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**SELF-EFFICACY AND INSTRUCTION IN MATHEMATICS**

**DISSERTATION**

**Presented in Partial Fulfillment of the Requirements for the Degree of**

**Doctor of Philosophy**

**Lynn University**

**By**

**Juana Patricia Ordóñez-Feliciano**

**2009**



Order Number: \_\_\_\_\_

**SELF-EFFICACY AND INSTRUCTION IN MATHEMATICS**

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Lynn University, 2009

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## **ABSTRACT**

According to the National Mathematics Advisory Panel (2008) differences in students' mathematical achievement were attributed to differences in teacher characteristics, including the use of instructional methods and their self-efficacy beliefs. Concurrently, today's mathematics teachers face challenges arising from Federal and State mandates requiring students' proficiency to improve on standardized tests. This study considered the relationship between two characteristics, mathematics teachers' self-efficacy and their choice of instructional strategies. Further, the relationship between teachers' self-efficacy and their demographic characteristics as measured by a researcher-developed questionnaire was explored.

The researcher utilized the Teacher Self-Efficacy Scale (TSES) and the Teachers' Instructional Practices Survey (TIPS), which were integrated onto the SurveyMonkey website. Members of the Florida Council of Teachers of Mathematics (FCTM) were invited to participate in this study through the FCTM Newsletter, as well as through an e-mail which included a hyperlink to the surveys. Additional access was made available to teachers via a link posted in the FCTM website. The link was kept active and data collected from April 24 through May 28, 2009.

A total of 101 middle school mathematics teachers completed all the questions in the surveys. Results indicated that instructional strategies chosen by teachers with higher self-efficacy differed by frequency of use from those employed by teachers with lower self-efficacy. Teachers with higher TSES scores demonstrated a significantly higher use of problem-based learning, direct instruction, and communication and study skills. Although not significant, it was notable that teachers with higher self-efficacy scores

(TSES scores) used manipulatives and multiple representations, and collaborative learning, more often than teachers with lower TSES scores during self-reported five period days. Nevertheless, teachers with lower self-efficacy tended to use technology aided instruction more often than teachers with higher self-efficacy.

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## CHAPTER I

### INTRODUCTION TO THE STUDY

#### Introduction and Background to the Problem

The *No Child Left Behind Act (NCLB)* of 2002 required States to develop challenging standards in mathematics, create annual assessments, desegregate the data and use research-based strategies in schools. *The Nation's Report Card* (2007) on mathematics showed that only 32% of eighth graders were at or above proficiency. In addition, the performance of U.S. high school students fell behind the performance of students in other industrialized countries in mathematics and science (Schiller & Muller, 2003).

Research indicated that mathematics was the subject most critical to students' choice of college majors and of their success in attaining a college degree (Dorner & Hutton, 2002; Hagedorn, Siadet, Fogel, Nora & Pascarella, 1999; Moreno & Muller, 1999; "The Expectation Gap", 2005). According to the *Foundation for Success Report* (2008), students who completed Algebra II were more than twice as likely to graduate from college as those who took less rigorous mathematics courses. Children not only compete with others in the United States, but also with students around the world who are more confident in their mathematical abilities (Funer, Yahya, & Duffy, 2005).

Student performance in mathematics received attention after the end of the Cold War and the release of *A Nation at Risk* report in 1983. High schools in the U.S. were blamed for not preparing students for college as well as the demands of the workforce. In 2001, President Bush signed the *NCLB Act* to reauthorize the *Elementary and Secondary Educational Act of 1965* (ESEA). The purpose of the *NCLB Act* was to allow the federal

government to monitor the States' efforts towards providing quality education for each child and closing the achievement gap between minority and disadvantaged students and their peers (NCLB Executive Summary, 2001). According to the *2007 National Assessment of Educational Progress* (NAEP), student groups made gains in mathematics; however, only the fourth grade White-Black score gap narrowed from 1990 to 2007.

In addition to the achievement gap, *Achieve, Inc.*, a non-profit organization created by U.S. governors and business leaders expressed its concerns with the existing gap between high school graduation requirements, the expectations of colleges, and the skills needed for the workforce. It was estimated that four out of ten high school graduates were not prepared for either college or the workforce ("Case for Action", 2008). *Achieve, Inc* conducted the study in 2005 known as *The Expectation Gap – A 50 State Review of High School Graduation Requirements*. The study revealed that in order for students to be prepared for post-secondary school and the workforce, they should take four years of rigorous English and Mathematics courses. The study also showed that only five states required students to complete four math courses (Achieve, Inc., 2005). These findings together with the *NCLB Act* suggested that schools needed to increase student enrollment in mathematics courses as well to be successful.

Early experiences in elementary and middle school mathematics influenced what courses high school students selected as well as the enrollment rate in the higher-level courses (Singh, Granville, & Dika, 2002). Moreover, the courses taken during high school affected student career aspirations in mathematics, science, and engineering. Even though there were various factors contributing to students' success in mathematics, Singh, Granville, & Dika (2002) identified more specific factors such as attitude,

aspirations, motivation, and engagement. These overlap those identified in the research on self-efficacy. Self-efficacy beliefs or the “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, p.3, 1997), influence motivation, interest, and thought processes all of which influence performance.

Ross, Hogaboam-Grey, and Hannay (2001) found that teacher efficacy positively related to student achievement in the area of computer abilities. Tucker, Porter, Reinke, Herman, Ivery, Mack, & Jackson (2005) found a positive correlation between increased teacher self-efficacy and academic engagement and academic achievement in culturally diverse learners. Studies relating instructional strategies and self-efficacy to interest and student achievement demonstrated a positive relationship between increased student self-efficacy and student performance (Anjun, 2006; Maier, & Curtin, 2005; Wadsorth, Husman, Duggan, & Pennington, 2007). Most importantly, research indicated that self-efficacy related to teacher’s motivation, effort, enthusiasm, and use of stronger instructional methods such as inquiry and group work (Pajares & Urdan, 2006).

According to NCTM, instructional strategies affected student performance (Principles and Standards, 2000). “Students’ understanding of mathematics, their ability to use it to solve problems, and their confidence in, and disposition toward mathematics are all shaped by the teaching they encounter in school” (p. 16). Alsup (2005) related instructional strategies that emphasized a Constructivist approach - student centered, hands-on activities, and highly interactive instruction - to decreased math anxiety and increased self-efficacy. Additionally, results from the 1999 *Trends in International Mathematics and Science Study* (TIMSS) assessment indicated that certain instructional

strategies not only effected student performance on the assessment, but also influenced student motivation in learning mathematics (House, 2005). Consequently, this study attempts to examine the relationship between teachers' self-efficacy and use of instructional strategies among middle school mathematics teachers.

### **Statement of the Problem**

Globalization is providing new challenges to the current generation of students. Corporations are willing to relocate to places where they can pay workers lower wages to reduce the cost of labor causing educated employees to compete with well-educated labor abroad (Bandura, 1997). The U.S. needs to keep abreast of these new challenges and make every effort to produce a more competitive workforce and "ensure the healthy development of a domestic workforce with adequate scale and top-level skills" (Foundations for Success, 2008, p.3). U.S. educators can take a lead in making a significant contribution toward that end.

Mathematical knowledge is crucial for preparing future high school graduates for college or the workforce; it also provides enhanced opportunities and options for their future ("Case for Action", 2008; Principles and Standards, 2000). "Research reveals that the ticket for student success in work or future learning is taking courses in math beyond Algebra II and advanced courses in English and Science" ("Case for Action", 2008; para. 2). According to the *National Center for Educational Statistics* (2007), the number of mathematics credits high school students completed increased from 2.7 credits in 1982 to 3.6 credits in 2004. The report also showed that the percentage of students enrolled in Calculus and Pre-calculus tripled from 1983 to 2004. Yet, only 23% of twelfth grade students performed at or above proficiency in the new mathematics assessment (The

Nation's Report Card, 2005), and 39% of fourth graders and 32% of eighth graders were at or above proficiency levels in mathematics (The Nation's Report Card, 2007). This last statement leads to a discussion of the first problem area:

### ***Student Performance in Mathematics***

The first issue addresses the performance of U.S. students in mathematics assessments. In the last few years, researchers closely monitored the progress of U. S. students in mathematics at the state, national, and international level. At the national level, the *NCLB Act* (2002) required that "every state and the District of Columbia hold schools accountable for improving academic achievement (Building on Results, 2007). The *Act* also required every state to participate in the *National Assessment of Educational Progress* (NAEP). The NAEP required students to demonstrate an understanding of mathematical concepts and apply these concepts to everyday situations.

According to The Nation's Report Card (2007) on mathematics, fourth and eighth grade students' average scores increased 27 points and 19 points respectively in the last seventeen years. However, the performance of eighth grade students was behind that of fourth graders. The report showed that 39% of fourth graders were at or above proficiency levels; whereas only 32% of eighth graders were at or above proficiency levels. Students made gains at all levels of performance. Nonetheless, the achievement gap had not changed since 1990 with the only exception being the White-Black achievement gap.

*Trends in International Mathematics and Science Study* and *Program for International Student Assessment* (PISA) monitored student performance at the international level. Each of them assessed students' mathematical knowledge in different

ways. TIMSS measured student achievement in mathematics, which meant it assessed mathematics concepts students learned in school. PISA assessed students' ability to apply mathematics knowledge and skills to solve real life situations.

According to TIMSS, the fourth grade students' average score of 518 remained unchanged between 1995 and 2003. The 2003 results indicated that U.S. fourth grade students' average score was above the average international score of 495. They outranked their peers in 13 countries but scored lower than students in 11 other countries. In comparison to students in other Organization for Economic Cooperation and Development (OECD) countries, U. S. fourth graders outperformed students in 5 countries, and they were outperformed by their peers in other 5 countries ("Highlights from the TIMSS", 2004).

TIMSS results showed significant gains in eighth grade average scores, which increased from 492 points in 1995 to 504 points in 2003. The 2003 score exceeded the international average score of 466. Eighth graders outperformed their peers in 25 countries and scored lower than students in 9 countries. In comparison to other *OECD* countries, U.S. eighth graders outperformed students in 2 countries, but they were outperformed by their peers in 5 countries ("Highlights from the TIMSS", 2004).

Results from the 2006 PISA were more concerning. U.S. 15 year-old students' average scores were 24 points below the *OECD* average score of 498 points, which was statistically significant (PISA 2006: Science competencies, 2007). U.S. students outperformed 4 *OECD* countries but were outperformed by 23 other *OECD* countries. Additionally, there were no measurable changes from 2003 to 2006 in mathematics literacy or in the U.S. average score compared to the other *OECD* countries. However,

Gerald Bracey (2006) argued that these comparisons do not provide the complete picture of the performance of U.S. students. He presented examples contrasting the proportion of students scoring in the “advanced” range in each of the participating countries and expressed the need to consider that the number of students in many of these countries was much smaller than in the U.S.

Proficiency levels in mathematics are slowly increasing at the national level. Nevertheless, at the international level, U.S. students are not keeping up with their counterparts in other OECD countries. PISA assessed mathematics literacy, which is defined as “the capacity of students to analyze, reason and communicate effectively as they pose, solve and interpret mathematical problems in a variety of situations involving quantitative, spatial, probabilistic or other mathematical concepts”(PISA 2006: Science competencies, 2007, p.51). Mathematics classrooms need to emphasize these higher order level-thinking skills. Trends in the NAEP and TIMSS are somewhat promising, but not all students are reaching proficiency levels in mathematics. This last statement leads to the discussion of the second problem area:

### ***No Child Left Behind Act Sanctions***

The second issue addresses the sanctions imposed by the *NCLB Act*. The law aimed “to improve the performance of America’s elementary and secondary schools while at the same time ensuring that no child is trapped in a failing school” (“NCLB Executive Summary”, 2001, para. 2). The purpose of the *NCLB Act* (2002) was to ensure quality education for all students and to reduce the achievement gap between disadvantaged and minority students and their peers.



Schools are expected to have high standards for all students and to provide parents with information about their child's academic performance through easy-to-read report cards. States are responsible for preparing and distributing State report cards but may also "prepare and produce district report cards", ("Report Cards Guidance", 2003, p.1). Report cards must provide information about student achievement levels, student performance on the *Adequately Yearly Progress (AYP)* indicators and teacher quality, Local Educational Agencies (LEAs) and individual schools (Report Cards, 2003). States set the AYP requirements based on proficiency standards and other academic indicators. These indicators include a 95% participation rate and an increase in graduation rate at the high school level (No Child Left Behind: A road map, 2005).

Additionally, schools receive report cards based on the performance of their students. Data from the schools' report cards is disaggregated by student subgroups to include the major racial and ethnic groups, the economically disadvantaged (ED), students with disabilities (SWD) and English Language Learners (ELL). Schools are identified as "in need of improvement", if they do not meet *AYP* in each of the subgroups for two years. Children who attend these schools have the choice of attending another public or charter school, which is meeting the standards.

Schools that fail to show progress towards meeting the standards were subject to severe sanctions (Schiller & Muller, 2003). Some of these sanctions for schools not meeting the proficiency goals included replacing the staff and the principal, instituting and implementing a new curriculum, decreasing management authority of the school, and restructuring the internal organization of the school (NCLB, Accountability and Adequately Yearly Progress, 2003). Students who fail the state assessments in the 3<sup>rd</sup>

grade are retained and 10<sup>th</sup> graders who do not pass the test do not receive a high school diploma until they pass the test (Ediger, 2005).

The AYP percent proficiency goals for mathematics and reading increase every year until they reach 100% proficiency for all students by the school year 2014. However, test results indicated that not all students are achieving the current goals to reach the required proficiency levels. Critics of this goal argued that it is unrealistic, inflexible and needs to consider sanctions that “build either the desire or the capacity to succeed” rather than punish schools (Rose, 2003, p. 338; Sanders, 2008). In addition, the *National Education Association* (NEA) called for a fix in these AYP requirements arguing that student performance in standardized tests should not be the only indicator of a rich and challenging educational experience (Packer, 2007).

According to the Nation’s Report Card (2007) on Mathematics, the percent of fourth graders at or above proficiency was White – 51%, Black – 15%, Hispanic – 22%, Economically Disadvantaged – 22%, Students with Disabilities – 19%, and English Language Learners – 13%. The report also indicated that the percent of eighth graders at or above proficiency was White – 41%, Black – 11%, Hispanic – 15%, Economically Disadvantaged – 15%, Students with Disabilities – 8%, and English Language Learners – 6%.

Issues concerning specific subgroups especially students with disabilities and English Language Learners have become evident as more schools struggle to make AYP and meet the *NCLB Act* (2002) guidelines. The *NCLB Act* (2002) stated that schools receiving federal funding were required to meet AYP, which meant 100% proficiency in reading and mathematics for all students by the year 2014. Schools must improve their

proficiency levels to avoid sanctions. The *NCLB Act* sanctions place schools under close monitoring and scrutiny of their programs, which must include the use of appropriate instructional practices that are research based. This last statement leads to the discussion of the third problem area:

### ***Identifying Mathematics Specific Instructional Strategies***

The third issue discusses identifying instructional strategies that aim to increase students' proficiency levels in mathematics. The importance of using effective instructional strategies was highlighted in the *NCLB Act*, "the federal government will invest in educational practices that work—that research evidence has shown to be effective in improving student performance" (The facts about investing in what works, 2004, para 3). The *NCLB Act* (2002) required schools receiving federal funding to use the most current research-based instructional methods and programs. The *Act* categorizes a program or method as research-based when there is empirical evidence that the method or program works.

In the areas of mathematics and science, the process of identifying research-based programs or methods is relatively new. The *Math Now* program for elementary and middle school students started in 2006. It included the creation of the *National Mathematics Panel*, which is a group of experts that evaluate the effectiveness of instructional methods to teach mathematics. The *Math Now* program promotes these identified practices and provides grants to promote effective research based practices in grades K-7.

However, the majority of the research studies that compared the use and effect of instructional strategies generalized their results across all subject areas (Au, 2007; Baker,

Gersten, & Lee, 2002; Vogler, 2002). Marzano, Pickering & Pollock (2001) claimed that further analyses of the effect of empirically validated strategies on specific subject areas are needed. Specifically, research on instructional strategies in the area of mathematics is relatively new and limited (Foundations for Success Final Report, 2008).

In the *Foundations for Success Final Report* (2008), The National Mathematics Advisory Panel underscored the limited amount of research in various areas of mathematics and stressed the need to conduct studies that compare the effects of teacher-directed and student-centered instruction in mathematics achievement. The Panel defined *teacher-directed instruction* as “instruction in which it is the teacher who is primarily communicating the mathematics to the students directly” (p.45); *student-centered instruction* included strategies “in which students are primarily doing the teaching” (p.45). Additionally, The Panel stated the need to conduct high quality research in instructional practices that improve the performance of low achieving students and students with learning disabilities. The Panel also stated the need for high quality research in the impact of using technology and applications of technology in mathematics, and in the use of real-world problems to teach mathematics (Foundations for Success, 2008).

The analysis of the effect of instructional strategies in specific subject areas needs to include information about the impact on specific groups of students (Marzano, Pickering & Pollock, 2001). The *NCLB Act* (2002) requires States to use assessments for reading, mathematics and science in local school districts and to disaggregate the data by student subgroups. Identifying the mathematics strategies that work and their impact on the subgroups could provide mathematics educators with a repertoire of strategies that are

proven to be effective. Equally, the role of the teacher in implementing these strategies and transmitting the information is notable. The National Council of Teachers of Mathematics articulated that “teachers’ actions are what encourage students to think, question, solve problems and discuss their ideas, strategies, and solutions’ (Principles and Standards, 2000, p.18). Therefore, the teacher is responsible for the classroom arrangement as well as for creating an environment that fosters active student participation.

The research related to self-efficacy further highlighted the importance and need to identify effective instructional strategies for teaching mathematics. Hall & Poton (2005) explained that, students’ past experiences in mathematics contribute to students’ opinion about their mathematical abilities and career choices in mathematics. They stressed the need to investigate the effect of specific instructional strategies on mathematics self-efficacy and student performance.

Having a repertoire of instructional strategies proven effective would assist teachers in selecting the strategies better suited to meet the needs of their students. According to Gardner (2006), “it is a mistake to present the same content in the same way (p. 60). Students are more likely to understand the material when it is presented “in a variety of guises and contexts” (p.60). The best way to help students understand the material is to draw on all of the intelligences that relate to the topic presented in the classroom (Gardner, 2006).

### **Self-Efficacy Theory**

Self-efficacy was grounded in the theoretical framework of Bandura’s *social cognitive theory* (Bandura, 1997). Bandura introduced the construct of self-efficacy in

his 1977 publication of "Self-efficacy: Toward a Unifying Theory of Behavioral Change" where he identified it as a missing and key element of *social cognitive theory* (Pajares, 2002). In 1997, Bandura published "Self-Efficacy: The Exercise of Control", a book that delineated his *theory of self-efficacy* and he explained its applications to diverse fields such as life-course development, education, health, psychopathology, athletics, business, and international affairs (Pajares, 2002).

*Self-efficacy theory* "posits that a belief in one's personal capabilities is central to how a person responds to tasks" (Maier & Curtin, 2005, p.353). According to Bandura (1997), self-efficacy influenced human functioning through motivation, thoughts, feelings and actions. He clarified that self-efficacy was sometimes mistaken with self-esteem even though these two concepts were different. Self-efficacy "is concerned with judgments of personal capabilities, whereas self-esteem is concerned with judgments of self-worth" (p.11). Specifically, a person may judge her inability to excel in a specific task negatively without thinking less of herself.

Pajares, Johnson, & Usher (2007) explained that self-efficacy beliefs were keys for human motivation, well-being, and sense of accomplishment because people had little incentive to get involved in difficult situations unless they believed that what they did would result in a desirable outcome. Self-efficacy also played a key role in anxiety arousal. People with stronger self-efficacy beliefs handled difficult situations "without being burdened with stress reactions" (Bandura, 1993, p. 133).

Singh, Granville, & Dika (2002) found that student performance in mathematics related to factors such as attitude, aspirations, motivation, and engagement. These factors overlap those factors influenced by self-efficacy beliefs. Research on self-efficacy has

focused on student self-efficacy as well as teacher self-efficacy and their relationship to academic performance.

### **Impacting Student Performance**

Teachers play a key role in the delivery of instruction; research showed that even when the school is relatively ineffective, an individual teacher could have a powerful effect on her students' learning (Marzano, Pickering, & Pollock, 2001). Unfortunately, some teachers do not realize their impact on the instructional processes and do not feel they can make a difference and move students to proficiency levels. Teachers can impact student performance by using instructional strategies that are proven to be effective in teaching mathematics.

However, only a limited number of studies have explored the factors that influence teachers' selection and use of instructional strategies in mathematics. These factors included teacher's knowledge and familiarity of mathematics context, teacher preparation and their beliefs about the meaning of mathematics (Maccini & Gagnon, 2002), and the number of years of mathematics teaching experience (Maccini & Gagnon, 2007). Lee & Olszewski-Kubilius (2006) identified time and the teachers' perception of students' capabilities as the two major factors affecting teachers' choice of instructional strategies in gifted mathematics classrooms.

High-stakes standardized tests resulting from the accountability movement were found to influence teachers' instructional decisions. After examining 49 qualitative studies, Au (2007) reported that 80% of the studies showed a narrowing of curriculum and an increase in teacher-centered instruction resulting from the implementation of high-stakes tests. This was contrary to Vogler's (2002) findings that showed teachers had

increased the use of open-response questions, creative/critical questions, problem-solving activities, the use of rubrics, writing assignments and inquiry lessons in response to high-stakes tests. The study indicated that the use of state mandated assessments contributed to changes in instructional practices (Vogler, 2002). Nonetheless, these studies did not report results by subject area and it was not possible to make conjectures about the factors influencing mathematics teachers' selection and use of instructional strategies.

