Question 2 sought to determine whether a relationship existed between teachers' personal and general efficacy teaching mathematics and students' SES with students' achievement in mathematics. The findings of this study did support the hypothesis that general efficacy and SES directly influences student achievement. However, the findings of this study did not support the hypothesis that personal efficacy and SES directly influences student achievement.

This study focused on a two-year job-embedded professional development program, the purpose of which was to improve teachers' general and personal efficacy. Teachers' general efficacy *directly* influenced student achievement. Therefore, it appears that teachers' general efficacy, students' SES, and student achievement are connected.

Findings of the study indicate a two-year job-embedded professional development program had a significant effect on teachers' personal and general efficacy. This finding is not new. However, this study also found that teachers' general efficacy had a significant relationship with student achievement. This finding is new and suggests that

student achievement is associated with higher perceptions of teachers' general efficacy, which may be a result from participating in a two-year job-embedded professional development program. Thus, it appears that there is an indirect relationship between student achievement and a professional development program that is job-embedded and is administered consistently over time.

Based on the findings of this study, a professional development program needs to emphasize the development of general efficacy over personal efficacy because general efficacy is the predictor for student achievement. It could be argued that the development of personal efficacy could lead to an increase in general efficacy in mathematics teaching. Although this study did not address the question of whether personal efficacy and general efficacy were positively correlated, a Pearson correlation was conducted. Results of this correlation are presented in Table 5.1

Table 5.1. Pearson Correlation for General and Personal Efficacy, Posttraining Scores

Variable	Test	General efficacy (mean posttraining)	Personal efficacy (mean posttraining)
General efficacy (mean posttraining)	Pearson correlation	1	.494
	<i>Sig.</i> (2-tailed)		.000
	<i>N</i>	708	708
Personal efficacy (mean posttraining)	Pearson correlation	.494	1
	<i>Sig.</i> (2-tailed)	.000	
	<i>N</i>	708	708

The results, as shown in Table 5.1, support the conclusion that there was a significant correlation between the two efficacies, $R(34) = .494$, $p < .05$. In order for teachers to have a sense of general efficacy as a group, they must also have a sense of

personal efficacy as a group. In other words, personal efficacy leads to general efficacy, which demonstrated a relationship with student achievement unlike what was indicated in the literature.

Implications of Research Findings

Legislators have expressed differing opinions on several components supporting educational reform. Kentucky Senate Bill 1 was passed by legislators who agreed on one common objective: to substantively raise the level of student achievement in Kentucky. Senate Bill 1 mandates more concise, rigorous content standards and effective implementation tools for teachers, with professional development being the essential component of this education reform. Effective teacher training will be needed to implement Kentucky's new core academic standards, research-based teaching methods, and technology appropriate to support these programs. The findings of this study have implications that are consistent with the goals of highly effective professional development to improve student achievement.

Because this study indicated that increasing teachers' general efficacy directly influenced student achievement, principals should be encouraged to prepare and implement a well-designed professional development program that can make a positive impact on teacher practice. Several important components are required for such program. One component is sufficient time for the professional development to be communicated and absorbed. District administrators need to understand that effective learning opportunities sustained over time are required to develop teacher capacity to teach reform-based mathematics. This study's professional development program was

conducted over a period of two consecutive years, with teachers meeting for one full instructional day, four times a year.

A second required component of the professional development program is that it be job embedded. To be effective, the content and pedagogy strategies should represent an integral part of teachers' daily practice rather than additional tasks. Teachers need to grapple with real issues related to the new content and instructional processes they face in their own classrooms.

A third component is mentorship of teachers between professional development sessions. The main goal and focus of the mentor would be to help teachers use newly gained mathematics content knowledge and research-based pedagogy strategies in their classrooms. Mentoring strengthens teachers' confidence in using new knowledge gained from the professional development sessions in their classrooms and develops the teachers to their fullest potential.

The final component is the professional development program's focus on content and strategies. Exploration of content and concentration on pedagogical strategies for instruction requires time and support. Teachers must have the opportunity to manipulate materials and ideas and make connections between math concepts and student learning.

Darling-Hammond et al. (2009) found that high-quality professional development was linked to instructional improvement of the school district. Making the connection resulted in student achievement. Similarly, the findings of this study suggest that principals who engage their teachers in high-quality professional development resulting in increased general efficacy can lead to an increase in student achievement. Thus, the

findings from this study provide direction for moving schools closer to their goal of high levels of student achievement.