Recent subject-specific research on teachers' self-efficacy showed a relationship between teachers' self-efficacy and teachers' instructional strategies and goals (Pajares, 2006). Teacher self-efficacy is concerned with teachers' judgments of their capacity to influence student engagement and learning, even with unmotivated and difficult students (Pajares & Urdan, 2006). These judgments result from the interaction between:

- a) Teachers' analysis of the task – the teacher appraises the factors that make accomplishing a specific task easy or difficult
- b) Teachers' assessment of their teaching abilities – the teacher self-assesses her instructional capabilities and limitations specific to the task

Once the teacher analyzes the teaching task and assesses her capabilities, she generates an efficacy judgment of herself that influences the goals she sets, the effort expended on achieving those goals and her persistence when difficulties arise. Consequently, teachers' perceived self-efficacy beliefs affected their own motivation and attitudes about themselves. Teachers with a high sense of efficacy believed in themselves and their students (Erdem & Demirel, 2007). Some of the teachers who believed they could not move their students to proficiency blamed the lack of student success on factors outside their control such as students' home environment, students' lack of motivation,



lack of parental support and students' limited skills (Bandura, 1997). On the contrary, teachers who had a higher sense of efficacy believed they could teach difficult students, and they attributed their success and their students' success to controllable factors such as increased effort, improved teaching or learning strategies, better explanations or instructional activities, and additional help and support (Bandura 1997; Pajares, 2006; Ross, Hagaboam-Gray, Hannay, 2001).

### **Definition of Terms**

The following definitions of terms were key concepts related to self-efficacy and student performance:

**Assessment** is “the process for collecting and using data” (Bedwell, 2004, p.11). Assessment is a process that involves collecting and evaluating data to improve teaching.

**Academic engagement** is the “active involvement, commitment, and attention as opposed to apathy and lack of interest” (Singh, Granville, & Dika, 2002). Some of the indicators of academic engagement in mathematics are students participating in class discussions, doing homework, being prepared, and attending class regularly.

**Contextualized instruction** is the approach that stresses the use of real-world applications and focuses on understanding underlying concepts of authentic problems (Baker, Gersten, & Lee, 2002).

**Direct instruction** is the teaching of concepts, rules, principles and problem solving strategies in an explicit manner (Baker, Gersten, & Lee, 2002).

**Efficacy** is defined as “a generative capability in which cognitive, social, emotional, and behavioral subskills must be organized and effectively orchestrated to serve innumerable purposes” (Bandura, 1997, p.36).

**Formative Assessment** is “the ongoing monitoring of student learning to inform instruction” (National Mathematics Advisory Panel, 2008).

**Explicit instruction** takes place when the teacher models solving a problem using various examples and provides students extensive practice on the new strategies and skills. Students also have the opportunity to discuss their thought process, and they receive extensive feedback (National Mathematics Advisory Panel, 2008).

**Instructional strategies** “determine the approach a teacher may take to achieve learning objectives. Strategies can be classed as direct, indirect, interactive, experiential, or independent” (Saskatchewan Education, 1991, para. 10).

**Instructional Methods** “are used by teachers to create learning environments and to specify the nature of the activity in which the teacher and learner will be involved during the lesson” (Saskatchewan Education, 1991, para. 10). Instructional methods are selected according to the instructional strategy used in the classroom. Some examples of instructional methods are cooperative learning, lecture, class discussion, hands-on activities, and inquiry.

**Intelligences or Multiple Intelligences** is a way to describe human cognitive competence in terms of a set of abilities, talents or mental skills (Gardner, 2006).

**Mathematics anxiety** is “commonly defined as feeling of tension, apprehension, or fear that interferes with math performance” (Ashcraft, 2002, p. 181). Students who experience this condition cannot be successful in the classroom because they are afraid of mathematics and avoid dealing with anything involving numbers.

**Motivation** refers to “a student's willingness, need, desire and compulsion to participate in, and be successful in, the learning process; it seeks to increase the factors

move a student toward becoming more involved in the class and subject matter” (Bomia, Beluzo, Demeester, Elander, Johnson & Sheldon, 1997, p. 3).

*Perceived self-efficacy* is “a belief about what one can do under different sets of conditions with whatever skills one possesses” (Bandura, 1997, p. 37).

*Teacher self-efficacy* is “a judgment about capabilities to influence student engagement and learning, even among those students who may be difficult and unmotivated” (Pajares & Urdan, 2006, p. 117).

### **Purpose of the Study**

The general purpose of this non-experimental, quantitative, exploratory (comparative) study was to examine the relationship between teachers’ self-efficacy, use of instructional strategies, and the frequency that middle school mathematics teachers used these strategies in Florida school districts. The National Mathematics Advisory Panel (2008) stated, “Substantial differences in mathematics achievement of students are attributable to differences in teachers” (p.35). Examining the factors that affect teachers’ instructional decisions could provide information about what teachers do in their instructional practices to stimulate learning. Pajares & Urdan (2006) explained that subject-specific research on self-efficacy related teachers’ self-efficacy to teachers’ goals and instructional strategies. However, the primary research did not find this type of study in the area of mathematics.

The specific purpose of this research was to examine the following:

1. The research based instructional strategies used by mathematics teachers.
2. The self-efficacy levels among mathematics teachers with different demographic information.

3. The instructional strategies used by teachers with different levels of self-efficacy.

### **Significance of Study**

This study was researchable because the variables were measurable and could be analyzed by statistical methods, using descriptive and inferential statistics. The study was feasible because its implementation took place within a reasonable amount of time, and the teacher participants for the study were available.

This investigation could be researched because the problem could be defined and the variables could be measured. The survey asked participants perception questions and contained measurable variables that identified the research-based strategies mathematics teachers used and measured their teacher self-efficacy level. Further research will be needed to clarify the relationship between the identified research-based instructional strategies and student mathematics performance at the middle school level.

The topic area of self-efficacy and instruction in mathematics is significant because research in the area of instructional strategies in mathematics is limited (Foundations for Success Final Report, 2008). The *NCLB Act* requires the use of proven educational methods or empirically validated instructional strategies. After many years of research in the area of reading, researchers already identified programs and strategies; however, research in the areas of math and science is relatively new. As stated in *The Facts about Math* document, “Over the last decade, researchers have scientifically proven the best ways to teach reading. We must do the same in math. That means using only research-based teaching methods and rejecting unproven fads”, (“The Facts about Math,” 2006, our nation must research).

The primary researcher selected the topic based on reading literature, personal interest and experience as a public school mathematics educator and instructional leader. The increased emphasis in using research-based instructional strategies in teaching mathematics and the challenges teachers face to identify the best strategies for their students prompted this research. Research studies related teacher self-efficacy to teacher's motivation, effort, enthusiasm, openness to new ideas and use of stronger instructional methods such as inquiry and group work (Pajares & Urdan, 2006). Exploring the relationship between mathematics teachers' self-efficacy and the selection of instructional strategies would benefit school administrators by providing additional training options for teachers and would also offer teachers valuable information. Additionally, the literature identified the need for more research in the area of math instruction, specifically identifying effective instructional practices and the "research about what effective teachers do to generate greater gains in student learning" (Foundations of Success, p. xxi, 2008).

### **Assumptions**

This study was build upon certain assumptions:

1. Students were in the appropriate mathematics course.
2. Teachers were able to access the online surveys.
3. Teachers utilized research-based instructional strategies.
4. Teachers were able to identify the appropriate type of instructional strategies.
5. Teachers were able to properly read and comprehend the survey questions.
6. Teachers completed the surveys truthfully and to the best of their ability.

## **Delimitations and Scope**

The sample population was limited to middle school teachers of mathematics who were members of the Florida Council of Teachers of Mathematics (FCTM). This exploratory study examined the relationship between teachers' self-efficacy and their instructional strategies. The primary investigator invited approximately 350 teachers of sixth, seventh, and eighth grade middle school mathematics to complete the survey. Potential participants worked at middle schools that employed a six period schedule and they taught five mathematics classes per day. These delimitations prevented the generalizations of the results to other populations.

## **Organization of the Study**

### **Chapter I**

The first chapter consisted of the introduction to the research problem. The chapter included the following sections: a discussion of student performance in national and international mathematics assessments, and the influence self-efficacy and instructional strategies have in mathematics performance, a statement of problem areas; the definition of terms; the purpose of the study; the significance of the study; the assumptions; delimitations and scope and the organization of the study.

### **Chapter II**

The second chapter provides a review of the literature and theoretical framework leading to the research questions and hypotheses of this study. The review of the literature begins with theoretical perspectives: *the theory of multiple intelligences*, *experiential learning theory*, and *self-efficacy theory*. It continues by describing the changes resulting from the *NCLB Act* and the research-based instructional strategies:

technology and technology applications, direct instruction, interactive instruction strategies, student-centered strategies, project CRISS, and SpringBoard strategies. The chapter concludes with the synthesis of the literature on self-efficacy and instruction, specifically the relationship between self-efficacy, instructional strategies and the performance of students and teachers.

Chapter III reflects the research methodology testing the hypothesized model, as well as the research questions and hypothesis. It consists of the research design, the target population, the sample population, research instruments, procedure of data collection, ethical considerations, methods of data analysis, and the methodology for evaluating the research. Chapter IV describes the reliability and validity of all variables, as well as the findings of research questions and hypothesis testing. Chapter V presents the conclusions, interpretations, and implications of the findings. In addition, Chapter V provides limitations of the study and suggestions for future research.

## **CHAPTER II**

### **REVIEW OF THE LITERATURE**

#### **Introduction**

The Nation's Report Card (2007) on mathematics reported that students made gains at all levels of performance. White, Black and Hispanic students showed better understanding of mathematics compared to previous years. However, the achievement gap remained the same with the exception of the White-Black achievement gap.

The top four states in closing achievement gaps between 2003 and 2007 were Florida, Delaware, Illinois and New Jersey (Top 4 states in closing achievement gaps, 2007). These four states showed the most progress in closing the White-Black and the White-Hispanic achievement gaps in fourth and eighth graders. Additionally, significant score increases were reported in the four states for Blacks, Hispanics and Economically Disadvantaged students (Top 4 states in closing achievement gaps, 2007).

In spite of the progress in Florida, The Nation's Report Card (2007) reported that only 38% of fourth grade students were at or above proficiency level in mathematics. At the eighth grade level, the percent of students at or above proficiency level in math was 31%. The significant increase in average scale scores was much larger at the 4<sup>th</sup> grade level. Students average scale scores were higher than 25 states and lower than 8 states in 2007. In 2005, 4<sup>th</sup> grade average scores were higher than 19 states and lower than 15 states. Results at the 8<sup>th</sup> grade did not show as much change from 2003 and 2005. Eighth grade average scale scores were higher than 9 states and lower than 31 states. In 2005, 8<sup>th</sup> grade scores were higher than 10 states and lower than 33 states.



The information disseminated in the Nation's Report Card (2007) showed the need for schools to improve math education for all students. More emphasis in the area of mathematics is imperative given the predominant focus on reading throughout the literature. The empirical and theoretical literature related to instructional strategies, self-efficacy and student performance provides a place from which to begin this exploration and may eventually provide some possible solutions to help improve student performance.

### **Theoretical Perspectives**

The *theory of multiple intelligences*, *experiential learning theory*, and *self-efficacy theory* emphasized the importance of learning experiences. Based on the *theory of multiple intelligences (MI)*, teachers could teach concepts in more than one way, which could build on students strengths and cultivate student sense of efficacy (Gardner, 2006). *Experiential learning theory (ETL)* emphasized the way that teachers present the material should be relevant to the student's background knowledge. Additionally, ETL proposed a four stage learning cycle where affective, perceptual, cognitive and behavioral processes played key roles (Kolb, 1986). These processes are consistent with aspects of self-efficacy, which influences human functioning (Bandura, 1997). *Self-efficacy theory* stressed enactive mastery experiences as the main source of self-efficacy. Therefore, based on these theories teachers could affect student performance through the experiences they choose to use in their classrooms. This review analyzed the three theories and identified *self-efficacy theory* as the key theory.

## *The Theory of Multiple Intelligences*

Howard Gardner introduced the *theory of multiple intelligences* in 1983. This theory provided an alternative view of human intelligence to the traditional Intelligence Quotient measure. “It is a pluralistic view of mind, recognizing many different and discrete facets of cognition, acknowledging that people have different cognitive strengths and contrasting cognitive styles” (Gardner, 2006, p.5). This idea went beyond looking at intelligence in a one-dimensional way and it took into consideration other areas of human endeavor. In this theory, Intelligences or Multiple Intelligences (MI) was a way to describe human cognitive competence in terms of a set of abilities, talents or mental skills.

The eight intelligences were musical, bodily-kinesthetic, logical-mathematical, linguistic, spatial, interpersonal, intrapersonal, and naturalistic intelligence.

- Musical intelligence involved the capacity to hear patterns, remember them, and manipulate them.
- Bodily-kinesthetic intelligence involved the capacity to move the body or parts of the body to create or solve a problem.
- Logical-mathematical intelligence included the ability to work with numbers, quantities and operations, to use logic or to understand principles of casual systems.
- Linguistic intelligence required the ability to use language to express thoughts and understanding of others.
- Spatial intelligence referred to the ability to represent, recreate or transform perceptions of the world around.

- Interpersonal intelligence involved the ability to understand others.
- Intrapersonal intelligence highlighted on the ability to understand oneself.
- Naturalistic intelligence referred to the ability to distinguish aspects of the natural world such as distinguishing the diverse plants, animals, mountains, and the like.

In addition to the eight intelligences, Gardner (2006) included a 9<sup>th</sup> intelligence – existential intelligence, which “is based on the human proclivity to ponder the most fundamental questions of existence” (p. 20). The 9 intelligences satisfied the requirements needed to be included as an intelligence. In order for a human intellectual competence to be considered an intelligence, it must entail a set of problem solving skills that:

- (a) enable individuals to resolve genuine problems or difficulties,
- (b) enable individuals to find or create an effective product that allows the acquisition of new knowledge,
- (c) are universal to all human species,
- (d) have an identifiable core operation or set of operations, and
- (e) are susceptible to encoding in a symbol system (Gardner, 2004, 2006).

According to Gardner (2006), three conclusions derived from MI *theory*:

1. Every individual has a full range of intelligences.
2. Every individual has distinct intellectual profiles, even genetically similar people (or even identical) have different experiences.
3. The fact that an individual has a strong intelligence does not necessarily mean that he or she acts intelligently. It is the use of those abilities what determines how intelligent one acts.

These conclusions had consequences in the educational area as MI ideas could be used to teach in many ways to activate a range of intelligences and improve the learning environment. MI ideas could be used to build on students' individual strengths, which can aide in building up students' confidence and self-efficacy. Goodnough (2001) explored the used of MI in the selection of learning experiences to move students to higher levels of scientific literacy. He found that using MI ideas not only increased student participation and enjoyment but also helped the teacher to become more sensitive to students' needs. The teacher created more student-centered curriculum and his approach to teaching and learning changed.

Green & Tanner (2005) found that students engaged more often and learned the material better when an online writing course incorporated MI ideas. Findings such as these prompted many to advocate for the use of MI theory ideas to engage students. One example is Shepard, (2004) who urged professionals to use MI theory to "build resiliency in today's youth by providing opportunities for meaningful participation through orchestrating learning activities that engage the youth" (p.16).

Ediger (2005) advocated for the use of *multiple intelligences theory* when teaching mathematics. He claimed that the best math curriculum possible needed to have three key components. It needed alignment with the state standards, demanded quality planning, and quality implementation. According to Ediger (2005), quality planning involved the development and selection of a variety of activities that considered multiple intelligences. He did not provide a comprehensive table; instead, he provided some examples of how to use MI in mathematics teaching. For example, for students who are

strong in bodily/kinesthetic, Ediger (2005) suggested “constructing items and objects as they relate to the unit being studied” (p. 713).

Similarly, Adams (2000) argued that, “it is not necessary to attempt to categorize children by intelligence, but only to provide them with a multitude of learning opportunities” (p.86). She proposed the overlapping of the National Council of Teachers of Mathematics (2000) Process Standards with Gardner’s multiple intelligences to develop accessible mathematics curriculum, instruction and assessment. “The five Process Standards - problem-solving, reasoning and proof, communication, connections, and representation – highlight ways of acquiring and using knowledge” (Principles and Standards, 2000, p.29). Adams (2000) developed a table that provided specific examples of how teachers could use multiple intelligences to help students achieve each Process Standard. For instance, when teaching children problem-solving, teachers might ask students to: write stories as context for word problems (linguistic); gather, record, and use numerical data to solve problems (logical); use drawings and diagrams as problem solving strategies (spatial); use dramatization (bodily-kinesthetically); translate problem solving strategies to help recall strategies (musical); solve problems through cooperative learning (interpersonal); set goals for growth in problem-solving (intrapersonal) (Adams, 2000).

Through the careful selection of instructional strategies, teachers could ensure that their instruction addresses the varied needs of their students. The *theory of multiple intelligences* proposed that everyone has a set of intelligences and that individuals may be stronger in one intelligence than in the others (Gardner, 2006). Students may use more than one intelligence as they go through the learning process. Adams (2000) explained

that when learning mathematics, students might use a variety of intelligences not just the logical-mathematical. MI could be used to assist the selection of instructional strategies and build on students' characteristics and strengths.

### ***Experiential Learning Theory***

According to Atherton (2006), the umbrella of learning theories has four different branches: behavioral, cognitive, humanistic and motivational. Education has focused on the cognitive branch, the section where the *experimental learning theory* (ELT) was found. Kolb (1984) explained that ELT was different from behavioral theories of learning in the emphasis it placed on the process of learning instead of focusing on the behavioral outcomes. "The theory of experiential learning rests on a different philosophical and epistemological base from behaviorist theories of learning and idealist educational approaches" (p.26). It assumed that ideas were re-formed as individuals go through various experiences, and that learning was a process where concepts were derived from and modified by the learner's experiences. This implied that as individuals embarked in a learning experience, they were not just "empty vessels" but instead they entered the experience with one or more ideas about the topic. Thus, Kolb suggested that, "one's job as an educator is not only to implant new ideas but also to dispose of or modify old ones" (p.28).

Kolb's *experimental learning theory* guided educational models in adult education programs, businesses and K-12 education. Incorporating the experiential learning models of Lewing, Dewey, and Piaget, he proposed four stages of learning: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). These four stages of learning provided insight about

the way people think and the knowledge acquisition process. The foundation of this *theory* relied on the idea that individuals built knowledge by going through the four-stage cycle (Kolb, 1986). First, students went through the experience. Then they observed and reflected. Next students formulated new concepts and then they applied the new knowledge. The knowledge, skills and dispositions learned in each stage were reinforced and expanded as individuals moved through the cycle. “Thus, learning results from the wholistic engagement and interplay of affective, perceptual, cognitive and behavioral processes” (Pajak, 2003, p.88).

Through each stage of the cycle, learners utilized different sets of abilities needed to go effectively through the learning process. Kolb (1986) explained that learners need to choose the set of learning abilities needed for specific learning situations, and he identified two dimensions to the learning process: concrete experiencing and abstract conceptualization. These two dimensions were placed at the end of the continuum and depending of where learners fell in the continuum; it determined their learning styles – Divergers, Assimilators, Convergengers, and Accommodators. Divergers preferred concrete experience (CE) and reflective observations (RO), and depended greatly on feelings, imagination and intuition (Williamson & Watson, 2006). Assimilators preferred abstract conceptualization (AC) and reflective observations (RO) and “are best at understanding a wide range of information and putting it into concise, logical form” (Kolb, Boyatzis, Mainemelis, 1999, p.5). Convergengers preferred abstract conceptualization (AC) and active experimentation (AE), and they tended to be problem solvers, analytical, pragmatic and had the ability to make decisions based on finding solutions to questions or problems (Williamson & Watson, 2006). Accommodators

preferred concrete experience (CE) and active experimentation (AE), and they tended to learn primarily from “hands-on experiences” (Kolb, et al., 1999).

Baker & Ansorge (2007) stated “experiential learning is based on a constructivist theory that supports that learning is an active process in which much of what an individual learns and understands is constructed by integrating new knowledge with existing knowledge” (p.233). They conducted a study designed to determine the effects of using a robotics curriculum in an after school program on achievement in science. They based their model on Kolb’s *theory of experiential learning* and it followed the four stages of the cycle. Results indicated the program was effective at increasing levels of achievement in science. Other studies using the experiential learning model in various subjects produced similar results in areas such as teaching environmental science (Tedesco & Salazar, 2006), science and technology (Baker & Ansorge, 2007), social justice (Warren & Loeffler, 2000), and graduate counselor education programs (Connolly, Carns & Carns, 2005).

NCTM (2000) included objectives that are consistent with the four learning cycles emphasized in ETL in each of the five Process Standards - problem solving, reasoning and proof, communication, connections, and representation. NCTM (2000) suggested that as students go through the learning experience, they should build new mathematical knowledge, reflect on the content learned, and apply and adapt the new knowledge to unfamiliar situations. For example, the problem solving strand stated that students should be able to: recognize reasoning and proof as fundamental aspects of mathematics (experience and observe); make and investigate mathematical conjectures (reflect);



develop and evaluate mathematical arguments and proofs (apply); select and use various types of reasoning and methods of proof (apply).

The NCTM Process Standards described learning situations that were student-centered and of Constructivist approach. Baker & Ansorge (2007) stated that ELT was based on a Constructivists approach. Therefore, the instructional strategy section of this dissertation includes this approach and the related research.

### ***Self-Efficacy Theory***

Self-efficacy is a component of Bandura's *social cognitive theory* (Bandura, 1997). Self-efficacy operates along with other components of the *theory* to influence people's thoughts, motivation and actions. "Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Perceived self-efficacy affected performance as individuals with similar skills may perform differently under the same circumstances depending on their beliefs of personal efficacy. Pajares (1996) explained that knowledge, skill, and prior experiences were frequently poor predictors of future performance because perceived self-efficacy strongly influenced the way in which people act. According to Bandura (1997), efficacy beliefs affected thought processes, level and persistence of motivation, and affective states. "People who doubt their capabilities in particular domains of activity shy away from difficult tasks in those domains", (p.39). Self-efficacy beliefs were key factors for human motivation, well-being, and sense of accomplishment because there was little incentive to act or confront difficult situations unless people believed that what they do will result in a desirable outcome (Pajares, Johnson, & Usher, 2007).

Self-efficacy beliefs came from four different sources: enactive mastery experiences, vicarious experiences, verbal persuasion and social influences, and physiological and affective states (Bandura 1997). Enactive mastery or previous performance was the most influential source of efficacy since it provided the “most authentic evidence of whether one can muster whatever it takes to succeed” (p.80). It provided individuals a strong set of beliefs that came from either success or failures in real life experiences. Pajares, Johnson & Usher (2007) found that elementary school students had greater mastery experience, vicarious experience, and social persuasion than middle and high school students in the subject of writing. Additionally, mastery experiences for the most part attributed to students’ writing self-efficacy beliefs variations. In a study designed to compare the self-efficacy of students in math developmental courses vs. students in calculus courses, Hall & Ponton (2005) argued that experiences producing positive outcomes in mathematics increased math self-efficacy and that experiences producing negative outcomes decreased math self-efficacy. This was consistent with the idea that enactive mastery experiences were the most influential source of self-efficacy.

Vicarious experiences derived from observing others model tasks. These experiences were not as strong as enactive mastery. However, the experience of others’ performance in similar tasks influenced those who had limited experience (Bandura, 1997).

Social persuasions were verbal judgments received from others. Research studies validated the influence of verbal persuasion in perceived self-efficacy. Jackson (2002) sent either a neutral e-mail or an e-mail designed to enhance efficacy beliefs to a group of

randomly selected students. He found that the e-mail designed to enhance self-efficacy affected self-efficacy beliefs. Similarly, Pajares, Johnson, & Usher (2007) found social persuasions were instrumental in creating students' writing self-efficacy beliefs in high school. Hutchinson, Follman, & Bodner (2008) examined the sources of self-efficacy of first year engineering students at Perdue University. Their findings showed that even though vicarious experiences and mastery experiences were the two main sources of efficacy for these students, social persuasions in the form of verbal and non-verbal feedback from other peers, family, and instructors were influential. Social persuasion was more significant "in the absence of direct experience" (McCormick, Ayres, & Beechey, 2006).

Physiological and affective states also influenced efficacy. "In judging their capabilities, people rely partly on somatic information conveyed by physiological and emotional states" (Bandura, 1997, p. 106). These states might be manifested in the form of anxiety, stress, arousal, and mood changes. Mills, Pajares & Herron (2006) explored the relationship between self-efficacy and anxiety and found a negative correlation between reading anxiety and reading self-efficacy in students enrolled in French classes. Likewise, Maier & Curtin (2005) underscored that math anxiety influences students' self-efficacy beliefs in mathematics, and used math "therapy sessions" to increase student self-efficacy and hence performance.

Self-efficacy regulated people's action, thoughts, and level of motivation through processes such as cognitive, motivational, affective and selective. According to Bandura (1997), efficacy beliefs produced their effects through these four processes, which affect the way people feel, think, act and are motivated. These four processes "usually operate

in concert, rather than isolation, in the ongoing regulation of human functioning” (Bandura, 1997, p.116). Self-efficacy affected the cognitive process by influencing thought patterns, which might be in the form of inferential thinking, perspective future time, setting goals, self-regulatory factors, and conception of ability. Bandura (1993) described people’s actions as originally shaped in thought. Their thoughts produced efficacy beliefs, which influenced the scenarios they visualized. Goals were based on the scenarios people created. Consequently, self-efficacy influenced the goals people set for themselves through self-appraisal abilities.

Self-efficacy also affected the motivational process. According to Bandura (1997) people who had high self-efficacy beliefs perceived difficult tasks as challenges instead of threats, and they were likely to set high goals and persevere in their efforts. Chase (2002) studied the relationship between children’s self-efficacy, motivation and attributions in physical education and found supporting evidence indicating that “higher efficacy children attributed failure to lack of effort, whereas, those with lower efficacy attributed failure to lack of ability” (p. 47). Stevens, Olivarez, Lan, & Tallent-Runnels (2004) found evidence suggesting that students’ self-efficacy beliefs and motivation played an important role in student achievement in mathematics. Self-efficacy beliefs about what people can do affected not only the setting of goals but also their interest and motivation to perform specific tasks.

Self-efficacy exerted influence in human functioning through affective processes. People experienced high levels of anxiety when they believed they could not manage “threats” or difficult situations. There was a negative relationship between self-efficacy and anxiety (Bandura 1993; Barbee, P., Scherer, D., & Combs, D. 2003; Mills, Pajares &

Herron 2006), which meant that as levels of self-efficacy increased the level of anxiety decreased and vice versa. Consequently, affective processes influenced human level of functioning.

The selective process was the fourth process influenced by self-efficacy. Individuals' beliefs in their capabilities influenced their choices (Bandura, 1997). Self-efficacy influenced not only the activities individuals chose but also the type of environment people got into. Highly efficacious people preferred difficult activities, persevered in their pursuits, and selected social environments they perceived they could manage.

Research on self-efficacy in the area of mathematics consistently demonstrated a positive relationship between mathematics self-efficacy and students' mathematics performance (Anjum, 2006; Del Siegle & McCoach, 2007; Stansberry, 2001; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). Stevens et al. (2004) compared this relationship across ethnicity and determined that the positive relationship between self-efficacy and mathematics performance could be expanded to include Hispanic students. Concurrently, Anjum (2006) found this relationship to be true in primary school girls at all grade levels and also found a significant correlation for boys in grades 4 and 5.

The study of self-efficacy was not limited to student performance but has also focused on the impact on teachers. Teacher self-efficacy is defined as "a judgment about capabilities to influence student engagement and learning, even among those students who may be difficult or unmotivated" (Pajares & Urdan, 2006, p. 117). Teacher self-efficacy is cyclical in nature. At first, information about one's efficacy comes from four sources: mastery experience, vicarious experiences, verbal persuasions and physiological

arousals (Bandura, 1997). According to Pajares & Urdan (2006), teachers then process the information by analyzing the teaching task and assessing their personal teaching competence. After the information is analyzed teachers generate efficacy judgments or teacher self-efficacy. Next, teachers use these judgments or self-efficacy beliefs to set their goals, determine the amount of effort they invest in achieving these goals, and their level of persistence. The performance and outcomes of their efforts provide new mastery experiences that lead to future efficacy judgments. It is noted that “like all self-efficacy judgments, teacher self-efficacy is context-specific” (p.118); therefore, teacher level of self-efficacy varies under different circumstances.

Teachers’ self-efficacy beliefs were found to particularly influence their instructional practices (Bandura, 1997; Pajares, 1992; Pajares & Urdan, 2006). Numerous studies related the use of specific types of instructional strategies to teachers’ self-efficacy; however, none of these was reported in the area of mathematics. Wilkins & Brand (2004) developed their study based on the notion that teacher self-efficacy influenced classroom practices. They investigated the extent to which a teacher methods course could help pre-service teachers change their beliefs and attitudes to be more consistent with those underlined in current mathematics reform presented by the NCTM. The results suggested that pre-service teachers who participated in the mathematics methods course “changed their beliefs in a way that was more consistent with current mathematics education reform and also changed their sense of self-efficacy in a positive way” (Wilkins & Brand, 2004, p. 231).

Training teachers in the use of specific instructional strategies could also result in increased student self-efficacy (Siegle & McCoach, 2007). Bandura (1997) explained

that self-efficacy is derived from enactive mastery experiences, vicarious experiences, social persuasions and physiological factors. Using these four types of experiences as guidelines, Siegle & McCoach (2007) explored the impact of specific strategies on student self-efficacy. They found that when teachers reviewed the lesson presented the previous day, asked students to record what was learned, encouraged students who perform poorly, recognized students accomplishments, provided specific feedback, and used student models for demonstrations, there was a stronger relationship between student self-efficacy and achievement.

### ***Measurement of Self-Efficacy***

Efficacy is observed and measured through observable indicants such as people reporting their efficacy beliefs. Measuring people's perceived self-efficacy does not involve measuring the skills individuals possess to perform a certain task, rather it involves collecting information about the belief of what they can do with these skills under different conditions (Bandura, 1997). When developing scales to measure self-efficacy, Bandura (1997) warned researchers not to create omnibus tests including "personal attributes designed to serve diverse purposes" (p. 39). Specifically, avoid writing item scales not presented within the context of the particular situations relevant to the area of interest or the domain of functioning under analysis. Pajares & Miller (1995) explained, "the appropriateness of the match between self-efficacy assessment and the outcome is crucial to optimal predication of that outcome" (p.192). Hence, the predictive value of an instrument was decreased when the self-efficacy beliefs assessed were not specific to the criterial task they was being compared.

Chen & Zimmerman (2007) explored another concern that might arise when measuring self-efficacy. They studied how the calibration of math self-efficacy instruments affected students' response on self-evaluations or effort judgments. They explained, "the difficulty level of the task may also influence one's accuracy in estimating one's capability to solve the task" (p. 224). They examined students' judgments and calibration variations within various levels of task difficulties; the sample population included seventh grade math students in the U.S. and Taiwan. The results indicated that there was a decrease in self-efficacy beliefs and calibration accuracy as the difficulty level of the items increased. Chen & Zimmerman (2007) noted that Taiwanese students were more accurate at reporting their self-efficacy beliefs than American students. They explained that it might be "necessary to test whether students' accuracy of self-efficacy beliefs is affected by their perceptions of their cultural contexts" (p.240).

This has consequences for future studies on self-efficacy in countries such as the U. S. where there is much diversity in the schools. Individuals' self-efficacy judgments may be as well affected by their cultural contexts and should be considered when student or teacher self-efficacy is measured. Therefore, in addition to examining the data results of the overall populations, researchers may also consider examining and comparing the data using race/ethnicity.

The type of assessment format students are given did not influence students' self-efficacy; however, Pajares & Miller (1997) found that varying the type of assessment from multiple choice to open-ended altered the relationship between self-efficacy and student performance. Students taking the open-ended assessments were overconfident in reporting their self-efficacy. They explained that "these differences altered the predictive



utility of self-efficacy and influenced calibration results” (p. 226) and warned researchers to account for these differences before generalizing about the relationship between self-efficacy and performance.

Onafowora (2005) brought up a similar concern when studying teacher efficacy issues. She used a mixed design to measure the level of self-efficacy of novice teachers. A closer look at the data revealed a discrepancy on the results with teachers showing higher self-efficacy on the likert scale instruments and the opposite on the results from written responses to open-ended questions. Anjum (2006) also highlighted this concern with self-reporting. He found that third grade boys had the tendency to overrate their mathematics capabilities. Consequently, researchers should develop self-efficacy instruments with caution.

### **Review of the Literature**

The review of the literature includes a review of the *NCLB Act (2002)* accountability principle and mathematics standards, instructional strategies, math anxiety, and self-efficacy as it relates to instruction. This review concludes with a synopsis of the literature from which the current study was developed.

#### ***NCLB Act and Standards for School Mathematics***

The four basic principles or pillars of the *NCLB Act (2002)* are stronger accountability for results, expanded options for parents and students, increased flexibility and local control in the spending of educational dollars, and proven education methods. To satisfy the principle of stronger accountability, the *NCLB Act (2002)* requires States to develop and implement statewide accountability systems that include all publicly funded schools. “These systems must be based on challenging State standards in reading and

mathematics, annual testing for all students in grades 3-8, and annual statewide progress objectives ensuring that all groups of students reach proficiency within 12 years” (NCLB Executive Summary, 2001, para. 4), the school year 2013-2014. This has caused some researchers to suggest that instead of reporting proficiency, States’ progress in meeting the standards could be better described in terms of averages, percentiles, and effect size (Ho, 2008).

The *NCLB Act (2002)* did not require the creation of national standards in the core content areas, instead it “reformed Federal educational programs to support State efforts to establish challenging standards, to develop aligned assessments, and to build accountability systems for districts and schools that are based on educational results” (Standards and Assessments Peer Review Guidance, 2004, para. 1). States established challenging content and achievement standards in reading, mathematics and science. The content standards included specific information stating expectations of what all students should know and be able to do, coherent and rigorous content, and promote higher order skills. Table 2-1 outlines the content areas, grade level, timeline and general specifications the *NCLB Act (2002)* required for content standards.

Table 2-1

*Content, grade level, and timeline requirements for content standards*

Content Area	Grade levels	Due	Notes
Reading/ language arts	<ul style="list-style-type: none"> <li>Each grade: 3 - 8;</li> </ul> <p style="text-align: center;">and</p> <p style="text-align: center;">Grade range: 10 - 12</p>	May 2003	<ul style="list-style-type: none"> <li>If a State's standards cover grade ranges (e.g., 3 - 5 and 6 - 8) rather than the specific grades, 3 - 8, the State must develop grade-specific expectations in addition to its standards.</li> </ul>
Mathematics	<ul style="list-style-type: none"> <li>Each grade: 3-8;</li> </ul> <p style="text-align: center;">and</p> <p style="text-align: center;">Grade range: 10-12</p>		
Science	<ul style="list-style-type: none"> <li>Grade ranges: 3 - 5; 6 - 9; 10 - 12</li> </ul>	By the 2005 - 2006 school year	<ul style="list-style-type: none"> <li>At the high school level, standards must define the knowledge and skills that are expected of all students prior to graduation. They may be linked to specific courses if all students must take these courses in order to graduate.</li> </ul>

From Standards and Assessments Peer Review Guidance: Information and Examples for Meeting Requirements of the No Child Left Behind Act of 2001, 2004, p.8.

High quality standards and assessment systems were key requirements for a State accountability system. The assessment system included the desegregation of data through report cards. Information included in the report card would provide parents, teachers and principals with information about each child's performance and progress in meeting the standards (Stronger Accountability - Testing for Results, 2004). *An Update in the State Standards and Assessment System* (2007) reported that as of May 2007 only twenty States had received a full approval or full approval with recommendations.

The National Assessment Governing Board (NAGB) sets the policy for the National Assessment of Educational Progress (NAEP). The NAEP or "National Report

Card” is the only national representative and continuing assessment in the U.S. and it has been providing periodic assessments since 1969 in reading, writing, math, science and other subjects. “NAEP is an indicator of what students know and can do. Only group statistics are reported, no individual student or teacher data are ever released” (About NAEP, para.3). NAGB determines and designs the NAEP assessments as well as develop the framework of each subject area assessment. However, the purpose of the frameworks is not to serve as the national curriculum but instead to provide the outline of what a national assessment should test.

The NAGB contracted the Council of Chief State School Officers (CCSSO) to design the mathematics framework for the 2007 NAEP. CCSSO used various sources of information including state mathematics content standards and frameworks, National Council of Teachers of Mathematics Standards, reports from the Third International Mathematics and Science Study, reports from the Achieve Project, and a 2001 NAEP report. The outcome included five content areas: Number Properties and Operations, Measurement, Geometry, Data Analysis and Probability, and Algebra. These five areas resemble the five NCTM Content Standards.

For years, NCTM has been working to increase student achievement. However, instead of developing a mathematics framework for assessment, it developed a set of K-12 Standards to guide the teaching of mathematics. These standards were identified as required to build a society that had the capability to think and reason mathematically and to be able to use mathematics in everyday contexts in this changing world. The publication, *Principles and Standards for School Mathematics* (2000), focused on presenting the Standards, goals and policies that support the curriculum framework for K-

12 in the United States. The document included the NCTM mission and vision, detail content and process standards as well as a rich collection of sample lessons.

The NCTM (2000) aim was consistent with the *NCLB Act* (2002), to provide equity and excellence in mathematics education. The vision shared in the *Principles and Standards for School Mathematics* (2000) was as follows:

Imagine a classroom, a school, or a school district where all students have access to high quality, engaging mathematics instruction. There are ambitious expectations for all with accommodations for those who need it. Knowledgeable teachers have adequate resources to support their work and are continually growing as professionals. The curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding...., (p. 3).

This vision demonstrated the commitment of NCTM to quality education. It was also an indication that mathematics education was up for a reform. *Principles and Standards for School Mathematics* (2000) highlighted the importance of providing meaningful experiences in the classroom, using a student-centered approach and the importance of building knowledge. Through the use of effective instructional strategies teachers could ensure their lessons were geared toward their targeted audience. Teacher self-efficacy was related to teacher's motivation, effort, enthusiasm, and use of stronger instructional methods such as inquiry and group work (Pajares & Urdan, 2006). Consequently, taking a closer look at math instructional strategies and teacher self-efficacy could be beneficial at it is discussed later in this review.

NCTM defined *standards* as “descriptions of what math instruction should enable students to know and do – statements of what is valued for school mathematics education” (p.9). There are ten NCTM Standards, five content standards and five process standards. The five content standards include:

1. Number and operations – It requires students to understand number systems and represent numbers in different ways, understand the meaning of operations and their relationship to one another, perform computations fluently, and make reasonable estimates.
2. Algebra – It emphasizes understanding patterns, relationship among quantities, functions, using mathematical models to represent and understand quantitative relationships, and analyzing change in various contexts.
3. Geometry – It requires students to analyze two and three dimensional geometric shapes and structures, to use visualization, spatial reasoning and geometric modeling to interpret and describe physical environments.
4. Measurement – It involves understanding measurable attributes of objects, number systems, and processes of measurement. In grades K-8, it requires students to be proficient in the use of measurement tools, techniques, and formulas.
5. Data Analysis and Probability – It involves collecting, organizing, displaying and analyzing data to answer questions. It also includes selecting and using appropriate statistical methods, make inferences and predictions based on data, and applying basic probability concepts.

The NCTM content standards played a pivotal role in the development of the state math standards mandated by the *NCLB Act*. Latterell (2007) found that forty-one of the states included all five NCTM content standards in their standards, five states included four of the NCTM content standards, and the last five used either some of the NCTM process standards or some resemblance to the content standards embedded in their objectives. “So, even among the nine states that do not list all five NCTM content strands among their own state standards, all show evidence of being influenced by NCTM standards” (p. 200).

### ***Instructional strategies***

The *NCLB Act* (2002) required schools to use the most current research-based instructional methods and programs. The Act categorizes a program or method as research-based when there is empirical evidence that the method or program works. The key characteristics of reliable research include the use of the scientific method, research that can be replicated and generalized, and research which meets rigorous standards and convergent findings (The facts about investing in what works, 2004). The *NCLB Act* (2002) limits federal funding strictly for research-based programs.

In the areas of mathematics and science, the process identifying research-based programs or methods is relatively new. In fact, a search in ProQuest database on math instructional strategies and programs from 1990 to the present, generated a list of relevant journal articles dated only as far back as the year 2000. The Math Now program for elementary and middle school students started in 2006. It includes the creation of the National Mathematics Panel, which is a group of experts that evaluate the effectiveness of instructional methods to teach mathematics. The Math Now program promotes these

practices and provides grants to promote effective research based practices in grades K-7. Grantees use funds to “implement scientifically based interventions and promising practices that involve intensive and systematic instruction and provide professional development for teachers and other staff that targets important mathematics content knowledge and effective practices” (Math Now: Advancing Math Education, 2006, para. 14).

*Instructional strategies* “determine the approach a teacher may take to achieve learning objectives” (Saskatchewan Education, 1991, para. 10). This term has been used interchangeably with *Instructional Methods*. Saskatchewan Education (1991) identified five different instructional strategies – direct, indirect, interactive, experiential, or independent, and under each instructional strategy, it included a list of corresponding instructional methods, which were more specific. Some of the instructional methods included were explicit teaching, drill and practice, cooperative learning, problem solving, inquiry, computer assisted instruction, reflective discussion, compare and contrast, homework, research project and many others.

In contrast, Marzano, Pickering & Pollock (2002) through a meta-analysis on effective instruction identified nine broad research-based instructional strategies “that have a high probability of enhancing student achievement for all students in all subject areas at all grade levels” (p.7). These nine broad instructional strategies were: identifying similarities and differences; summarizing and note taking; reinforcing effort and providing recognition; homework and practice; non linguistic representations; cooperative learning; setting objectives and providing feedback; generating and testing hypotheses; and questions, cues, and advance organizers. Yet others such as Alsup



(2005) and Andrew (2007) viewed instructional strategies using a broader classification, constructivist versus traditional instruction. Regardless of the classification, studies shared similarities among the specific instructional strategies chosen. This review of the literature focused on those shared instructional strategies.

The studies found in this review examined the effect of a specific strategy, set of strategies, or program on student achievement. Several meta-analyses were also included. Although the emphasis was on the effect of instructional strategies in mathematics achievement, some of the studies found did not analyze the results by subject area.