In addition to finding that teachers' general efficacy is related to student achievement, this study also found that SES continued to explain student achievement. However, through a professional development program designed to make a positive impact on teachers' expectations and teaching strategies for lower SES students, teachers can improve student achievement even though SES is a significant predictor of student achievement. Professional development facilitators need to equip teachers with information about various types of instruction based on what they know about the individual differences of lower SES students. Initiating a proactive relationship with families of lower SES students is yet another important component the professional development program should address. There is a connection between the teachers' expectations demonstrated through their choice of classroom processes and student achievement.

This study raises implications for university departments of educational leadership and administration. These departments need to design course work for preservice leaders in curriculum and supervision that will enable tomorrow's school leaders to design professional development programs that will bring about student achievement. These same leadership departments need to design, implement, and demonstrate comprehensive professional development programs that would enable today's in-service school leaders to become more knowledgeable about planning and conducting highly effective professional development in their schools and or districts to increase teacher efficacy and raise student achievement. The type of preservice and in-

service professional development program suggested by this study needs to be conducted on a wide scale. If these professional development programs are conducted effectively, they could leverage a genuine restructuring of the way professional development is designed and delivered, in the process; make a significant impact on student achievement.

Likewise, state policy makers must seek the funding necessary to support the development of high-quality professional development. This requirement is especially important to effectively implement new academic standards and research-based teaching methods, as mandated by law. For example, Senate Bill 1, a law passed by the General Assembly of Kentucky, includes as one of the major requirements the revision of the P-12 accountability system. The law requires a revision of standards, based on national and international benchmarks, to increase the rigor and focus on the mathematics content of the P-12 curriculum to better prepare students for success in college and the workforce and to significantly decrease remediation levels. The KDE, in collaboration with the KCPE, is guiding the planning and implementation of these revisions.

According to the Higher Education Workgroup (2009), a unified strategy designed by the KDE and the KCPE—in collaboration with the Education Professional Standards Board, the Collaborative Center for Literacy Development, the Kentucky Center for Mathematics, college of education faculty, elementary and secondary teachers, and workforce representatives—has been developed around four key areas to promote readiness and graduation. These four areas include (a) accelerated learning opportunities (advanced placement, dual credit, international baccalaureate, and Project Lead the Way /STEM); (b) secondary intervention programs (credit recovery, transitional courses, bridge programs); (c) postsecondary intervention programs and services (placement

testing, summer bridge programs, developmental education programs with accelerated and online learning opportunities, early-alert intervention programs, advising and mentoring programs, tutoring and student support services, and adult education services), and (d) college and career readiness advising (monitoring students progress using the individual learning plan, advising and transition programs, Kentucky Scholars Initiative, and Gear UP and KnowHow2GO programs and services). Effective, high-quality professional development is crucial for these designated areas to develop and strengthen in order to strongly promote readiness and graduation.

If teachers are to implement concise, rigorous content standards and effective pedagogical teaching strategies into their daily instruction, a well-designed professional development must be implemented to sustain a positive impact on teacher practice that influences student achievement. It takes funding to create and sustain these types of professional development programs. With school districts and state departments suffering major financial cutbacks, state legislators are going to have to find a way to pay for the cost of high-quality, job-embedded professional development programs that are sustained over time to increase student achievement.

Limitations and Delimitations of the Study

Several limitations must be acknowledged. One limitation is the generalizability of the findings. The study was limited to 35 third-grade teachers in 10 schools in one county in Kentucky. While the findings may generalize to other geographical districts, grades, and levels of schools, these findings are delimited to a particular population.

A second limitation involves self-reporting of efficacy of the instrument administered in the context of a specific professional development program.

Administering the survey only one time, at the end of the professional development program, may have caused the participants to reflect inaccurately on two previous years of efficacy and challenged their combined capacity for introspection and retrospection. It is recommended that the efficacy survey be given as a pre- and postsurvey for consideration of the effectiveness of a professional development program.

Finally, the measure of student achievement used in this study must be acknowledged as a limitation. The reliability and validity of the KCCT has been questioned by professionals in the area of assessment. However, the KDE has taken the position that the instrument is a valid and reliable measure of student achievement. The accountability system in Kentucky focuses primarily on schools. Kentucky's accountability system is based upon measuring continued improvement toward a long-term goal, and thus has built in monitoring to ensure real and enduring improvement. While the system does provide for school district accountability, the long-term accountability model adopted by the Kentucky Board of Education is a growth model with schools serving as their own baseline. All students and thus all schools are expected to demonstrate improvement within the system.