### ***Using Technology and the Applications of Technology***

Xin & Jitendra (1999) conducted a meta-analysis to examine the effects of various instructional strategies in solving math word problems and found that computer assisted instruction (CAI) reported the largest effect size out of four intervention approaches. Similarly, Ysseldyke, Betts, Thill & Hannigan (2004) studied the effects of an instructional management system – Accelerated Math – on mathematics performance in students grade 3 through 6 participating in Title I programs. They found that the experimental group showed significant gains in math achievement. Similarly, when inquiry-based learning with the integration of technology was used to enhance student learning, it yielded comparable results (Owens, Hesser, & Teale, 2002).

Funkhouser (2003) studied a group of 10<sup>th</sup> and 11<sup>th</sup> graders enrolled in a geometry class to explore the effects of technology on student performance and attitudes. He found that the use of a constructivist approach with computer-augmented activities helped students “achieve stronger gains in knowledge of geometry concepts than students who

received more traditional geometry instruction” (p.172). However, there was no significant difference in students’ attitudes towards math. On the contrary, the control group attitudes towards math significantly increased in at least one measure. These results were conflicting with other studies including one Funkhouser conducted previously.

Studies on the effect of technology in teaching mathematics also focused on its effect in achievement and student disposition to continue the use of graphing calculators. Weigand (2008) evaluated a one-year project that used the TI Voyage 200 for teaching mathematics to 10<sup>th</sup> grade students in Germany. He found that the use of calculators improved student achievement in working with graphs of functions but no difference in working with variables, and terms. Additionally, the improvement was noticeable amongst low and average performing students. Students’ attitudes about continuing the use of the calculator were mixed; one group was willing to continue using the graphing calculator and another group did not enjoy using it (Weigand, 2008).

On another study, Leng, Choo, Soon, Yi-Huak & Sun (2005) explored the effects of using the TI Voyage 200 in Junior College math classes in Singapore. Their findings showed that even though using the calculator did not significantly improve student achievement, it had positive effects on students’ attitudes about using the graphing calculators. Consistently, Powers, Allison, & Grassl (2005) reported that there was no significant difference in performance when students used the TI-92 handheld Computer Assisted System (CAS) in a Discrete Mathematics course. However, they concluded that using CAS might increase students’ problem-solving approaches. The overall results from the literature suggested that using graphing calculators to teach math “can enable

students approach situations graphically, numerically and symbolically, and can support student visualization, allowing them to explore situations which they may not otherwise be able to tackle” (Jones, 2005, p.31). According to Jones (2005), graphing calculators might increase student achievement indirectly because students increase their use of graphical solution strategies.

The use of technology in teaching mathematics is not limited to graphing calculators. Gorgievski, Stroud, Truxam, & Defranco (2005) examined students’ perceptions of using the Tablet PC as an instructional tool to teach Calculus. The focus of the study was on the effectiveness and efficiency of using the Table PC for delivering the math content. The instructor used the Tablet PC to deliver the instruction, create notes, and post them on a website. Students downloaded the notes from the website, which allowed them to participate during class. Students reported that the Tablet PC “helped to create an active learning environment, to stimulate their interest, and to enhance their learning in a large-group lecture format” (p.98).

### ***Direct Instruction Strategies***

In addition to technology, the literature also emphasized that direct instruction had a positive effect in mathematics achievement. Flores, & Kaylor (2007) studied the effects of a direct instruction program in teaching fractions to at-risk middle school students. This study was unique because it used a direct instruction program traditionally implemented with students with disabilities to help students without disabilities. The program followed the *Corrective mathematics, basic fractions* Direct Instructional program by Engelmann & Steely (2005). Teachers used a manual containing scripted lessons. The strategies used included teacher demonstration and modeling, the use of

pictures and drawings to develop understanding, guided practice, and frequent group verbal responses followed by immediate feedback. Results indicated that pre-test students' scores significantly increased during the post-test, with the mean performance increasing from 20% to 77% respectively (Flores & Kaylor, 2007).

Baker, Gersten, and Lee (2000) conducted a Meta analysis to synthesize the available research on the effects of instructional strategies in teaching math to low achieving students. They found that explicit instruction had positive to moderately strong effect on low achieving students, with an effect size of .58. Consistently, Hass (2002) found that direct instruction, technology aided instruction, and problem-based instruction were effective strategies to teach Algebra 1. Harris (1998) also recognized direct instruction as an effective teaching practice to increase student achievement and he emphasized the need for it to be structured, organized and to provide continuous feedback. Harris (1998) added that 'providing feedback' might need to be distinguished and delineated among the different instructional strategies as a strategy itself. Therefore, the effects of specific instructional strategies on student achievement may need further investigation because teachers may use several of them simultaneously.

Pre-teaching and re-teaching were two strategies that helped low achieving students increase mathematics achievement (Lalley & Miller, 2006). The National Mathematics Advisory Panel (2008) found that explicit instruction improved the performance of these students. Lallay & Miller (2006) examined not only the impact of pre-teaching and re-teaching on low achieving students but also compared the differences between these two strategies. They found that both strategies "resulted in significant

increases in Math Concepts, Math Problems, and Math computations” (p. 752); however, they found not significant difference between pre-teaching and post-teaching.

### ***Interactive Instruction Strategies***

Besides the direct and experiential strategies identified, other instructional strategies studied fall under the “interactive instruction” category. Peer-assisted learning strategies (PALS) included strategies for a stronger ability student to coach and provide immediate feedback to a weaker ability student. Students reversed their roles during the follow up tutoring session and teachers monitored and awarded points as recommended by PALS. Baker, Gersten, Dimino & Griffins (2004) studied the impact of PALS on students and teachers, and they found that not only students’ attitudes and performance were affected but also teachers incorporated the strategies used in PALS in their daily lessons.

Baker, Gersten and Lee (2000) findings were consistent with the ones described above. They found that peer-assisted instruction had positive effects on student learning, with an average size effect of .62. However, five out of the six studies they considered examined the effects of this strategy on computation. Therefore, “it is safest to conclude that the peer-assisted learning approaches demonstrated a consistent, moderately strong positive effect on the computational abilities of low achievers” (Baker, Gersten and Lee, 2000). They explained that it was not clear how this strategy might affect other areas of mathematics.

The McNeill Program used at the University of Colorado to teach challenging courses to non-traditional and at-risk students incorporated multiple strategies such as group activities, class discussions, real-life contexts, technology, one-on-one tutoring and

workshops to increase success in mathematics. Students received instruction in a classroom and attended a lab. While in the classroom, instructors used a multidimensional teaching format that included lectures, discussions, interactive dialogues and collaborative learning (Mendez, 2006). In the lab, students worked in teams to solve real-life case studies, complete long-term projects or do homework. In addition to the class and lab experience, students received support through computer labs, calculators, e-mail, and scheduled workshops on selected topics. The combination of strategies incorporated in the program was effective. Data showed that at-risk students in the McNeill program scored the same or higher than other students not participating in the program (Mendez, 2007).

Another strategy used in schools is after school tutoring. Baker, Rieg & Clendaniel (2006) studied the impact of tutoring in an elementary after school program. The ten weeks tutoring program consisted of one after school 90-minute session, 15 minutes for snacks, 30-40 minutes for homework, and the rest of the time for skill reinforcement or structured games. The tutors were college students who had completed their math methods courses, or they were elementary education majors. Each university tutor worked with two students at the time. They worked closely with the supervising teachers, who provided teaching suggestions and modeled the use of manipulatives as well as the asking of higher-level questions (Baker, Rieg, & Clendaniel, 2006). District summary reports showed that teachers expressed approval of the program and students' attitude and level of confidence increased. Consistently, in their meta-analysis of out of school time programs such as after school and summer programs, Lauer, Akiba, Wilkerson & Apthrop (2006) concluded that these programs have positive effect on the

student achievement in both reading and mathematics, and that these programs should focus on academic as well as social activities.

Some after school tutoring programs used student peer tutors to ameliorate the performance of low achieving students. Walker (2007) investigated the impact of a peer tutor program on the development of a learning community centered on improving mathematics. He found that when high performing students act as peer tutors, they were able to provide assistance and equip low performing students with valuable strategies to solve mathematical problems. This program was beneficial for both the peer tutor as well as the tutees. Peer tutors expanded their use of problem solving strategies and more frequently solicited homework help from the teacher. Similarly, Mayfield & Bollmer (2007) found that the use of home based peer tutors assisted at-risk students to improve mathematics performance in target skills, and it benefited both the tutors and tutees.

### ***Student-Centered Strategies***

Alsop (2005) studied the effects of using traditional versus constructivist teaching strategies on math pre-service teachers' performance. He hypothesized that pre-service teachers taught using constructivists strategies such as student-centered strategies, manipulatives, and problem solving would show a decrease in math anxiety and an increase in teaching efficacy, conceptualization of new mathematical concepts and teaching autonomy. However, he found no significant difference between the experimental and the control group in all areas except in math anxiety. The effects of constructivist strategies on pre-service teachers were inconclusive. Andrew (2007) noted that pre-service teachers in classes where instructors used constructivist's strategies may

be getting exposed to the strategies but the implementation of these varied depending on the instructors' opinions and beliefs (Andrew, 2007).

Huang (2004) studied the impact of using real world settings to teach math in student mathematics performance in Taiwan. He found that extraneous information confused students who did not have prior experience with the real world setting presented in the problem. Huang (2000) concluded that providing prior exposure to the real-life situation presented in the problem could help students be more successful.

In a meta-analysis on the effect of contextualized instruction in teaching math to low achieving students, Baker, Gersten, & Lee (2002) found that it had almost no effect on instruction. The overall effect size of the studies included was .01. Two of the studies examined the effect of contextualized instruction on teaching word problems and application of concepts. These studies had both positive effect sizes. The other two studies investigated the effect of contextualized instruction on math performance. The effect sizes in these studies were negative.

### ***Project CRISS***

Project CRISS (Creating Independence through Student-owned Strategies) started in Montana in the late 1970s and then became a national project in 1985 when it was validated as an exemplary program by the National Diffusion Network of the U.S. Department of Education. Project CRISS became a private corporation in 2002 and it is currently being used in many states in the U.S., three Canadian provinces, Egypt, and Norway (Santa, Havens, & Valdes, 2004). The project emphasis is teaching students how to learn using reading, writing, and listening (Santa, Havens, & Valdes, 2004).



Project CRISS is a professional development program that uses “concepts drawn from cognitive psychology and brain research” (Project CRISS, “Principles and Philosophies”, 2008). Teachers participate in three to four day trainings where they learn the principles of learning and ready to use strategies. Although the program originally was used to teach reading and high school content areas, it is currently used by teachers from all content areas and all grade levels (Santa, Havens, & Valdes). Results from research on the positive effect of CRISS strategies in middle and high social studies, science, mathematics classrooms as well as elementary school students were consistent (Santa, 2004; Santa 1995; & Santa 1993).

Project CRISS includes more than thirty strategies that can be used across the subject areas to improve learning by focusing on vocabulary, formal and informal writing, organization of information, classroom discussions, understanding patterns and structure of reading passages, and using prior knowledge (Santa, Havens, & Valdes, 2004). Santa (1995) found that students taught using CRISS strategies were able to recall “significantly more information than students in the control group” (p. 4). Additionally, when students in the math classes were asked to identify the CRISS strategies that they found to be the most useful, students identified Venn diagrams, two-column notes, spool papers, and Know-Want to Know-Learned (KWL), (Santa, 1995).

In the CRISS manual, Santa, Havens, & Valdes (2004) described these strategies as follows:

- Venn diagrams are graphic organizers that “provide students with a structure for making comparisons” (p. 96). These consist of two circles overlapping. Students

record the differences in the two non-overlapping areas of the circles and the similarities in the common area.

- Two-column notes are used to organize information depending on the instructional goal, such as problem-solution, conclusion-support, main idea-detail, or process notes.
- Spool papers are used to teach formal writing. A spool paper “is a standard method of organization for expository text” (p.179), organized in the shape of a spool. The paper starts broad in the introduction, then it narrows in the supporting paragraphs and then it widens in the conclusion.
- KWL is a graphic organizer that allows students to activate prior knowledge, determine what they would like to know, and document what they learned.

### *SpringBoard™*

SpringBoard™ is a research-based English and Math curriculum developed by the College Board for grades 6-12. The program focuses on higher order critical thinking skills, students taking responsibility for their learning, problem solving skills, conceptual understanding, process skills, expanding vocabulary, and media literacy (College Board, Standards for Success, 2008). The program uses the College Board Standards for College Success as the framework to align with the curriculum and assessments with college readiness requirements (College Board, College Board Standards, 2008). SpringBoard integrates rigor, relevance, relationships, and results and connects a rigorous curriculum with the assessment and professional development components.

“SpringBoard provides teachers with strategies to implement and sustain increased rigor in classroom instruction” (College Board, “FAQ”, 2008). A characteristic

of the program is support for differentiated instruction for ELL and SWD subgroups through the various instructional strategies embedded in the activities. Some of these strategies include collaborative learning, contextual activities, and problem solving strategies (College Board, “FAQ”, 2008). In the problem solving category, the program includes: act out the problem, draw a sketch, identify a subtask, look for a pattern, organized lists, work backward, and write a number sentence strategies.

Many school districts have adopted this program. In fact, “more than 7,000 teachers and 600,000 students are involved in SpringBoard courses” (Administrator workshop participant booklet, 2008). Some school districts such as The School District of Palm Beach County in Florida follow a school-within-a-school choice option where students are part of a “special cadre” allowing teachers to develop close and supportive relationships with students. The program is being implemented in 13 middle schools and four high schools. SpringBoard trained teachers who receive ongoing professional development teach these courses (SpringBoard Program Description, 2008). This professional development is focused on teachers using instructional strategies and assessments embedded in relevant context, (College Board, “Professional Development”, 2008).

### ***Comparing the Effects of Instructional Strategies***

When comparing the effect of instructional strategies across countries, results revealed cross-cultural similarities. In his study from the TIMSS 1999 assessment, House (2005) examined the relationship between several instructional strategies and student interest in mathematics. He found that students in Japan and the United States showed a positive correlation between three instructional strategies – practical

applications for learning math, cooperative learning, and teacher demonstrations – and attitudes towards learning mathematics. Students taught using these three strategies consistently scored higher in the TIMSS and displayed higher levels of enjoyment for learning mathematics (House, 2005). This indicated the importance of using specific instructional strategies while teaching mathematics.

After reviewing the available literature on the impact of using real-world problems to teach mathematics, the National Advisory Panel (2008) concluded that “if mathematical ideas are taught using “real-world” contexts, then students’ performance on assessments involving similar problems is improved” (p. 50); however, students’ performance in other aspects of mathematics is not improved. Results of these studies may be affected by different factors including the fact that “teachers’ knowledge and capacity to use such problems effectively varies greatly” (p.50), as well as the fidelity of the strategy’s implementation and the complexity of its evaluation. The report expressed the need for more research to determine the use of real-world problems on different areas of mathematics, grade levels, and definitions of real-world problems. The *Panel* added that assessing the implementation of such strategy was difficult to evaluate due to other contextual factors such as socioeconomic status. These findings suggested that exposure to a particular strategy was not enough to draw conclusions. Before making inferences about the effectiveness of a strategy, researchers needed to look at the implementation of the strategy and the kind of effect studied or examined.

The 2008 National Advisory Panel Final Report provided a review of the available literature on the effect of instructional strategies in mathematics achievement and offered some important recommendations that need mention. The *Panel* found that

study results were mixed and inconclusive when it came to teacher direct instruction and student-centered instruction. The *Panel* concluded that “high-quality research does not support the exclusive use of either approach” (p.45). In the area of technology and applications of technology, the *Panel* found that the impact of calculators had limited to no effect on calculations skills, problem solving and conceptual development. However, it noted that these studies were inconclusive because they examined the use of calculators in a short-term period and no study examined the effect of long-term use of calculators. The *Panel* also found that Computer Assisted Instruction (CAI) had positive effects on mathematics achievement. Studies showed that “technology-based drill and practice and tutorials can improve student performance in specific areas of mathematics” (p. 50).

These results are inconclusive and indicate the need to explore further the effects of instructional strategies on student performance. The 2008 National Advisory Panel Final Report specifically stated the need for more research to identify effective instructional practices, materials, and principles of instructional design, as well as ways to enhance teachers’ effectiveness. The Panel added that even though the number of studies has increased in the last few years, “these studies are only beginning to yield findings, and their number remains comparatively small” (xxvi). Additionally, the effectiveness of instructional strategies on different student populations, and specific subject areas need to be studied (Marzano, Pickering, Pollock, 2001). Particularly, researchers should consider other factors affecting student performance and their relationship to instructional strategies.

### ***Instructional Decisions***

Research on instructional strategies in the area of mathematics is limited. NCTM recommended the use of student-centered strategies and *NCLB Act* (2002) required the use of research based instructional strategies. However, this review found no study aiming to identify the most frequently research based instructional strategies mathematics teachers use and the effect of these strategies on teaching mathematics.

Concurrent with these findings, Marzano, Pickering & Pollock (2001) highlighted the need to investigate the effects of instructional strategies in specific subject areas, grade levels, and type of students. Additionally, there is limited information about what influences teachers' instructional decisions such as their selection of instructional strategies. According to Maccini & Gagnon (2007), "no national information exists that examines the factors that contribute to teachers' use and frequency of use of these instructional strategies". This section reports the few studies found on teachers' use and selections of instructional strategies.

Different factors might affect teachers' decisions on the selection and use of instructional strategies. Some of them included the teacher's knowledge and familiarity of the math context, teacher preparation and their beliefs about the meaning of math (Maccini & Gagnon, 2002). In a later study, Maccini & Gagnon (2007) continued their research and examined three factors believed to contribute to teachers' use and frequency of empirically validated instructional strategies: teachers' knowledge of mathematics topics, preparation based on the number of methods courses taken, and years of math teaching experience. Results revealed that the three-predictor variables accounted for 12.4% of the variance and the only predictor variable statistically significant on the beta

weights was number of teachers' methods courses (Maccini & Gagnon, 2007). Although the study provided some insight at the possible factors influencing teachers' selection of instructional strategies, it had limitations. These limitations included a small sample size due to low survey return rate, which was less than 50%, and the inability to make comparisons between respondents and non-respondents due to confidentiality restrictions.

Lee & Olszewski-Kubilius (2006) explored gifted teachers' selection of instructional strategies. The two major factors affecting teachers' choice of instructional strategies in these gifted classrooms were time and the teachers' perception of students' capabilities. The teachers' selection process was compared in a three-week instruction course versus a nine-week instruction period. The material taught remained unchanged; however, the instructional strategies were adjusted based on time and perception of students' capabilities (Lee & Olszewski-Kubilius, 2006).

Another factor affecting the selection and use of instructional strategies was the effect of high-stakes standardized tests resulting from the accountability movement. Vogler (2002) surveyed a sample of 257 teachers who were teaching at least one math, English, or science course to determine the impact of high-stakes tests on instructional practices. The data collected showed that overall teachers had increased the use of open-response questions, creative/critical questions, problem-solving activities, the use of rubrics, writing assignments and inquiry lessons. Teachers reported a decrease in the use of multiple-choice and true or false questions, textbook based assignments, and lecturing. However, Vogler (2002) did not show results of teachers by subject; instead, he only examined overall results. It was therefore not possible to determine if math teachers adopted these strategies at the same rate as the English or Science teachers or if they

adopted them at all. The analysis of the data also showed teachers with 13-19 years of teaching reported the highest increase on the use of the strategies. The study overall indicated that the use of state mandated assessments contributed to changes in instructional practices (Vogler, 2002).

Vogler's results conflicted with findings that are more recent. For instance, Au (2007) conducted a qualitative metasynthesis of 49 qualitative studies to examine the relationship between high-stakes tests and curriculum and instruction. His findings showed that 80% of the studies reported a curricular content change resulting from the implementation of high-stakes tests. The majority of the studies reported a narrowing of curriculum. Pedagogic changes were also evident, with "a significant majority of the changes included an increase in teacher-centered instruction associated with lecturing and the direct transmission of test-related facts" (Au, 2007, p. 263). The overall results suggested that in the majority of the studies, high-stakes tests were associated with an increase of teacher-centered instruction, and content fragmentation and contraction (Au, 2007). These results just like Vogler (2002) did not disseminate the data by subject areas, which did not allow the formulation of conclusions focused specifically in math teachers' adoption of instructional strategies.

With the use of high stake state assessments comes the practice to monitor student progress through assessments. *Assessment* is the process of collecting and using data to improve teaching (Bedwell, 2004). The use of data generated from assessments related to instructional decisions. Bedwell (2004) explained that the use of the data-driven instructional model involved the "collection, analysis, and interpretation of meaningful data in order to facilitate high-quality decisions about instruction" (p.19). Even though



articles recommending the use of data to drive instruction were found (Hosp & Hosp, 2003; Moore, Dexter, Berube, & Beck, 2005; & Bedwell, 2004), limited research relating the use of data to make instructional decisions in mathematics was found.

Baker, Gersten & Lee (2002) examined the effect of using data to increase student performance through a meta-analysis. They found four studies where students and/or teachers were provided with data and feedback about the students' performance. The results showed an overall effect size of .29 in studies where teachers used the data to monitor the progress of their low achieving students, and also graphed it and shared it with their students. However, the overall effect size increased to .51 in studies where teachers monitored students progress, graphed and shared the data with their students, and received instructional recommendations based on their students' data.

The National Mathematics Advisory Panel (2008) findings were similar to those of Baker, Gersten & Lee (2002). The *Panel* found that when teachers used formative assessments, the average learning gain in mathematics was marginally significant. However, the learning gains were significant in those studies where teachers used formative assessments, received the data, and instructional suggestions based on the data.

The results presented in this section are not conclusive. Teachers make instructional decisions based on more than one factor. This section discussed those identified through the research. Factors influencing teachers' decisions include content knowledge, number of methods courses taken, number of years teaching, and the use of statewide assessments. Additional research is needed in the area to explore other factors influencing teachers' selection and use of strategies, as well as identifying the research strategies most effective in particular subject areas.

## ***Mathematics Anxiety***

Various studies have reported that mathematics self-efficacy beliefs are predictive of students' capabilities to solve mathematical problems (Pajares & Miller, 1997).

"These judgments also mediate the influence of other predictors such as math background, math anxiety, perceive usefulness of mathematics, prior achievement, and gender" (p. 214). Due to this influence, this section presents a synopsis of how mathematics anxiety affects student performance and its relationship to self-efficacy.

According to Ashcraft (2002), mathematics anxiety is "commonly defined as feeling of tension, apprehension, or fear that interferes with math performance" (p. 181). People who experience math anxiety fear and avoid dealing with numbers. These people cannot concentrate and often forget facts or concepts they are taught. The effect of mathematics anxiety may extend beyond the classroom in direct and subtle ways. "It has been suggested that mathematics anxiety may be partly responsible for the widespread anti-technological pressures in our society. Others have noted that mathematics anxiety is a contributing factor in keeping women and minorities out of the technical curricula and therefore out of the boardrooms of major corporations" (Posamentier & Stepelman, 1990, p. 211). However, Ma (1999) did not find a significant difference in gender when studying the relationship between math anxiety and mathematics achievement.

Researchers have explored the relationship between math anxiety and performance in mathematics in students as well as teachers. The development of math anxiety could be traced to the first years of schooling (Ma, 1999; Posamentier & Stepelman, 1990). In a meta-analysis, Ma (1999) found that "studies are rare in the early elementary grades" (p.18) and attributed it to the lack of instruments to measure math

anxiety at this level. Another important issue Ma identified was the significant relationship between math anxiety and mathematics achievement from grades 4 through 12, and he argued that math anxiety might be the reason for a decrease in mathematics achievement during early secondary years. According to Posamentier & Stepelman (1990), math was regarded as a difficult subject and something to fear that only the very bright students could do. However, math anxiety and overall intelligence were weakly related with a  $-.17$  correlation (Ashcraft, 2002).

Ashcraft (2002) stated that the causes of math anxiety were not yet determined. Conversely, Furner & Berman (2003) claimed that negative dispositions resulting from parents' negative "attitude or limited experience with math" (p. 171) may cause math anxiety. They argued that it was important for teachers to distinguish between preventing math anxiety and reducing math anxiety. In their view, teachers could prevent math anxiety using instructional strategies such as incorporating writing in the math curriculum, teaching critical thinking, using alternative forms of assessments, and working collaboratively with other teachers (Furner & Breman, 2003). Posamentier & Stepelman (1990) also suggested some strategies teachers could use to help students reduce their level of anxiety. These included: relax and enjoy while teaching, curb excessive competitiveness, eliminate timed tests, praise students' efforts, do not humiliate students when they cannot answer a question, have a sense of humor, do not punish students by giving them extra math problems, incorporate reading strategies in math, treat both genders equal, discuss the difficulties of the lesson, involve students in class discussions, and ask them to develop their own math problems.

Math anxiety has been viewed as a subject specific test anxiety (Zettle, R., & Raines, S., 2000). “Individuals who are high in math anxiety also tend to score high in other anxiety tests. The strongest interrelationship is with test anxiety, a .52 correlation” (Ashcraft, 2002, p. 182). Numerous researchers applied the theoretical models of test anxiety to math anxiety (Ho, Senturk, Lam, Zimmer, et al. 2000). One of these models was a two-factor model composed of an affective component and a cognitive component. Ma (1999) found few studies focused on the cognitive factors and underscored the potential value of these to develop treatments for math anxiety. These findings were consistent with a study conducted by Maier & Curtin (2005) showing students attending “therapy sessions” focused on skill development, improved more than students who did not attend the sessions.

Studies have shown a significant negative relationship between cognitive test anxiety and test performance; however, the literature findings showed mixed results. In a cross-national study comparing the dimensionality and level of math anxiety across sixth grade students in China, Taiwan and the U.S., Ho et al. (2000) found that the affective factor was “consistently related to mathematics achievement for all three national samples whereas the cognitive factor yields inconsistent results across the samples” (p. 18).

Research on math anxiety in teachers has focused especially on pre-service teachers since “math anxiety is an extremely common phenomenon among college and university students today” (Malinski, Ross, Pannels, & McJunkin, 2006, p.274). These studies were motivated from concerns that math anxiety might affect teacher effectiveness (Malinski et al., 2006; Tooke & Lindstrom 1998). Methods courses

designed to teach pre-service teachers how to teach math instead of just teaching them the math, significantly reduced the level of anxiety experienced by pre-service teachers (Tooke & Lindstrom, 1998). Malinski et al. (2006) studied the level of math anxiety of pre-service teachers in various subject areas and their results suggested that some students indeed experience math anxiety.

Studies on math anxiety consistently found it to affect performance negatively (Ho et al., 2000) and it should not be ignored when examining the factors affecting student performance in mathematics or when examining the factors affecting teacher effectiveness. Maier & Curtin, (2005) concluded that through their “math therapy sessions” they could increase students’ self-efficacy and decreased math anxiety. Therefore, self-efficacy beliefs of the student and the teacher could influence math anxiety.

### ***Self-efficacy and Instruction***

Effective instruction does not depend only on one factor. Instead, it is the interplay of a number of factors that determines student success. As noted in Marzano et al. (2001), effective pedagogy involves three related areas provided and developed by teachers: instructional strategies, management techniques, and curriculum. In addition to these areas, educators affect instruction in subtle ways. Specifically, teachers’ view of themselves influences their teachers’ role and their choices in the classroom (Pajak, 2003). Students also play a crucial role in instruction as they enter the classroom with different intelligences, interests, dispositions, and beliefs about their capabilities. Being aware of the aforementioned is a way in which teachers get to know their students better, their needs and “tap into their preferences through intentional planning, explore the

diversity that they bring to the classroom, and make the right choices” (Gregory, 2005, p. 3). With all the variances involved in the instructional process, researchers have not just focused on the effect that instructional strategies have on performance but have also included other variables such as interest, learning styles, motivation, attitude, and self-efficacy beliefs.

### ***Self-efficacy, Instructional Strategies and Performance***

This portion of the review focused on studies relating the effects of instructional strategies, self-efficacy beliefs and student performance. In some cases, research has been complex and included several strategies at one time. Marat (2005) studied the relationship between motivational strategies, cognitive and metacognitive strategies, self-regulated learning, and resource management strategies and academic achievement in mathematics. The results demonstrated that these strategies and self-efficacy in mathematics curriculum affect academic achievement. Wadsworth et al. (2007) examined the effects of self-efficacy and cognitive and motivational strategies on online mathematics achievement and found that these impacted student performance.

Other studies focused on a specific instructional strategy at a time. While studying the relationship between self-regulation strategies, self-efficacy and student achievement, Mousoulides (2005) found a positive relationship between self-efficacy and math achievement and a negative relationship between self-regulation strategies and math achievement. This was contrary to findings showing a positive relationship between self-regulated learning and student performance in mathematics (Pape & Smith, 2002). In the area of reading, direct instruction was consistently identified to be an effective way to

improve student performance by increasing student interest as well as self-efficacy (McCrudden, Perkins, & Putney, 2005; Nelson, Manset-Williamson, 2006).

This body of research was extensive and results seemed to indicate the importance and need to explore further the relationship between self-efficacy, instructional strategies and student performance. The instructional strategies teachers used in the classroom indeed influenced students' understanding of mathematics, their confidence to solve the problems, their ability to apply the new knowledge and their attitudes towards learning (Principles and Standards, 2000). Self-efficacy affected the processes students and teachers went through during the learning process. Self-efficacy influenced students' motivation, perseverance and disposition to acquire a skill and "children with the same level of cognitive skill development differ in their intellectual performance depending on the strength of their perceived self-efficacy" (Bandura, 1993, p. 136). Thus, the combination of effective instructional strategies and self-efficacy beliefs could contribute to student success.

### ***Teacher Self-Efficacy, Collective Efficacy and Performance***

The literature underscored the key role of the teacher in the instructional process. Studies showed that "an individual teacher can have a powerful effect on her students *even if the school doesn't*" (Marzano, Pickering, & Pollock, 2001, p.2). With results showing that U.S. students are not scoring as high as other industrialized countries and the mandates of the *NCLB Act* (2002), teachers' impact in the classroom can now be monitored through data disaggregated from state standardized assessment results. In addition, there is an added focus on identifying ways to improve teacher performance and effectiveness in the classroom.

Teachers in the U.S. structure their lessons in similar ways, beginning with a review, followed by the presentation of the new material and ending with a practice (Givvin, Hiebert, Jacobs, Hollingsworth, & Gallimore, 2005). However, the presentation of the new material varies from teacher to teacher. What could be the reason for these variations? One possible reason may be the teachers' instructional self-efficacy.

Bandura (1997) explained that teacher's self-efficacy beliefs influenced not only their orientation towards instruction but also the specific instructional activities they chose. Teachers with low instructional self-efficacy "favor a custodial orientation that relies heavily on extrinsic inducements and negative sanctions to get students to study" (Bandura, 1993, p.140) and those with high instructional self-efficacy tended to focus on developing students' intrinsic interest and self-directed learning. Teachers' instructional self-efficacy contributed to the way teachers structured their academic activities in the classroom, which in turn affected their students' academic development and self-efficacy beliefs (Pajares & Urdan, 2006). Although this review did not find research studies relating specific instructional strategies to mathematics teachers' self-efficacy, relationships between teachers' self-efficacy and their instructional strategies have been examined in subject specific research studies in the areas of science, and English (Pajares & Urdan, 2006).

Studies repeatedly demonstrated that teachers' self-efficacy influenced student performance (Ross, Hogaboam-Gray, Hannay, 2001; Tucker et al. 2005). Low-performing students who were moved from a teacher with low self-efficacy to a teacher with high self-efficacy, set higher academic expectations for themselves; furthermore when low-achieving students moved from a high self-efficacy teacher to a low self-



efficacy teacher, students tended to set lower expectations for themselves (Bandura, 1998).

Teacher self-efficacy affected student performance in two ways. First, it affected the quality of instruction in their individual classroom. According to Bandura (1998), highly efficacious teachers spent more time in academic activities and less time dealing with disciplinary issues. They also provided guidance for students and praised them for their academic accomplishments. On the other hand, teachers with a low sense of instructional self-efficacy gave up on their students, criticized them when they made mistakes and believed that students' low performance was the result of factors outside the school such as the home environment (Bandura 1998). Teacher self-efficacy also influenced teachers' choice of academic activities. Those with higher self-efficacy tended to be more enthusiastic, organized, open to new ideas, and used more complex teaching methods instead of lectures (Pajares & Urdan, 2006).

Outside the classroom, teachers are part of a social system responsible for creating the school culture. Although teachers work could be isolated in their classrooms, the social influence of the school culture had an effect on their thought and beliefs (Goddard, Hoy & Woolfolk, 2004). Research suggested that there was a strong relationship between teachers' self-efficacy and perceived collective efficacy. In fact, "a strong sense of collective efficacy enhanced teachers' self-efficacy beliefs while weak collective efficacy beliefs undermine teachers' sense of efficacy, and vice versa" (Goddard, Hoy & Woolfolk, 2004, p. 8).

The quality of leadership influenced collective school efficacy since strong principals had the ability to create a shared vision and empower their staff. In schools

where staff believed that they did not have the power to move their students to achieve success, there was a collective sense of academic futility and an environment not conducive to learning (Bandura, 1993). This was opposite to schools where staff believed they were capable of promoting academic success; in these schools, there was a positive learning environment and high collective school efficacy. Overall, the findings highlighted the importance of studying the relationship of self-efficacy, instruction and performance.

### **Conclusion**

The purpose of this literature review was to analyze the theoretical and empirical literature, which emphasized the impact of instructional strategies and self-efficacy on student performance. The focus was to examine the instructional strategies mathematics teachers used and how these strategies affected instruction. Specifically, a closer look at the relationship between teacher self-efficacy, instructional strategies and student performance were explored to identify problem areas and future areas of scholarly inquiry.

Student performance was defined through data analyzed and compared at the state, national, and international levels. This research identified mathematical and critical thinking skills acquired through math courses as being important for success in today's technological society. Research studies positively related success in mathematics to success in college (Achieve.org, 2007; Dorner & Hutton, 2002; Hagedorn, Siadet, Fogel, Nora & Pascarella, 1999; Moreno & Muller, 1999). Results from the *TIMSS* showed that U.S. students were performing slightly above average and students from certain other industrialized nations were outperforming U. S. students ("Special Analysis", 2006). On

the other hand, results from the *PISA* showed that U.S. students scored lower than the OECD average, (*PISA 2006: Science competencies*). At the national level, the achievement gap remained unchanged since 1990 despite gains by students at all levels of performance in mathematics; with the exception of the White-Black Gap (*Nation's Report Card, 2007*).

The federal government stepped in through its enactment of the *NCLB Act (2002)* requiring States to develop challenging standards in mathematics that would ensure that every child received a quality education. The annual assessment of these standards and the desegregation of data added accountability for schools with the purpose of ensuring all students made progress. The *NCLB Act (2002)* went further and required schools to use research-based strategies. However, as previously mentioned, research based mathematics strategies are relatively a new area (“The Facts about Math,” 2006, our nation must research). Additionally, this review found that research on subject specific strategies was needed (*Marzano, Pickering & Pollock, 2001*).

The NCTM played a pivotal role in raising the mathematics achievement bar. The *NCLB Act (2002)* required each State to develop its own set of standards and the majority of them used the NCTM Standards to develop their own standards. In addition to providing standards, NCTM went further to suggest effective ways to introduce mathematical concepts and endorsed the use of student-centered strategies.

The *NCLB Act* stated, “the federal government will invest in educational practices that work” (*The facts about investing in what works, 2004, para. 3*) acknowledging the importance of research based instructional strategies as one of those practices. In addition, the NCTM recommendations were very consistent with the literature indicating

that instructional strategies were one of the key factors affecting student performance in mathematics. Concurrently, the *theory of multiple intelligences* underscored the importance in using MI ideas in instruction to activate in many ways the different intelligences and improve the learning environment. These ideas could be implemented through the careful selection and use of instructional strategies geared towards the needs of the student. Likewise, *experiential learning theory* emphasized the key role of the learning experience, which assumed that students built knowledge throughout each stage of the learning process. Finally, research on self-efficacy demonstrated that enactive mastery experiences were the main source of self-efficacy, which alone can have an impact on performance above skills and knowledge. Therefore, multiple sources agree that instructional strategies used during each learning experience affected the learning process from every angle.

Instructional strategies were classified using different criteria, some general and others more specific. For instance, Saskatchewan Education (1991) identified five different instructional strategies – direct, indirect, interactive, experiential or independent, whereas Marzano, Pickering & Pollock (2002) identified nine broad research-based instructional strategies. However, under each classification, these categories converged in the majority of instructional strategies i.e. cooperative learning, direct instruction, class discussions, projects, manipulatives, graphic organizers, and centers.

For the most part, studies that examined the effect of these strategies in specific subject areas combined them with other constructs packaged into a structured program or considered them as part of a professional development component. These packages or components were not necessarily used by teachers or available to every school. Haas

(2002) in his dissertation explored the effect of instructional strategies used in Algebra and Pre-Algebra classrooms. His findings showed that direct instruction, technology aided instruction, and problem-based instruction were effective strategies for teaching algebra (Haas, 2002). This study was the only one of its nature found in the literature review. Such studies seem needed and could provide math teachers with the most effective instructional strategies in the area.

According to Marzano, Pickering & Pollock (2001), the analysis of the effect of instructional strategies on specific subject areas needed to include also information about their impact on specific groups of students. Identifying the strategies that are most effective in teaching mathematics could provide math teachers with a repertoire of strategies. This could benefit them in two ways. First, it would assist in the selection of the math instructional strategies best suited for their students. Second, it would contribute to increasing motivation, interest, engagement, and reduced anxiety of both students and teachers because positive mastery experiences would improve student self-efficacy. Hall & Poton (2005) explained that, students' past experiences in math contributed to students' opinion about their mathematical abilities and career choices in math.

In addition to identifying effective mathematics specific instructional strategies, the literature suggested to look at other factors that affect student performance. Motivation, engagement, math anxiety, self-efficacy, and instructional strategies were factors repeatedly identified in the literature as influencing student performance in mathematics. Most notably, self-efficacy significantly affected motivation, engagement,

and math anxiety and the research identified it as influencing performance in mathematics. Consequently, the key theory used in this review was *self-efficacy theory*.

The four sources of self-efficacy are enactive mastery experiences, vicarious experiences, verbal persuasion, and psychological and affective states (Bandura, 1997). Enactive mastery experiences were identified as the most influential because they provided a “stronger and more generalized efficacy beliefs” (p. 80), which emphasized the importance of enactive mastery experiences in developing high self-efficacy beliefs.

The importance of enactive mastery experiences placed within the context of education emphasized the importance of selecting and using the instructional strategies that provide the best possible experiences for students in the classroom. There was a link between students’ experiences or activities and the instructional methods or strategies used. In fact, the instructional method determined the nature of the activity used in the creation of a learning environment (Saskatchewan Education, 1991). Thus, there may be a relationship between instructional strategies and self-efficacy. Even though the primary researcher found extensive research in the relationship of instructional strategies and self-efficacy as it related to the student, this review found limited information in the relationship between teachers’ instructional self-efficacy and instructional strategies.

Teachers play a key role in the delivery of instruction; research showed that even when the school is relatively ineffective, an individual teacher had a powerful effect on her students’ learning (Marzano, Pickering, & Pollock, 2001). Teachers’ perceived self-efficacy beliefs affect their attitudes and motivation. Teachers with low self-efficacy beliefs often blamed the lack of student success to factors outside their control such as students’ home environment, lack of motivation and parental support, and students’

limited skills (Bandura, 1997). Teachers' self-efficacy beliefs influenced their instructional preferences and the specific instructional activities chosen (Bandura 1997). Pajak (2003) similarly described teachers' view of themselves as affecting their choices in the classroom. Pajares & Urdan (2006) described a relationship between teachers' motivation, effort, enthusiasm, and the use of instructional methods requiring a more student centered approach. However, research that related teachers' instructional self-efficacy and selection of instructional strategies in mathematics was limited.

As previously addressed, self-efficacy was a factor that influenced academic performance. Since the main source of self-efficacy was enacted mastery experiences, it could be inferred that self-efficacy could be linked to instruction through the mastery experiences that teachers provide for students, which can ultimately impact students' performance. With the use of effective instruction strategies, teachers could ensure that their approach would reach their targeted audience. According to Saskatchewan Education (1991), instructional strategies determined the specific type of activity teachers could use to achieve their learning objectives. Identifying the specific instructional strategies that mathematics teachers use and investigating how teacher self-efficacy relates to their instructional strategies could be used to improve student performance, which has been identified as an area for future research.

## CHAPTER III

### RESEARCH METHODOLOGY

The following chapter describes the methodology used to investigate the relationship between teachers' self-efficacy and the instructional strategies used by mathematics teachers. The research questions and hypotheses resulted from gaps in the literature and the dearth of research exploring the influence of mathematics teachers' self-efficacy in their use of instructional strategies. This chapter begins by describing the purpose of the study and continues with the research design, study's population and sampling plan, instrumentation, data collection procedures and ethical aspects, data analysis methods, and finishes with the evaluation of this study's research methods.

#### **Purpose of the Study**

The purpose of this study was to examine the relationship between teachers' self-efficacy as measured by the Teachers' Sense of Efficacy Scale (TSES) (See Appendix A) (Tschannen-Moran, & Woolfolk Hoy, 2001) and type of instructional strategies used by mathematics teachers as measured by the Teachers' Instructional Practices Survey (TIPS) (See Appendix C). Subject specific research studies in the areas of science, and English examined relationships between teachers' self-efficacy and their instructional strategies (Pajares & Urdan, 2006). The influence of instructional strategies and student performance were related in other studies but the results were generalized across all subject areas (Marzano, Pickering & Pollock, 2001). However, there was limited research in the area of mathematics (Graham, Bellert, Thomas, & Pegg, 2007; Foundations for Success, 2008). Therefore, this study examined how self-efficacy and teachers' instructional strategies were related.



## **Research Design**

This study used an exploratory quantitative research design, and employed two survey instruments containing Likert scale questions. The primary investigator surveyed middle school mathematics teachers who were members of the Florida Council of Teachers of Mathematics. This exploratory study examined the relationship between teachers' self-efficacy and their use of instructional strategies.

The data collected and analyzed included the teachers' self-efficacy level and their instructional strategies to determine if there was a difference in the use of instructional strategies by teachers with different levels of self-efficacy. Additionally, this study analyzed demographic information, specifically gender, race/ethnicity, number of years teaching mathematics, type of teaching certificate, and highest level of education achieved of the participants. The research determined whether these variables affected the relationship between self-efficacy and instructional strategies through the analysis of this data.

TSES, TIPS, and Demographic Characteristics Surveys integrated onto the SurveyMonkey.com were utilized to collect the quantitative data (see Appendix A; Appendix C; & Appendix E). The researcher used inferential statistics, a statistical analysis used to compare or relate two or more variables (Creswell, 2005). The primary investigator utilized a Multivariate Analysis of Variance (MANOVA) tests to examine the data.