Recommendations for Future Research

This study provided insights into how elementary students' mathematics achievement could be improved through sustained, job-embedded professional development focused on enhancing teachers' knowledge of mathematics content and constructivist pedagogy. The study showed gains in teachers' general and personal efficacy. While the effects of this study are limited to the participants, it can be inferred that the professional development initiative is worthy of replication and continuation.

Hence, it is recommended that districts make professional learning for elementary mathematics teachers a high priority in the district's comprehensive plan.

Additional research on the effect monitoring has on the implementation of the professional development program within the classrooms between the quarterly sessions is recommended. During the two-year period, monitoring of teachers utilizing the information gained as well as the research based activities was weak. One reason would be the lack of knowledge the principals had on what was being shared or training information given to the teachers. This lack of knowledge was due to the principals and district administrators not attending the math professional development training sessions. During instructional rounds, the principals and district administrators had no idea what to look for that reflected instructional practices or content knowledge introduced during the professional development program.

Another recommendation would be to conduct further research on the link between personal efficacy and general efficacy. Future researchers should consider administration of the efficacy survey instrument prior to and outside the context of professional development to avoid the limitation of retrospection. The results of this study suggest professional development indirectly influences student achievement. Future research should consider intervening variables, such as teacher efficacy, in models to investigate the effect of professional development on student achievement.

Finally, even though SES continues to predict student achievement, SES can be moderated with professional development that addresses content and teaching strategies over time. For future research, it is recommended that districts make it a high priority that coherent and comprehensive professional learning for elementary teachers target

educational needs of low-SES students. The unique learning processes of students in special education programs, a population not included in this study should also be researched to identify optimal strategies to improve this group's academic achievements.

Conclusion

The trend of increasing percentages of high school graduates entering college with developmental mathematics needs is a major concern for mathematics educators in Kentucky and the nation. Elementary, middle, and secondary math education must be improved. Effective quick-fix solutions promoted by politicians simply do not exist. A plan to address the problems in mathematics must be developed and instructors at all levels must stop pointing fingers at each other and start supporting each other in the pursuit of answers. Efforts must be directed to providing opportunities for all stakeholders to work towards effective ways to remedy this problem.

In this study, a high-quality, job-embedded professional development program sustained over a two-year period was found to increase teachers' general and personal efficacy in teaching mathematics. In addition, it was determined that teachers' general efficacy had a direct impact on student achievement in mathematics. While the study did not find teachers' personal efficacy had a direct impact on student achievement, an indirect impact was determined as personal efficacy was correlated with general efficacy. Thus, the conclusion reached is that job-embedded, sustained professional development indirectly leads to improved student achievement in mathematics. This finding was true even when student SES was taken into account.

APPENDIX A:

MATHEMATICS TEACHING EFFICACY BELIEF INSTRUMENT(MTEBI)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate numbers below each statement. The first row represents prior to the math training and the second row represents after the math training.

1—Strongly disagree

2—Disagree

3—Barelydisagree

4—Barelyagree

5—Agree

6—Strongly agree

1. When a student does better than usual in math, it is often because the teacher exerted a little extra effort.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

2. I am continually finding better ways to teach math.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

3. Even when I try very hard, I don't teach math as well as I do most subjects.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

4. When the math grades of students improve, it is most often due to their teacher having found a more effective teaching approach.

Prior to math training	1	2	3	4	5	6
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Posttraining	1	2	3	4	5	6
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5. I know the steps necessary to teach math concepts effectively.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
--------------	---	---	---	---	---	---

6. I am not very effective in monitoring math achievement through hands-on activities.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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7. If students are underachieving in math, it is most likely due to ineffective math teaching.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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8. I generally teach math ineffectively.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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9. The inadequacy of a student's math background can be overcome by good teaching.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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10. The low math achievement of some students cannot generally be blamed on their teachers.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

11. When a low achieving child progresses in math, it is usually due to extra attention given by the teacher.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

12. I understand math concepts well enough to be effective in teaching elementary math.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

13. Increased effort in math teaching produces little change in some students' math achievement.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

14. The teacher is generally responsible for the achievement of students in math.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

15. Students' achievement in math is directly related to their teacher's effectiveness in math teaching.

Prior to math training	1	2	3	4	5	6
Posttraining	1	2	3	4	5	6

16. If parents comment that their child is showing more interest in math at school, it is probably due to the performance of the child's teacher.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
--------------	---	---	---	---	---	---

17. I find it difficult to explain to students why and how mathematics works.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
--------------	---	---	---	---	---	---

18. I am typically able to answer students' math questions.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
--------------	---	---	---	---	---	---

19. I wonder if I have the necessary skills to teach math.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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20. Effectiveness in math teaching has little influence on the achievement of students with low motivation.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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21. Given a choice, I would not invite the principal to evaluate my math teaching.