The dependent variables were the instructional strategies used by mathematics teachers as measured by the TIPS (See Appendix C) and teacher self-efficacy as measured by the TSES (See Appendix A). The independent variables were teacher

demographics (See Appendix E), gender, race and ethnicity, number of years teaching mathematics, type of teaching certificate, and highest level of education achieved, and teacher self-efficacy as measured by the TSES (See Appendix A). Other variables not included, which may have affected the results of this study, were mathematics teachers' preferred courses for teaching and collective teacher self-efficacy.

This research design resulted from considering previous investigations and gaps noted in the literature. The following research questions and hypotheses intended to address some of these areas.

### **Research Questions**

Q1. Does the level of self-efficacy of middle school mathematics teachers differ based on their demographic characteristics (gender, race and ethnicity, level of education, type of certificate, and years of experience)?

Q2. Is there a difference in the instructional strategies used by middle school mathematics teachers based on their levels of self-efficacy?

### **Research Hypotheses**

H1. Middle school teachers of mathematics with higher levels of education, or experience will report higher levels of self-efficacy. ( $\alpha = .05$ )

H2. Middle school teachers of mathematics with higher levels of self-efficacy will use different instructional strategies from middle school teachers of mathematics with lower levels of self-efficacy. ( $\alpha = .05$ )

### **Independent Variables**

The independent variables were the following:

Teacher self-efficacy – Teacher sense of self-efficacy as measured by the TSES (See Appendix A), which measures teacher’s self-efficacy using a Likert scale questionnaire that is categorized under three factors, efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement. Teacher self-efficacy is “judgment about capabilities to influence student engagement and learning, even among those students who may be difficult or unmotivated (Pajares & Urban, 2006, p. 117).

Teacher demographics (See Appendix E) – Gender (dichotomous), race/ethnicity (nominal), number of years teaching mathematics (interval), type of teaching certificate (nominal), and highest level of education achieved (nominal).

### **Dependent Variables**

The dependent variables in the study were instructional strategies derived from the (TIPS) (See Appendix C) and teacher self-efficacy as measured by the (TSES) (See Appendix A):

Instructional strategies – A continuous variable representing the frequency that mathematics teachers use these strategies. Instructional strategies “determine the approach a teacher may take to achieve learning objectives” (Saskatchewan Education, 1991, para. 10). Instructional strategies were classified under the six broad categories identified by Haas (2002) in his dissertation as having the greatest mean effect sizes. He identified these categories through a meta-analysis that synthesized research studies from 1980 to 2001 on methods for teaching algebra (or pre-algebra) at the secondary level.

These include:

Cooperative learning – “is a method of instruction characterized by students working together to reach a common goal” (Haas, 2002, p.50).

Communication and study skills – involves teaching students to read and learn mathematical information in an effective manner and provides students with the opportunity to communicate their ideas in writing or verbally (Haas, 2000). CRISS strategies such as Venn diagrams, two-column notes, spool papers, and KWL fall under this category.

Direct instruction - is the teaching of concepts, rules, principles and problem solving strategies in an explicit manner (Baker, Gersten, & Lee 2002).

Technology aided instruction – is “instruction characterized by using computer software applications and/or hand-held calculators” (Haas, 2002, p.55).

Problem-based learning – “is teaching through problem solving where students apply a general rule (deduction) and draw new conclusions or rules (induction) based on information presented in the problem” (Haas, 2002, p. 57). This is similar to contextualized instruction, the approach that stresses the use of real-world applications and focuses on understanding underlying concepts of authentic problems (Baker, Gersten, & Lee 2002).

Manipulatives, models and multiple representations – is an instructional strategy that focuses on teaching students how to represent algebraic concepts in either a concrete, symbolic or an abstract form (Haas, 2000). NCTM (2000) also categorized these instructional as student-centered strategies and highly encouraged mathematics teachers to use them.

Teacher self-efficacy – Teacher sense of self-efficacy as measured by the TSES (See Appendix A), which measures teachers’ self-efficacy using a 12 questions likert scale questionnaire.

## **Population and Sampling Plan**

### ***Target Population***

A target population is a group of individuals that share the same characteristics (Creswell, 2005). The target population for this study consisted of middle school mathematics teachers in the state of Florida. The Florida Department of Education reported that there were 11,401 secondary (6-12) mathematics teachers in Florida (Critical Shortage Areas, 2008) and it was estimated that approximately 4,800 of the secondary mathematics teachers were middle school teachers.

### ***Eligibility-Inclusion criteria***

The investigator included the following teacher population in this study:

1. Middle school teachers of mathematics employed in the State of Florida who were members of the Florida Council of Teachers of Mathematics (FCTM).
2. Middle school teachers of mathematics who were FCTM members working in Florida middle schools and teaching five mathematics classes.

### ***Eligibility-Exclusion criteria***

The investigator included the following participants in this study:

1. Any teacher outside of the targeted area.
2. Teachers who were not members of the Florida Council of Teachers of Mathematics.
3. Teachers whose job responsibilities included teaching subjects other than mathematics.

### *Sample Population*

The sample is “a subgroup of the target population that the researcher plans to study for generalizing about the target population” (Creswell, 2005, p. 146). This research used convenience sampling. According to Creswell (2005), convenience sampling includes participants that are “willing and available to be studied” (p. 149). The sample population for this study included approximately 350 middle school mathematics teachers in the State of Florida who were members of the Florida Council of Teachers of Mathematics.

### *Setting*

To ensure confidentiality, the primary investigator e-mailed the invitation to participate in the study to the FCTM President. She forwarded the invitation to the FCTM Regional Directors for dissemination to local affiliates. Additionally, the FCTM President mentioned the research in the Florida Council of Teachers of Mathematics Journal and Spring Newsletter. The invitation directed participants to log on to the FCTM website and click on the secure SurveyMonkey website link, named Self-Efficacy and Instruction Research Study, to access the surveys. SurveyMonkey.com used Secure Socket Layer (SSL) encryption (See Appendix K) for both the survey link and survey pages during transmission. SurveyMonkey did not record any personal identification information including e-mail address and IP address. The primary researcher accessed no identifying information while conducting this project. Each teacher participant completed the online version of the surveys (See Appendix A; Appendix C; & Appendix E) individually and submitted it once it was completed.

## Instrumentation

This study included two questionnaires, the TSES (See Appendix A) and TIPS (See Appendix C). These surveys took participants approximately ten to fifteen minutes to complete. Additionally, the researcher included five demographic questions, which took less than one minute to complete.

### *Teachers' Sense of Efficacy Scale (TSES)*

Tschannen-Moran & Hoy developed the TSES instrument in 2001. They examined five of the self-efficacy measurement instruments that existed at that time and compared their validity and reliability. These five instruments included the *teacher efficacy (TE)* instrument created by Rand researchers in 1976, the *responsibility for student achievement (RSA)* instrument by Guskey (1981), the *teacher locus of control (TLC)* by Rose and Medway (1981), the *teacher efficacy scale (TES)* by Gibson and Dembo (1984), and the 30-item *teacher self-efficacy scale* by Bandura (1997). The Gibson & Dembo's *TES* built upon the self-efficacy concepts used by the Rand studies and added self-efficacy concepts introduced in Bandura's *Social Cognitive Theory* (Tschannen-Moran & Hoy, 2001).

Tschannen-Morgan & Hoy (2001) established the relationships between the five self-efficacy instruments and they stated, "these measures are describing related constructs, but overlap is not perfect" (p. 792). They decided to develop a new measure that captured the best way to best measure teacher efficacy. Bandura (1997) warned researchers not to create omnibus tests including "personal attributes designed to serve diverse purposes" (p. 39). He specifically suggested to avoid writing item scales not presented within the context of the particular situations relevant to the area or the domain

under analysis. Pajares (1996) added that “global measures obscure what is being measured” (p.794) but also noted that self-efficacy instruments’ specificity and precision could compromise its external validity and relevance.

To develop the TSES, a team of two researchers and eight graduate students with teaching experience ranging from 5 to 28 years, was formed. The group chose a measure based on Bandura’s scale and expanded the list of items to include more items about teacher capabilities. The first study included a 52 items scale with 23 out of the 30 items of Bandura’s scale were retained. The instrument named the *Ohio State teacher efficacy scale* (OSTES) underwent three studies to refine it before finalized. The results were a short and a long version, both with high reliability. The long version was a 24-item scale with a reliability of .94 and the short version was a 12-item scale with a reliability of .90 (Tschannen-Moran & Hoy, 2001).

The construct validity was assessed by examining “the correlation of this new measure and other existing measures of teacher efficacy” (Tschannen-Moran & Hoy, 2001, p.801). Participants in the third study responded to the *OSTES* as well as the *TE* and the Hoy and Woolfolk (1993) 10-item adaptation of the Gibson and Dembo *TES*. Total scores on the OSTES (long form) were positively related to the TE items ( $r=.18$  and  $r=.53$ ,  $p<.001$ ) and the two factors of the Gibson and Dembo measure ( $r=.64$  and  $r=.16$ ,  $p<.001$ ). Similarly, total scores on the OSTES (short form) were positively related to the TE items ( $r=.18$  and  $r=.52$ ,  $p<.001$ ) and the two factors of the Gibson and Dembo measure ( $r=.61$  and  $r=.16$ ,  $p<.001$ ) (Tschannen-Moran & Hoy, 2001).



### *Teachers' Instructional Practices Survey (TIPS)*

Haas (2002) designed the TIPS as part of his study to determine the influence of teaching methods on student achievement. He developed the instrument after synthesizing research findings on the methods for teaching Algebra and algebraic concepts in grades 7-12. The purpose of this instrument was to identify the instructional strategies used by mathematics teachers and use it to compare these strategies to student achievement on the Virginia's end of the course Algebra assessment. He developed this survey using Dillman's Total Design Method for surveys, and he grouped teaching methods in six broad categories derived from a meta-analysis he conducted.

Haas (2002) selected the studies in his meta-analysis based on the following criteria:

1. Studies between 1980 and 2001 at the secondary level (grades 7-12) with a focus on algebra instruction
2. Experimental design studies where the dependent variable was a measure of the subject's algebra knowledge and skills achievement
3. The method of instruction in the study dealt with algebra knowledge and skills achievement

The three Algebra Course levels included in the meta-analysis were pre-algebra, algebra or advanced algebra. Haas (2002) tabulated the size effects of the instructional strategies used in these studies and then classified them into six broad categories. He clarified that these six teaching methods categories "should not be considered mutually exclusive because one method may contain another" (p.33); therefore studies using

combinations of teaching methods were classified into a category using the definition of the teaching method and the description of the purpose of the study.

To determine the effectiveness of an instructional strategy, Haas (2002) used the effect sizes. The effect size is “the difference between treatment and control group means on a measurement of algebra knowledge and/or skill divided by the standard deviation of the control group” (p. 35). Using effect sizes provided the researcher with a standardized unit of measurement to make comparisons.

The first version of the survey resulting from the meta-analysis had seven categories of teaching methods for teaching algebra and 114 questions. The first round of the instrument validation was given to a class of secondary mathematics teaching methods students. Participants had to place the item in a category of teaching methods. Items were included in the final version of the instrument if 80% of the participants placed it in a category. After the first round, the research team dropped one of the seven categories “because it appeared ambiguous to the content validation experts” (Haas, 2002, p. 74). The instrument changed to six categories of teaching methods and questions eliminated. The second round of the instrument validation given via e-mail used the same criterion for retaining items as the first round.

Administering the questionnaire to a sample of 15 high school mathematics teachers tested the reliability of the instrument. The data analysis for internal consistency was the split-half technique. The reliability coefficient of  $r=.89$  was obtained after using the Spearman-Brown prophecy formula.

## ***Teacher Demographic Characteristics Survey***

The researcher created an instrument to collect information about teachers' demographic characteristics (Appendix E) for the purpose of data analysis. This five-question survey included information about gender, race/ethnicity, number of years teaching mathematics, type of teaching certificate, and highest level of education achieved. This instrument was as reliable and valid as the self-reporting participant was in responding to the items.

### **Procedures**

#### ***Ethical Considerations***

The primary researcher invited middle school mathematics teachers to participate in the study through an invitation (See Appendix I) sent to the FCTM President and disseminated through the Regional Directors. Additionally, the FCTM President mentioned the study in the FCTM Journal and Spring Newsletter. In the invitation, teachers were directed to the secure SurveyMonkey.com website link posted in the FCTM website to access the online versions of the surveys. They clicked on the link to complete the surveys, which was available for five weeks. They submitted the survey responses by clicking the submit button at the end of the surveys. As ethical considerations, teachers were not asked to provide any identifying information and the researcher followed the necessary procedures to avoid coding errors.

#### ***Data Collection Methods***

The researcher followed these steps:

1. Downloaded permission letter to use the TSES instrument from Hoy and Tschannen-Moran (see Appendix B) from the Ohio State University

website. Tschannen-Moran & Hoy (2001) copyrighted the instrument; however, they indicated that there were no copyright restrictions on the instrument when it was used for scholarly research or non-profit educational purposes. The authors made available online the permission letter for individuals conducting scholarly research.

2. Obtained permission to use the TIPS from Haas (see Appendix D).
3. Obtained approval from FCTM (Appendix G & Appendix H).
4. Created invitation (see Appendix I) that was distributed to eligible participants.
5. Integrated the TSES and the TIPS onto the SurveyMonkey.com website and created a viable link to the survey, which was posted in the FCTM website:  
  
[https://www.surveymonkey.com/s.aspx?sm=Thic4dIcYyDkVUnLfiBDZg\\_3d\\_3d](https://www.surveymonkey.com/s.aspx?sm=Thic4dIcYyDkVUnLfiBDZg_3d_3d).
6. Obtained Institutional Review Board approval for the study from Lynn University. The following required forms: IRB Form 1 – *Application and Research Protocol for Review of Research Involving Human Subjects in a New Project IRB* and the IRB Form 3 – *Request for Expedited Review* were submitted to Lynn University Institutional Review Board.
7. Provided FCTM President with copy of approved Lynn University IRB Form (see Appendix J) and confirmed data collection period which was expected to start April 24, 2009 and end by May 28, 2009. The data

collected was accessed by the researcher on the SurveyMonkey secured website with a username and password.

8. Sent FCTM President the SurveyMonkey link to be placed on the FCTM website. The link was named "Self-Efficacy and Instruction Research Study".
9. Sent FCTM President the electronic copy of the invitation (See Appendix I) requesting middle school mathematics teachers to participate in the study. She e-mailed the invitation and the hyperlink to Regional Directors for dissemination to local affiliates.
10. Provided potential participants with the eligibility criteria within the first three pages of the survey to reduce the chance that individuals not meeting the criteria complete the survey. (Appendix F)
11. If the participants met the criteria (they were currently middle school mathematics teachers in Florida, FCTM members teaching five mathematics courses and were at least 21 years of age) and wished to continue, they read the Voluntary Consent Form and indicated they agreed by clicking the "I Agree" option to take the survey. If the participant did not agree, then they clicked the "Exit this survey" option and they were returned to the FCTM website.
12. Sent two follow-up emails to the FCTM President which she forwarded to the Regional and Local FCTM representatives as a reminder.
13. Downloaded the data collected and transferred it to Microsoft Excel.
14. Coded and downloaded data into SPSS (Version 17.0).

15. Submitted IRB Report of Termination of Project to Lynn University within four weeks of the conclusion of the data collection.
16. Performed data analyses using SPSS (Version 17.0).
17. Stored data on a password-protected computer.
18. Kept all surveys at the researcher's office in a locked file cabinet.
19. Retained data for five years. After five years, the researcher will destroy all data.

### **Data Analysis**

After administering the two instruments and the demographic information questionnaire, the primary investigator entered the data into the Statistical Package for the Social Sciences (SPSS) (Version 17.0), which was a computer program used for statistically analysis. The researcher checked for coding errors using a frequency distribution, and estimated the reliability using the Cronbach's Alpha formula. The researcher also checked the criterion-related validity using a MANOVA.

#### ***Objective of Research Question 1 and the Means to Answer***

Does the level of self-efficacy of middle school mathematics teachers differ based on their demographic characteristics (gender, race/ethnicity, level of education, type of certificate, and years of experience)? The objective was to determine if mathematics teachers' with different demographic information showed a difference in their sense of self-efficacy. The primary researcher answered this question by comparing TSES (See Appendix A) results of teachers with different gender, race/ethnicity, number of years teaching mathematics, type of teaching certificate, and highest level of education achieved utilizing MANOVA. The MANOVA analyzed the difference between the

demographic variables and the teachers' level of self-efficacy as well as the difference within these variables.

### ***Objective of Research Question 2 and the Means to Answer***

Is there a difference in the instructional strategies used by middle school mathematics teachers based on their levels of self-efficacy? The objective was to determine if teachers with different levels of self-efficacy used similar or different instructional strategies to teach mathematics. The primary researcher answered this question by examining the TIPS results of teachers with different levels of self-efficacy as measured by the TSES utilizing MANOVA. The MANOVA analyzed accuracy and compared the results between teachers' level of self-efficacy and their instructional strategies.

### ***Methodology to test Hypothesis 1***

Middle school teachers of mathematics with higher levels of education, or experience will report higher levels of self-efficacy. Teachers had different levels of self-efficacy depending on the demographic variables. The methodology included a comparison between the results of the teachers' sense of self-efficacy level and demographic variables utilizing MANOVA tests.

### ***Methodology to test Hypothesis 2***

Middle school teachers of mathematics with different levels of self-efficacy will use different instructional strategies from middle school teachers of mathematics with lower levels of self-efficacy. The level of self-efficacy affected the instructional strategies mathematics teachers used. The methodology included a comparison between

the teachers' self-efficacy level and their instructional strategies utilizing MANOVA tests.

## **Evaluation of Research Methods**

### ***Internal Validity***

Internal validity “refers to the extent to which we can accurately infer that the independent variable caused the effect observed on the dependent variable” (Christensen, 2004, p. 198). This study did not include a pretest (history) that might have influenced the outcome. Subjects did not mature (maturation) since the collection of the data took place only at one point in time. The TSES and the TIPS were reliable instruments allowing for strength of internal validity. However, the use of a convenience sample presented a threat to the internal validity of the study because it may have created a selection bias.

### ***External Validity***

External validity is “the extent to which the variable relationships can be generalized to other settings, other treatment variables, other measurement variables, and other participant populations” (Best & Kahn, 1993, p. 140). This study used a sample population of middle school mathematics teachers in the Florida who were members of the Florida Council of Teachers of Mathematics. Teachers' demographics information collected determined the characteristics of the sample and ability to generalize the results. However, “one cannot assume that samples taken from cooperating schools are necessarily representative of the target population” (Best & Kahn, 1993, p. 145). These schools may have characteristics that other schools did not have such as faculties with high morale and willingness to try new approaches (Best & Kahn, 1993), and the



researcher cannot confidently say that the sample population was a representative sample (Creswell, 2005).

### *Threats to Validity*

A threat to internal validity was the use of a convenient sample that may have posed a potential selection bias. Selection bias “is likely when upon invitation, volunteers are used as members of an experimental group” (Best & Kahn, 1993, p. 143).

Participants in a convenience sample may be more motivated to participate than the representative population, which may result in a threat to the internal validity.

A threat to external validity was the interaction of selection and treatment. Best & Kahn (1993) explained that since researchers rarely are able to select random samples, “generalizations from samples to populations are hazardous” (p. 145). The use of convenient sample and lack of randomization prevented the generalization of the results to other populations. The primary researcher attempted to reduce this threat by allowing all FCTM members currently teaching at a Florida middle school to participate. Teachers received the survey’s link in an invitation sent through the e-mail.

Chapter III described the research methodology that the primary researcher used to answer the research questions and tested the hypotheses about the relationship between teachers’ self-efficacy level and their instructional strategies. This chapter also described the purpose of the study, research design, the sampling plan, instruments, procedures and data collection methods, and data analyses methods. Chapter IV explains the findings of this study and Chapter V include the conclusions, interpretations, and implications of the findings in the research study. Additionally, Chapter V provides limitations of the study and suggestions for future research.

## CHAPTER IV

### RESULTS

This study examined the relationship between teachers' self-efficacy and their use of instructional strategies. Teacher self-efficacy was measured using the Teachers' Sense of Efficacy Scale (TSES) (See Appendix A) (Tschannen-Moran, & Woolfolk Hoy, 2001). Teachers' use of instructional strategies was measured using the Teachers' Instructional Practices Survey (TIPS) (See Appendix C) (Haas, 2002). Further, this research explored the relationship between teachers' self-efficacy and teacher demographic characteristics as measured by a researcher-developed questionnaire.

Data was collected from April 24 through May 28, 2009. The TSES, TIPS and the demographic characteristics surveys were integrated onto the SurveyMonkey website and a link to access them was posted in the Florida Council of Teachers of Mathematics (FCTM) website. Participants were invited to participate in this study through the FCTM Newsletter, as well as through an e-mail which included a link to the survey. A total of 118 middle school mathematics teachers responded to the three online surveys. However, only 101 teachers completed all three surveys. The data collected from that sample was analyzed with descriptive statistics using SPSS Version 17.0 as described in Chapter 3.

The researcher computed frequency distributions on all variables, no missing data were discovered, and all figures were coded properly. The gender distribution included 23 males and 78 females (See Table 4-1). Further participants included 77 White, 15 Black, 6 Hispanics, and 3 Other. All participants were certified teachers, 4 in elementary education (K-6), 76 in mathematics – middle grades (5-9), 15 in mathematics – high

school (6-12), and 6 had Other Type of Teaching Certificate. Years of teaching experience included 30 teachers with 0-5 years of teaching, 30 with 6-10 years of teaching, 19 had 11-15 years of teaching, 11 teachers had been teaching 15-20 years, and 11 teachers had been teaching 20 years of more. Also, there were 62 teachers who held a Bachelor, 39 teachers held a Masters Degree or higher.

Table 4-1

*Demographic Characteristics of Teachers of Middle School Mathematics*

<b>Demographic Variables</b>	<b>Frequency</b>	<b>Valid Percent</b>
Gender (n=101)		
Male	23	22.7%
Female	78	77.3%
Race and Ethnicity		
White	77	76.2%
Black	15	14.9%
Hispanic or Latino	6	5.9%
Other	3	3.0%
Years of Teaching		
0-5	30	29.7%
6-10	30	29.7%
11-15	19	18.8%
16-20	11	10.9%
20 or more	11	10.9%
Teaching Certificate		
Elementary (K-6)	4	4.0%
Middle Mathematics (7-9)	76	75.2%
Secondary Mathematics (6-12)	15	14.9%
Other	6	5.9%
Level of Education		
Bachelors	62	61.4%
Masters or higher	39	38.6%

Cronbach Alpha Coefficients were calculated on the TSES and TIPS to assess reliabilities (See Table 4-2). Cronbach's Alpha is a coefficient of reliability not a statistical test. It is a method to measure the reliability of a scale. It measures of internal consistency of an instrument, that is, the extent to which all items within the instrument

measure the same thing (George & Mallery, 2005). The coefficient alpha varies between 0 and 1, with greater internal consistency achieved when alpha is closer to 1. The threshold for internal consistency reliability in social research is .7 (Nunnally, 1978). Results from the analysis of the TSES were classified into three factors: efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management. While analysis from the TIPS were categorized into six domains: cooperative learning, communication and study skills, technology-aided instruction, problem based learning, manipulatives and multiple representations, and direct instruction. Reliability scores were in the acceptable range for both the TSES and TIPS as shown in Table 4-2.

Table 4-2

*Cronbach Alpha Reliability Coefficients for the TSES and the TIPS*

Scale Instrument	Coefficient Alphas
Teacher Self Efficacy Scale (TSES)	.80
Teacher Instructional Practices Survey (TIPS)	.75

The TSES uses a 9 point Likert scale, with four visible labels denoted as 1=nothing, 3=very little, 5=some influence, 7=quite a bit, 9=a great deal. The numbers 2, 4, 6 and 8 were not labeled but implied the degree of self-efficacy between the labeled points. The TSES was developed into a short and long form. The long form, a 24-item scale was recommended by the authors to be used with pre-service teachers. However, this study focused on experienced teachers; hence, the short form was utilized. The TSES short form was comprised of a 12-item rating scale that assessed teachers' beliefs across three different subscales: efficacy in student engagement, efficacy in instructional strategies, and efficacy in classroom management. Means from the participants

responses on the items from the TSES scale that load each factor scale were computed to determine the level of efficacy in each factor. Additionally, means of self-efficacy scores were computed to determine the overall teacher self-efficacy. Higher TSES means indicated higher sense of teacher self-efficacy.

The researcher derived the means, standard deviations, and variances for each of the TSES factors (See Table 4-3). It was observed that the mean score for instructional strategies domain was highest followed by the mean score for classroom management with the mean score of student engagement considerably lower.

Table 4-3

*Mean Scores, Standard Deviations, and Variance of TSES Factors (n=101)*

Factor	Mean Score	Standard Deviation	Variance
Engagement	6.50	1.25	1.58
Instructional Strategies	7.53	1.05	1.10
Classroom Management	7.47	1.17	1.38
Total Teacher Self-Efficacy Scale	7.17	.96	.93

In addition to the TSES, participants were asked to complete a demographic characteristics survey, which included gender, race, years teaching, certificate, and level of education. Gender was coded as 1=male and 2=female. Race and ethnicity was coded as 1=White, 2= Black, 3=Hispanic, 4=Other. Years of teaching was coded as 1=0-5 yrs, 2=6-10 yrs, 3=11-15 yrs, 4=15-20 yrs, and 5=20 and more years. Type of teaching certificate was coded as 1=Elementary, 2=Mathematics Middle, 3=Mathematics High, and 4=Other. Level of education was coded as 1=Bachelors and 2=Masters or higher.

Demographic information was compared using descriptive statistics. The researcher computed the mean scores, standard deviations and variance of each of the

three TSES factors by gender, race/ethnicity, years of teaching, teaching certificate, and level of education (See table 4-4). The data indicated that males self-efficacy means ( $M=7.14$ ,  $SD=.90$ ) and females self-efficacy means ( $M=7.18$ ,  $SD=.98$ ) were comparable. However, females reported greater self-efficacy scores in the student engagement and instruction factors than males, but not in the student management factor. With respect to race and ethnicity, Hispanic participants reported greater total self-efficacy mean scores ( $M=7.27$ ,  $SD=.95$ ) as well as efficacy in student engagement ( $M=6.92$ ,  $SD=1.06$ ) than all other participants. While White participants reported greater efficacy in instruction ( $M=7.57$ ,  $SD=1.03$ ) than all other participants. Furthermore, the student management factor reported the greatest efficacy mean scores ( $M=8.08$ ,  $SD=.95$ ) in the Other participants category.

Teachers with 11-15 years of experience reported greater total self-efficacy mean scores ( $M=7.39$ ,  $SD=.78$ ), engagement ( $M=6.79$ ,  $SD=1.18$ ) and management ( $M=7.79$ ,  $SD=.97$ ) than other participants. Whereas, teachers who had been teaching 20 years or more reported greater instructional self-efficacy ( $M=7.80$ ,  $SD=1.07$ ). Regarding teaching certificate, participants who held an elementary teaching certificate scored higher in total self-efficacy ( $M=7.62$ ,  $SD=1.36$ ), engagement ( $M=7.06$ ,  $SD=1.85$ ) and efficacy in instruction ( $M=8.19$ ,  $SD=.90$ ) than other participants. However, teachers holding Other type of certificates reported greater mean scores ( $M=7.79$ ,  $SD=1.44$ ) in efficacy in management. Finally, participants with a masters degree or higher reported greater total self-efficacy ( $M=7.28$ ,  $SD=.82$ ) and greater efficacy in all three domains, engagement ( $M=6.75$ ,  $SD=1.06$ ), instruction ( $M=7.57$ ,  $SD=.93$ ), and management ( $M=7.51$ ,  $SD=1.05$ ) when compared to individuals with a bachelors degree.

Table 4-4

*Mean Scores and Standard Deviations of TSES Factors by Gender, Race, Years**Teaching, Certificate, and Education*

n=101	Total Teacher Self-Efficacy Scale			Engagement		Instruction		Management	
	n	M	SD	M	SD	M	SD	M	SD
<b>Gender</b>									
Male	23	7.14	.90	6.43	1.23	7.37	1.09	7.61	1.05
Female	78	7.18	.98	6.52	1.27	7.57	1.04	7.43	1.21
<b>Race and Ethnicity</b>									
White	77	7.16	.92	6.47	1.25	7.57	1.03	7.45	1.10
Black	15	7.21	1.18	6.64	1.39	7.52	.94	7.45	1.65
Hispanic	6	7.27	.95	6.92	1.06	7.38	1.22	7.50	.84
Other	3	6.89	1.21	5.92	1.18	6.67	1.81	8.08	.95
<b>Yrs Teaching</b>									
0-5	30	7.00	.91	6.48	1.19	7.26	1.05	7.28	1.12
6-10	30	7.32	1.04	6.56	1.38	7.66	1.16	7.71	1.12
11-15	19	7.39	.78	6.79	1.18	7.58	.82	7.79	.97
16-20	11	6.95	1.27	6.20	1.31	7.55	1.09	7.09	1.66
20+	11	7.07	.82	6.23	1.23	7.80	1.07	7.18	1.34
<b>Certificate</b>									
Elem.	4	7.62	1.36	7.06	1.85	8.19	.90	7.63	1.61
Middle	76	7.12	.95	6.48	1.24	7.46	1.11	7.40	1.16
High	15	7.23	.88	6.36	1.23	7.65	.72	7.65	1.11
Other	6	7.38	1.10	6.75	1.22	7.58	.97	7.79	1.44
<b>Education</b>									
Bachelors	62	7.08	1.04	6.33	1.35	7.49	1.11	7.43	1.25
Masters or higher	39	7.28	.82	6.75	1.06	7.57	.93	7.51	1.05

The TIPS survey was designed to determine the instructional strategies used to teach mathematics during a five-period day. It was comprised of six categories or domains: cooperative learning (CL); communication and study skills (CSS); technology aided instruction (TAI); problem-based learning (PBL); manipulatives, models, and multiple representations (MMM); and direct instruction (DI). Each domain included eight statements describing activities associated with the domain. Teachers were asked to rank from one to five their use of each activity during a five-period day, 1=1 time, 2=2 times, and so forth. Participant's responses for all eight statements as well as the results for each domain were averaged and the percent use of each instructional strategy domain were tabulated.

Table 4-5 summarized the mean averages and percent usage of instructional strategies of the 101 respondents. These initial results indicated that teachers preferred using direct instruction 80.69% of the time in a five-period day. This was followed by communication and study skills (74.63%), problem-based learning (68.22%), cooperative learning (62.57%), manipulatives, models, and multiple representations (61.66%), and technology aided instruction (44.75%) in a given five-period day.



Table 4-5

*Mean Scores and Percent Use of Instructional Practices on Teachers' Instructional**Strategies Practice (TIPS) Survey by Item and Domain*

<b>Item</b>	<b>M</b>	<b>Percent Use</b>
Cooperative Learning Domain	3.13	62.57%
I collaborate with the whole class in finding a solution to a problem.	3.94	78.81%
I allow students to engage in cooperative problem solving.	3.64	72.87%
I allow students to discuss solutions to algebra problems with peers.	3.66	73.27%
I allow students to begin homework in class with peer assistance.	3.61	72.28%
I pair students to work as peer tutors.	3.15	62.97%
I reward group performance in the cooperative setting.	2.51	50.30%
I assign students to work in homogeneous groups.	1.45	28.91%
I assign students to work in heterogeneous groups.	3.06	61.19%
Communication and Study Skills Domain	3.73	74.63%
I encourage students to use mathematics vocabulary terms in class discussions.	4.46	89.11%
I have students describe their thought processes orally or in writing during problem solving.	3.87	77.43%
I require students to share their thinking by conjecturing, arguing, and justifying ideas.	3.20	63.96%
I have students write about their problem solving strategies.	2.43	48.51%
I encourage students to ask questions when difficulties or misunderstandings arise.	4.80	96.04%
I encourage students to explain the reasoning behind their ideas.	4.31	86.14%
I use reading instructional strategies to help students with comprehension.	3.12	62.38%
I provide students with study skills instruction.	3.67	73.47%
Technology Aided Instruction Domain	2.24	44.75%
I have students use calculators during tests or quizzes (given five typical test or quiz administrations).	3.38	67.52%
I have students use calculators for problem solving instruction and activities.	3.29	65.74%
I have students use calculators to help them develop problem-solving strategies.	2.99	59.80%
I have students use calculators for computations.	3.12	62.38%
I have students use graphing calculators to explore linear relationships.	0.64	12.87%
I have students use computer spreadsheets, such as Microsoft Excel, for problem solving instruction.	0.35	6.93%
I assign students to use calculators as a requirement for class participation.	1.45	28.91%
I use computer software to provide practice opportunities.	2.69	53.86%

Table 4-5 (Continued)

Item	M	Percent Use
Problem Based Learning Domain	3.41	68.22%
I have students create their own rules in new problem solving situations.	2.05	40.99%
I draw mathematical concepts from "real-life" situations.	3.96	79.21%
I have students pursue open-ended and extended problem solving projects.	2.88	57.62%
I create problems from the interests of individual students.	3.15	62.97%
I recognize many alternative problem-solving practices.	3.87	77.43%
I emphasize the problem solving process, rather than the solution.	4.03	80.59%
I anchor problem solving skills instruction within situations meaningful to the students.	3.67	73.47%
I encourage students to experiment with alternative methods for problem solving.	3.67	73.47%
Manipulatives, Models, and Multiple Representations Mean	3.08	61.66%
I have students use cubes or blocks to represent algebraic equations.	1.53	30.69%
I illustrate mathematical concepts for students with pictures.	3.51	70.30%
I teach students to represent algebraic equations with graphs.	2.77	55.45%
I teach students to represent problems with tables.	3.40	67.92%
I teach students to represent problems with charts to break information into smaller pieces.	3.26	65.15%
I emphasize the use of multiple representations: words, tables, graphs, and symbols.	3.75	75.05%
I provide math games for students to practice algebraic skills.	2.88	57.62%
I use diagrams to help students learn to solve equations.	3.55	71.09%
Direct Instruction Mean	4.03	80.69%
I grade homework and provide feedback.	4.06	81.19%
I close instruction by reviewing concepts with students, emphasizing comparisons to previously covered concepts.	3.97	79.41%
When providing feedback, I target incorrect responses and error patterns.	3.99	79.80%
I identify a new skill or concept at the beginning of instruction and provide a rationale for learning it.	4.02	80.40%
I provide graduated sequence of instruction, moving students from concrete to abstract concepts in defined steps.	3.91	78.22%
I require students to indicate a one-step-at-a-time process in working equations.	4.34	86.73%
I use pre-worked examples to introduce or reinforce topics.	3.70	74.06%
When assigning practice work, I ensure that the majority of the problems review previously covered material.	4.29	85.74%

The researcher derived the means, standard deviations, and variances for each of the TIPS domains (See Table 4-6). Results indicated that teachers preferred using direct instruction most of the time (M=4.03, SD=.71) followed by communication and study skills (M=3.73, SD=.73), and then problem-based learning (M=3.41, SD=.92). These results indicated that technology aided instruction was the least preferred method of instruction by teachers (M=2.24, SD=1.23). It should be noted that technology aided instruction was the only domain used less than three times during a regular five-period day.

Table 4-6

*Mean Scores, Standard Deviations, and Variance of TIPS Domains (n=101)*

Domain	Mean Score	Standard Deviation	Variance
Cooperative Learning	3.13	.87	.75
Communication and Study Skills	3.73	.73	.53
Technology Aided Instruction	2.24	1.23	1.51
Problem-Based Learning	3.41	.92	.85
Manipulatives, Models, and Multiple Representations	3.08	.99	.98
Direct Instruction	4.03	.71	.50

The researcher also compared the results of TIPS and the TSES (see Table 4-7). Teachers were assigned to two groups based on the TSES results. The first group was comprised of 43 teachers with TSES mean scores ranging from 4 to 6. The second group was comprised of 58 teachers with TSES scores with means from 7 to 9. The two groups were then compared utilizing the TIPS results. Both groups demonstrated the same preference from greatest to smallest mean average for instructional practices: direct instruction; communication and study skills; problem-based learning; manipulatives

models, and multiple representations; and technology aided instruction. In five out of the six domains with the exception of technology aided instruction, teachers in the higher TSES group reported greater mean scores than teachers in the lower TSES group.

Greater means in the TIPS domain indicated higher use of that particular instructional practice. Technology aided instruction was not only the least used instructional practice, but it was also the only instructional practice where teachers in the lower TSES reported greater mean scores (M=2.47, SD=1.04) when compared to the higher TSES group (M=2.06, SD=1.34).

Table 4-7

*Mean Scores and Standard Deviations of TIPS Domains by TSES*

TIPS Domains	Mean		Standard Deviation	
	Lower TSES n=43	Higher TSES n=58	Lower TSES n=43	Higher TSES n=58
Collaborative Learning	2.97	3.24	.78	.91
Communication and Study Skills	3.58	3.84	.75	.70
Technology Aided Instruction	2.47	2.06	1.04	1.34
Problem-based Learning	3.12	3.63	1.08	.72
Manipulatives, Models, and Multiple Representations	2.82	3.28	1.02	.93
Direct Instruction	3.87	4.16	.75	.65

Subsequently, the researcher tested for homogeneity of variance using the Levene’s test. Homogeneity of variance is the assumption that “the variance of your outcome variable or variables should be the same in each of these groups” (Field, 2005, p.97). If the Levene’s test was not significant, then the assumption of homogeneity of variance was met and the researcher could assume that the multivariate test statistics are robust (Field, 2005). The Levene’s test was used to determine the difference between the

spread of scores of the variables around their mean instead of only examining the means. It tested the null hypothesis that variances of the groups were equal.

The researcher found no significant difference among the variables in collaborative learning  $F(1,99) = .030, p > .05$ ; communication and study skills  $F(1,99) = .291, p > .05$ ; manipulatives, models, and multiple representations  $F(1,99) = 4.03, p > .05$ ; and direct instruction  $F(1,99) = 1.358, p > .05$ . However, differences were found in problem-based instruction  $F(1,99) = 10.635, p < .05$ .

### **Main Analysis**

The results of this study were analyzed using Multivariate Analysis of Variance (MANOVA) as described in the previous chapter. The MANOVA is a general linear model that allows the researcher to detect group differences when there are one or more independent variables and several dependent variables (Field, 2005). It allows examining the interaction between the independent variables and contrasting the differences between the groups, as well as reducing the probability of type I errors caused when multiple ANOVAs are used.

### ***Effects of Demographics in Self-Efficacy***

The first research question was “Does the level of self-efficacy of middle school mathematics teachers differ based on their demographic characteristics (gender, race and ethnicity, level of education, type of certificate, and years of experience)?” It considered if mathematics teachers’ with different demographic information show a difference in their sense of self-efficacy. The researcher utilized a MANOVA to compare the teachers’ level of self-efficacy and the difference between the demographic variables contrasting

TSES scores of teachers by gender, race and ethnicity, number of years teaching mathematics, type of teaching certificate, and level of education.

Specifically, the researcher used the Hotelling T multivariate test to determine if there were any differences between the TSES mean scores and demographic variables. Multivariate tests focused on the independent variables and their interactions. Hotelling T MANOVA was designed to test if there was a difference between the means of the variables (George & Mallery, 2005). It is considered an appropriate technique when performing multivariate statistical designs and it is used when analyzing between and within group differences from one dichotomous independent variable among several dependent variables (Wendorf, 1997). Unlike other methods, this approach explored the appropriate differences and led to a reduced chance of performing a type 1 error (Gall & Borg, 2004). This error did not occur and allowed the researcher to use all material based on the Hostelling T MANOVA. Although the Hotelling T MANOVA was designed to show significance, it does not provide information about the nature of the effect or how groups differ from each other (Field, 2005).

Results indicated that there were significant differences for race and ethnicity  $F(12, 134)=54.831, p<.001$  and type of teaching certificate  $F(12, 134)=43.193, p<.001$ . However, there were no significant differences for gender  $F(4, 46)=.331, p>.05$ , years of teaching  $F(16,178)=.96, p>.05$  and level of education  $F(12,134)=1.004, p>.05$ . Table 4-8 depicts partial MANOVA results.

Table 4-8

*MANOVA of TSES Scores and Teachers Demographic Characteristics Survey*

		Multivariate Tests <sup>b</sup>				
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.962	290.354 <sup>a</sup>	4.000	46.000	.000
	Wilks' Lambda	.038	290.354 <sup>a</sup>	4.000	46.000	.000
	Hotelling's Trace	25.248	290.354 <sup>a</sup>	4.000	46.000	.000
	Roy's Largest Root	25.248	290.354 <sup>a</sup>	4.000	46.000	.000
Gender	Pillai's Trace	.028	.331 <sup>a</sup>	4.000	46.000	.856
	Wilks' Lambda	.972	.331 <sup>a</sup>	4.000	46.000	.856
	Hotelling's Trace	.029	.331 <sup>a</sup>	4.000	46.000	.856
	Roy's Largest Root	.029	.331 <sup>a</sup>	4.000	46.000	.856
Race and Ethnicity	Pillai's Trace	1.062	6.575**	12.000	144.000	.000
	Wilks' Lambda	.056	20.010**	12.000	121.996	.000
	Hotelling's Trace	14.731	54.831**	12.000	134.000	.000
	Roy's Largest Root	14.593	175.113**	4.000	48.000	.000
YTeaching	Pillai's Trace	.296	.978	16.000	196.000	.482
	Wilks' Lambda	.727	.971	16.000	141.170	.491
	Hotelling's Trace	.345	.960	16.000	178.000	.502
	Roy's Largest Root	.228	2.794	4.000	49.000	.036
Certificate	Pillai's Trace	.960	5.643**	12.000	144.000	.000
	Wilks' Lambda	.076	16.694**	12.000	121.996	.000
	Hotelling's Trace	11.604	43.193**	12.000	134.000	.000
	Roy's Largest Root	11.564	138.764**	4.000	48.000	.000
Education	Pillai's Trace	.232	1.007	12.000	144.000	.445
	Wilks' Lambda	.779	1.007	12.000	121.996	.446
	Hotelling's Trace	.270	1.004	12.000	134.000	.448
	Roy's Largest Root	.205	2.463	4.000	48.000	.058

a. Exact statistic.

b. Design: Intercept + Gender+Race+YTeaching+Certificate+Education.

\*\* $p < .01$ .