Prior to math training	1	2	3	4	5	6
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Posttraining	1	2	3	4	5	6
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22. When a student has difficulty understanding a math concept, I am usually at a loss as to how to help the student understand it better.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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23. When teaching math, I usually welcome student questions.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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24. I don't know what to do to turn students on to math.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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25. Even teachers with good math teaching abilities cannot help some kids learn math.

Prior to math training	1	2	3	4	5	6
------------------------	---	---	---	---	---	---

Posttraining	1	2	3	4	5	6
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I hereby give my consent for Krista Althausser to use my MTEBI survey results for mathematics research.

Teacher's Name

Date

APPENDIX B:
IRB EXEMPTION



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NOTICE OF IRB EXEMPTION STATUS

Protocol Number: 09-111

Institutional Review Board IRB00002836, DHHS FWA00003332

Principal Investigator: **Krista Althausser** Faculty Advisor: **James Rinehart**

Project Title: **Elements of Effective Mathematics Instruction and/or Professional Development and Its Impact on Teacher Efficacy**

Exemption Date: **06/10/2009**

Approved by: **Dr. Debbie Haydon, IRB Committee Member**

This document confirms that the Institutional Review Board (IRB) has granted exempt status for the above referenced research project as outlined in the application submitted for IRB review with an immediate effective date. Exempt status means that your research is exempt from further review for a period of three years from the original notification date if no changes are made to the original protocol. If you plan to continue the project beyond three years, you are required to reapply for exemption.

Principal Investigator Responsibilities: It is the responsibility of the principal investigator to ensure that all investigators and staff associated with this study meet the training requirements for conducting research involving human subjects and follow the approved protocol.

Adverse Events: Any adverse or unexpected events that occur in conjunction with this study must be reported to the IRB within ten calendar days of the occurrence.

Changes to Approved Research Protocol: If changes to the approved research protocol become necessary, a description of those changes must be submitted for IRB review and approval prior to implementation. If the changes result in a change in your project's exempt status, you will be required to submit an application for expedited or full IRB review. Changes include, but are not limited to, those involving study personnel, subjects, and procedures.

Other Provisions of Approval, if applicable: None

Please contact Sponsored Programs at 859-622-3636 or send email to gus.benson@eku.edu or tiffany.hamblin@eku.edu with questions.



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APPENDIX C:
REVISED IRB EXEMPTION



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NOTICE OF IRB EXEMPTION STATUS

Revision to Protocol Number 09-111

Institutional Review Board IRB00002836, DHHS FWA00003332

Principal Investigator: **Krista Althaus**

Project Title: **Elements of Effective Mathematics Instruction and/or Professional Development and Its Impact on Teacher Efficacy**

Exemption Date: **August 2, 2010**

Approved by: **Dr. Debbie Haydon, IRB Member**

This document confirms that the Institutional Review Board (IRB) has granted exempt status for the above referenced research project as outlined in the application submitted for IRB review with an immediate effective date. Exempt status means that your research is exempt from further review for a period of three years from the original notification date if no changes are made to the original protocol. If you plan to continue the project beyond three years, you are required to reapply for exemption.

Principal Investigator Responsibilities: It is the responsibility of the principal investigator to ensure that all investigators and staff associated with this study meet the training requirements for conducting research involving human subjects and follow the approved protocol.

Adverse Events: Any adverse or unexpected events that occur in conjunction with this study must be reported to the IRB within ten calendar days of the occurrence.

Changes to Approved Research Protocol: If changes to the approved research protocol become necessary, a description of those changes must be submitted for IRB review and approval prior to implementation. If the changes result in a change in your project's exempt status, you will be required to submit an application for expedited or full IRB review. Changes include, but are not limited to, those involving study personnel, subjects, and procedures.

Other Provisions of Approval, if applicable: None

Please contact Sponsored Programs at 859-622-3636 or send email to gus.benson@eku.edu or tiffany.hamblin@eku.edu with questions.



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Madison County, KY

RECENT SCHOLARLY PUBLICATIONS

Althausser, K., & Wilder, M. (2009). Elements of effective mathematics professional development. *Kentucky Middle School Journal*, 10(1), 28.

Madden, A., & **Althausser, K.** (2010). Cookin' up culture: Connecting Appalachian food and family with technology and mathematics. *Kentucky Middle School Journal*. Retrieved from www.middleschoolhouse.eku.edu/CMSAA/aboutcmsaa.php/

RECENT SCHOLARLY PRESENTATIONS

Baines, M., Farris, E., Sugg, S., Wood, A., **Althausser, K.**, Davis, S., . . . Stanfield, W. (2010, August). *Student dropouts: A qualitative study connecting rural communities and rural schools*. Copresenter at the National Council of Professors of Educational Administration, Washington, DC.

Goertz, J., **Althausser, K.**, & Barrett, T. (2010, May). *Expanding instruction through technology*. Copresenter at the Kentucky Conference on the Scholarship of Teaching and Learning, Lexington, KY.

Althausser, K., Bowling, T., Gregory, A., Janowiecki, K., Phillips, N., Schultz, M., & Vance, K. (2010, April). *It's time for a conceptual change*. Copresenter at the National Math Recovery Conference, Albuquerque, NM.

Althausser, K., Reister, B., & Anderson, L. (2010, April). *Professional development partnership to promote constructive learning*. Copresenter at the National Math Recovery Conference, Albuquerque, NM.

Althausser, K. (2010, January). *Math & economics: Connections for life workshop*. Presenter for the Madison County Schools Professional Development in Mathematics. Richmond, KY.

Althausser, K. (2009, December). *Math & reading intervention strategies for struggling students*. Presenter for the Southeast/South-central Educational Cooperative, Richmond, KY.

Althausser, K. (2009, September). *Math & economics: Connections for life workshop*. Presenter for the Madison County Schools Professional Development in Mathematics. Richmond, KY.

Althausser, K. (2009, July). *Recess games that teach math*. Presenter at the Madison County Teaching, Learning, and Technology Conference. Richmond, KY.

- Barrett, T., & **Althausser, K.** (2009, July). *Turning minds on to math through technology and manipulatives*. Co presenter at the International Society for Technology in Education/National Educational Computing Conference, Washington, DC.
- Althausser, K.**, & Gabbard, A. (2009, April). Kentucky's growing mathematics intervention initiative. Copresenter at the National Math Recovery Conference, Minneapolis, MN.
- Althausser, K.** (2009, March). *In a first-grade classroom*. Presenter at the KCM Numeracy Conference. Louisville, KY.
- Althausser, K.** (2009, March). *Math & economics: Connections for life workshop*. Presenter for the Center for Economic Education, Eastern Kentucky University, Richmond, KY.
- Althausser, K.**, & Barrett, T. (2008, September). *Effective integration of math and technology for student achievement*. Copresenter at the Technology in Mathematics Education K-12 Mathematics Teachers Workshop, Eastern Kentucky University, Richmond, KY.
- Althausser, K.** (2008, July). *What does formative assessment look like in math instruction?* Presenter at the Wilderness Trail Educational Cooperative, Somerset, KY.
- Althausser, K.** (2008, July). Turning Minds on Requires Hands-On Activities for Instruction of Mathematics." Presenter at Wilderness Trail Educational Cooperative, Somerset, KY.
- Althausser, K.**, & Barrett, T. (2008, June). *Effective integration of math and technology for student achievement*. Copresenter at the Center for Innovation and Instruction for Diverse Learners, University of Louisville, Louisville, KY.

PROFESSIONAL AFFILIATIONS

American Educational Research Association
 Association for Supervision and Curriculum Development
 Kentucky Association for Supervision and Curriculum Development
 Kentucky Association for Supervision and Curriculum Development, state president,
 2007-2010
 National Council of Teachers of Mathematics
 Kentucky Council of Teachers of Mathematics
 National Math Recovery Council
 Alpha Delta Kappa, Honorary Sorority for Women Educators
 Alpha Delta Kappa, Honorary Sorority for Women Educators, treasurer, Alpha Eta
 Chapter, 2008–2010

HONORS AND AWARDS

MESA Award—Kentucky Council of Teachers of Mathematics—2008

Krista L. Althaus