The tests of between subjects' effects were examined to determine the nature of the effect (see Table 4-9). There were no significant differences by gender, and race and ethnicity or teaching certificate in any of the TSES domains, the two domains with significant differences based on the Hotelling T MANOVA multivariate test. However, the results indicated marginal significance  $t(3) = 2.69, p = 0.056$  between teachers holding graduate degrees and teachers holding a Bachelors degree on the total TSES scale. Additionally, teachers with higher degrees scored significantly higher than teachers with a Bachelors degree in efficacy of student engagement  $t(3) = 3.05, p <.05$ .



Table 4-9

*Multivariate Analyses of Variance Comparing Demographic Characteristics and Teacher Self-Efficacy Scale (TSES) Factors*

Source	Dependent Variable	Df	Mean Square	F	Significance
Gender	Engagement	1	.361	.218	.643
	Instruction	1	.221	.156	.694
	Management	1	.109	.091	.764
	Total TSES	1	.062	.064	.802
Race and Ethnicity	Engagement	3	2.197	1.328	.276
	Instruction	3	1.339	.946	.426
	Management	3	.801	.669	.575
	Total TSES	3	.867	.889	.453
Years Teaching	Engagement	4	1.764	1.066	.384
	Instruction	4	.593	.419	.794
	Management	4	2.934	2.450	.058
	Total TSES	4	1.244	1.275	.292
Certificate	Engagement	3	1.073	.648	.588
	Instruction	3	.196	.138	.937
	Management	3	.595	.497	.686
	Total TSES	3	.439	.450	.718
Education	Engagement	3	5.044	3.048*	.037
	Instruction	3	1.299	.918	.439
	Management	3	2.634	2.199	.100
	Total TSES	3	2.628	2.694	.056

\* $p < .05$ .

The researcher further analyzed the data by conducting post-hoc tests. These tests examined the significance of differences in levels of an independent variable with respect to a dependent variable. Post-hoc tests are univariate in nature rather than multivariate; therefore, they were applied only after significance was established using multivariate F tests of group differences. The purpose of multiple comparison and post-hoc tests was to

establish which group means were significantly different from others. This helped identify the nature of the overall effect determined by the F test (Garson, 2009).

Post-hoc tests on race and ethnicity as well as type of teaching certificate by TSES factors were performed but results indicated no significant differences. Tukey's Honestly Significant Difference HSD was used to make pairwise comparisons of the means of all combinations of levels of the independent variables after a significant F-value was observed (George & Mallery, 2005). Post-hoc analyses using Tukey's HSD indicated that TSES scores did not differ significantly depending on race and ethnicity and teaching certificate between participants scores ( $p > .05$ ).

### ***Effects of Self-Efficacy on Instructional Strategies***

The second research question was "Is there a difference in the instructional strategies used by middle school mathematics teachers based on their levels of self-efficacy?" It considered the difference in the instructional strategies used by teachers in the lower self-efficacy group and teachers in higher self-efficacy group. This question was examined utilizing a MANOVA to compare the use of instructional strategies of teachers reported in the TIPS to their self-efficacy scores in the TSES.

Specifically, the Hotelling T MANOVA was considered to determine if the null hypothesis was supported. The null hypothesis was that there were no differences in the instructional strategies between the two TSES groups, low and high efficacy.

Additionally, the Hotelling T MANOVA tested the difference between the means of the variables and was an appropriate technique to analyze between and within group differences. It reduced the chance of a type 1 error. The results illustrated in Table 4-10

indicated that there were significant differences between the higher efficacy group and the lower efficacy group  $F(6, 94)=.147, p<.05$ .

Table 4-10

*MANOVA of TIPS and TSES Scores*

		Multivariate Tests <sup>b</sup>				
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.979	722.481 <sup>a</sup>	6.000	94.000	.000
	Wilks' Lambda	.021	722.481 <sup>a</sup>	6.000	94.000	.000
	Hotelling's Trace	46.116	722.481 <sup>a</sup>	6.000	94.000	.000
	Roy's Largest Root	46.116	722.481 <sup>a</sup>	6.000	94.000	.000
TSESG	Pillai's Trace	.128	2.299 <sup>a *</sup>	6.000	94.000	.041
	Wilks' Lambda	.872	2.299 <sup>a *</sup>	6.000	94.000	.041
	Hotelling's Trace	.147	2.299 <sup>a *</sup>	6.000	94.000	.041
	Roy's Largest Root	.147	2.299 <sup>a *</sup>	6.000	94.000	.041

a. Exact statistic.

b. Design: Intercept + TSESG.

\* $p<.05$ .

Further analysis of the data tested the differences between the subjects' effects. These results are depicted in Table 4-11. There were no significant differences in three of the TIPS domains: collaborative learning, communication and study skills, and technology aided instruction. Nevertheless, significant differences were found in problem-based learning  $t(1)=8.05, p<.01$ ; manipulatives, models and multiple representations  $t(1)=5.42, p<.05$ ; and direct instruction  $t(1)=4.40, p<.05$ .

Post-hoc tests on the significance of teachers' instructional strategies domains and teacher self-efficacy groups were not performed because there were only two groups, therefore the researcher could not study the variables within the groups and could only compare between the groups.

Table 4-11

*Multivariate Analyses of Variance Comparing Teacher Self-Efficacy Scale (TSES) and Teachers' Instructional Practices Survey (TIPS) Domains*

Source	Dependent Variable	Df	Mean Square	F	Significance
TSES	Collaborative Learning	1	1.80	2.42	.123
	Communication and Study Skills	1	1.62	3.12	.081
	Technology Aided Instruction	1	4.08	2.73	.102
	Problem-Based Learning	1	6.37	8.05**	.006
	Manipulatives, Models, and Multiple Representations	1	5.07	5.42*	.022
	Direct Instruction	1	2.12	4.40*	.039

\* $p < .05$ . \*\* $p < .01$ .

### Research Question 1

The first research question asked if the level of self-efficacy of middle school mathematics teachers would differ based on their demographic characteristics (gender, race and ethnicity, level of education, type of certificate, and years of experience). From the comparison of the mean raw scores, greater differences in the means were found in race, years of teaching and type of teaching certificate. Scores compared by race and ethnicity differed as much as .38 between Hispanics ( $M=7.27$ ) and participants in the Other category ( $M=6.89$ ). When comparing years of teaching experience, scores differed as much as .44 between teachers with 11-15 years of experience ( $M=7.39$ ) than those with 16-20 years of experience ( $M=6.95$ ). Further, scores compared by teaching certificate differed as much as .50 between teachers with elementary teaching certificate ( $M=7.62$ ) than those with middle school math certificates ( $M=7.12$ ).

Results from the MANOVA analysis yielded non significant differences in gender, years of teaching, and level of education. Differences were found in the

demographic variables of race and ethnicity as well as type of teaching certificate. However, given the small sample size significance could not be established and conclusions could not be drawn. A test between the subjects revealed no significant differences for these two demographic variables in all TSES factors including the total TSES. Interestingly, the test of between subject effects yielded a correlation for participants level of education and efficacy of student engagement factor ( $p < .05$ ).

### **Research Question 2**

The second research question asked if there was a difference in the instructional strategies used by middle school mathematics teachers based on their levels of self-efficacy. From the comparison of the mean scores, it appeared that the order in which teachers preferred to use these instructional practices was consistent in the two groups, the higher self-efficacy teachers and the lower self-efficacy teachers. Teachers used instructional practices in the following order: direct instruction; communication and study skills; problem-based learning; manipulatives, models and multiple representations; collaborative learning; and technology aided instruction.

A closer look at the data revealed that there were differences between the mean scores of the lower TSES group and the higher TSES in each of the TIPS domains. The greatest difference of .51 was found between the higher SES group mean ( $M=3.63$ ) and the lower SES group mean ( $M= 3.12$ ) in the problem-based learning domain. The researcher conducted a MANOVA and determined that there were statistical significant differences among the two groups. Additionally the between subjects tests revealed significant differences in problem-based learning; manipulatives, models and multiple representations; and direct instruction.

## **Hypothesis 1**

H1. Middle school teachers of mathematics with higher levels of education, or experience will report higher levels of self-efficacy. ( $\alpha = .05$ ).

The researcher examined whether teachers had different levels of self-efficacy depending on the demographic variables. The MANOVA was used to compare the demographic characteristics survey and TSES results. Results indicated that this hypothesis was partially supported. Teachers holding a masters degree or higher reported greater TSES mean scores ( $M=7.28$ ) than teachers holding a Bachelors degree ( $M=7.08$ ). Although this difference was a marginal significance,  $t(3) = 2.69$ ,  $p = 0.056$ , a statistical significance was found in the efficacy of engagement factor  $t(3) = 3.05$ ,  $p < .05$ . With reference to years of teaching experience, the hypothesis was not supported. Teachers with 11-15 years of experience reported greater TSES mean scores ( $M=7.39$ ) than teachers with 16-20 years of experience ( $M=6.95$ ) and those with 20+ years of experience ( $M=7.07$ ). Only a marginal significance in the efficacy of student management factor,  $t(3) = 2.45$ ,  $p=.058$  was found.

## **Hypothesis 2**

H2. Middle school teachers of mathematics with higher levels of self-efficacy will use different instructional strategies from middle school teachers of mathematics with lower levels of self-efficacy. ( $\alpha = .05$ ).

The researcher investigated if the level of self-efficacy affected the instructional strategies mathematics teachers used. The MANOVA was used to compare the TSES and TIPS results. This hypothesis was partially supported. Teachers in the lower and higher self-efficacy groups chose their instructional strategies in the same order of

preference; however, the extent to which they used the strategies was different. Data indicated that there were significant differences in teachers' use of problem-based learning  $t(1)=8.05$ ,  $p<.01$ , direct instruction  $t(1)=4.40$ ,  $p<.05$ , and manipulatives, models and multiple representations  $t(1)=5.42$ ,  $p<.05$  during a five-period day.

Chapter V will present a summary of the findings, conclusions, limitations, recommendations for future research, and implications for practice pertaining to this study, based on the literature and findings related to teacher self-efficacy, instructional strategies, and teacher demographic characteristics among teachers of middle school mathematics.

## **CHAPTER V**

### **DISCUSSION**

#### **Summary of Findings**

The purpose of this study was to determine whether the self-efficacy of mathematics teachers was related to their choice of instructional strategies. This research further explored the relationship between teachers' self-efficacy and their demographic characteristics as measured by a researcher-developed questionnaire. According to the National Mathematics Advisory Panel (2008) differences in students' mathematical achievement were "attributable to differences in teachers" (p.35). Differences identified included the use of instructional methods and their self-efficacy beliefs. Much research has highlighted the important role that teachers play in increasing student achievement. Concurrently, Pajares & Urdan (2006) examined numerous studies linking subject-specific research to teachers' self-efficacy, goals, and instructional strategies.

The National Council of Teachers of Mathematics (NCTM) also emphasized the role of the teacher by explaining that their actions promoted students' thinking, questioning, problem solving, discussing of ideas, and learning strategies (Principles and Standards, 2000). NCTM concluded that students' understandings, abilities, confidence, and dispositions towards mathematics were shaped by the teaching approach (Principles and Standards, 2000).

Hall & Poton (2005) demonstrated that past experiences of students in mathematics contributed to their opinions, abilities, and career choices related to mathematics. They stressed the importance of examining the effects of instructional



strategies in the development of mathematics self-efficacy and student mathematics performance.

Other research studies emphasized a Constructivist approach, which is a student centered, hands-on, and highly interactive way of teaching and learning. These studies related instructional strategies to decreased math anxiety and increased self-efficacy (Alsup, 2005). Results from the 1999 *Trends in International Mathematics and Science Study (TIMSS)* assessment indicated that certain instructional strategies not only effected student performance but also influenced student motivation in learning mathematics (House, 2005).

Mathematics teachers face daunting challenges to bring all students to proficiency levels in mathematics as a result of federal mandates. The No Child Left Behind (*NCLB Act* (2002) requires schools to use assessments for reading, mathematics and science, and to disaggregate the data by student subgroups. Mathematics education would benefit from not only identifying the effective mathematics strategies, but also acknowledging the teachers' role in using these teaching strategies and determining the factors that affect these types of instructional decisions most. Consequently, this study examined the relationship between teachers' self-efficacy and instructional strategies among middle school mathematics teachers.

The ultimate goal of this study was to determine if there was a difference in the use of instructional strategies by teachers with different levels of self-efficacy. Teachers were classified into two groups, low self-efficacy and high self-efficacy, depending on their self-efficacy scores in the TSES. Responses of the two groups were compared and analyzed. Furthermore, this study analyzed teachers' demographic characteristics

(gender, race and ethnicity, years of teaching, type of teaching certificate, and level of education) and compared it to teachers' self-efficacy to determine if there were relationships among these variables.

The researcher chose the Teacher Self-Efficacy Scale (TSES) to measure teachers' self-efficacy due to its high reliability in three related subscales that affect teaching: instruction, classroom management, and student engagement. This instrument is often referred to as the Ohio State teacher efficacy scale (*OSTES*). It could be used in a short or long version, both with high reliability  $r=.94$  and  $r=.90$  respectively. The TSES was also found to have construct validity. Tschannen-Moran & Hoy (2001) positively correlated the TSES to other existing measures of teacher self-efficacy. The short form is customarily used to assess experienced teachers. Therefore, it was utilized in this study given that the final sample group was comprised of experienced teachers.

To determine the instructional strategies used by mathematics teachers, the researcher selected the Teachers' Instructional Practices Survey (TIPS). The TIPS was designed to determine teachers' use of instructional practices in a given five-period day. It asked teachers to provide information about their use of instructional strategies categorized into six domains: collaborative learning; communication and study skills; technology aided instruction; problem-based learning; manipulatives, models and multiple representations; and direct instruction. The TIPS was chosen because of its validity and reliability. Several pilot experiments were conducted to establish the validity of the TIPS. The reliability coefficient of  $r=.89$  was obtained after using the Spearman-Brown prophecy formula (Haas, 2002).

The researcher investigated whether teachers' self-efficacy levels varied based on their demographics characteristics (gender, race and ethnicity, years of teaching, type of teaching certificate, and level of education) to assess if personal characteristics influenced self efficacy scores. TSES results by race and ethnicity as well as type of teaching certificate yielded significant differences,  $p < .001$ . However, this data needs to be interpreted cautiously given the small sample size. Hispanic teachers reported greater self-efficacy mean scores ( $M=7.27$ ) than White ( $M=7.16$ ), Black ( $M=7.21$ ), and Other ( $M=6.89$ ) teachers in a scale from 0 to 9. Additionally, teachers holding elementary teaching certificates reported greater self-efficacy mean scores ( $M=7.62$ ) than teachers with middle school math certificates ( $M=7.12$ ). These findings also need to be interpreted with caution given the small sample size. These results were unexpected and may indicate the need to further research this area.

It was initially hypothesized that middle school mathematics teachers with higher levels of education or experience will report higher levels of self-efficacy ( $\alpha = .05$ ). Based on the results of this study, the first hypothesis was partially supported. The data indicated that teachers holding a masters degree or higher reported greater TSES mean scores ( $M=7.28$ ) than teachers holding a Bachelors degree ( $M=7.08$ ). While teachers holding graduate degrees did not score significantly higher than teachers holding a Bachelors degree on the total TSES scale, the results indicated a marginal significance,  $t(3) = 2.69$ ,  $p = 0.056$ . Additionally, teachers with higher degrees scored significantly higher than teachers with a Bachelors degree in efficacy of student engagement  $t(3) = 3.05$ ,  $p < .05$ . In terms of years of teaching experience, the hypothesis did not hold true. Teachers with 11-15 years of experience reported greater TSES mean scores ( $M=7.39$ )

that teachers with 16-20 years of experience (M=6.95) and those with 20+ years of experience (M=7.07). While these results did not yield significance, they indicated a marginal significance in the efficacy of student management factor,  $t(3) = 2.45, p=.058$ .

The researcher also investigated whether teachers' instructional strategies varied based on their level of self-efficacy. It was hypothesized that middle school teachers of mathematics with higher levels of self-efficacy used different instructional strategies than middle school teachers of mathematics with lower levels of self-efficacy ( $\alpha = .05$ ). Based on the TIPS and TSES results, the second hypothesis was partially supported. Both groups chose their instructional strategies in the same order of preference, with the most preferred being direct instruction and the least preferred technology aided instruction. However, data indicated that there were significant differences in teachers' use of problem-based learning  $t(1)=8.05, p<.01$ , direct instruction  $t(1)=4.40, p<.05$ , and manipulatives, models and multiple representations  $t(1)=5.42, p<.05$  during a five-period day. Table 5-1 depicts the differences between the mean scores.

Table 5-1

*Mean Scores and Differences of TIPS Domains by TSES*

TIPS Domains	Mean		Difference
	Lower TSES N=43	Higher TSES n=58	
Problem-based Learning	3.12	3.63	.51
Manipulatives, Models, and Multiple Representations	2.82	3.28	.46
Direct Instruction	3.87	4.16	.29

Results indicated that the extent to which strategies were chosen by teachers with higher self-efficacy were different from the ones used by teachers with lower self-

efficacy. Teachers with higher self-efficacy scores tended to use problem-based learning, direct instruction, manipulatives and multiple representations, collaborative learning, and communication and study skills more often than teachers with lower self-efficacy during self-reported five period days. In addition, teachers with lower self-efficacy tended to use technology aided instruction more often than teachers with higher self-efficacy.

The findings in this study were consistent with existing research in other subject areas. Pajares & Urdan's (2006) findings suggested that teachers with higher self-efficacy were more likely to use direct instruction, inquiry learning, and small group work. These teachers tended to be more enthusiastic, organized, and open to new ideas. They used more complex teaching methods and were "less critical of students who make errors" (p.120). Similarly, Bandura (1998) argued that highly efficacious teachers spent more time in academic activities, guiding and praising students along the way, and less time dealing with discipline. These teachers believed that student and teacher success was attributed to controllable factors such as increased effort, improved teaching or learning strategies, better explanations or instructional activities, and additional help and support (Bandura 1997; Pajares, 2006; Ross, Hagaboam-Gray, Hannay, 2001).

Nonetheless, not all studies agreed that higher self-efficacy always had positive effects on teachers' decisions. According to Wheatley (2002), benefits from self-efficacy included reflection, motivation to learn, greater responsiveness to diversity, productive collaboration, and change-provoking disequilibrium. While these benefits could result in positive teacher decisions there was not unanimity that they did. Several studies suggested teachers doubted their instructional decisions. Another study suggesting deviation from particular effects was presented by Zientek (2007) who found that

teachers completing teacher preparation programs reported a high sense of self-efficacy regardless of their certification route.

It was also noted that only a limited number of studies explored the factors that influence teachers' instructional strategies in mathematics. Self-efficacy was only one of the factors identified in the literature. Other researchers such as Maccini & Gagnon (2002 & 2007) claimed that teacher's knowledge and familiarity of mathematics context, teacher preparation and their beliefs about the meaning of mathematics, and the numbers of years of mathematics teaching experience, were influential in teachers' instructional decisions. Furthermore, Lee & Olszewski-Kubilius (2006) identified time and the teachers' perception of students' capabilities as the two major factors affecting teachers' choice of instructional strategies in gifted mathematics classrooms.

### **Conclusions**

This chapter underscores the importance of understanding the interaction between teacher self-efficacy, demographic characteristics, and instructional strategies of middle school mathematics teachers. Multivariate analyses indicated that teachers' self efficacy levels can be influenced by demographic characteristics and that their instructional strategies can be influenced by teachers' self-efficacy, which ultimately influences student mathematics performance.

This study suggests that self-efficacy and instructional strategies were related. Specifically, it focused on the six effective instructional strategies identified in the literature as being effective and mostly used in mathematics classrooms: collaborative learning; communication and study skills; technology aided instruction; problem-based learning; manipulatives, models, and multiple representations; and direct instruction

(Haas, 2002). The research in this study was to determine if there was a difference in the instructional strategies used by teachers with different levels of self-efficacy. Based on interpretations of data analyses of research questions and hypotheses, specific conclusions were drawn.

1. Differences between the instructional strategies used by the low self-efficacy teachers and high self-efficacy teachers were significant in three of the six instructional practices: problem-based learning, manipulative and multiple representations and direct instruction. Teachers in the high self-efficacy group tended to use these three strategies more frequently during a five period day than teachers in the low self-efficacy group. These teachers also used collaborative learning and communication and study skills strategies more often than teachers in the low self-efficacy group. Technology aided instruction was the only domain that teachers in the low self-efficacy group seemed to use more often than teachers in the high self-efficacy group.
2. Although statistical significance was found in the race and ethnicity of mathematics teachers regarding teacher self-efficacy levels, no conclusion can be drawn at this time due to the small sample size. According to the data, Hispanic teachers had the greatest self-efficacy mean scores than the other groups. They also reported the greatest mean scores in the efficacy of student engagement factor, but not in the efficacy in instruction and student management factors.
3. Statistical significance was noted with the type of teaching certificate of mathematics teachers and teacher self-efficacy levels. However, the sample

size was not robust enough to draw any definitive conclusions. Middle school mathematics teachers holding an elementary teaching certificate reported the greatest self-efficacy mean scores compared to the other groups. These teachers also reported the greatest mean scores in the efficacy in student engagement and efficacy of instruction factors.

### **Limitations**

The conclusions of this study were based on a sample of one group of mathematics teachers—teachers with affiliation to the Florida Council of Teachers of Mathematics. This study did not take into account some other factors that may influence teachers' self-efficacy, such as collective teacher self-efficacy and principal's leadership style. Research suggested a strong relationship between teachers' self-efficacy and perceived collective efficacy. Goddard, Hoy & Woolfolk, (2004) argued that a strong sense of collective efficacy enhanced teachers' self-efficacy beliefs and a weak collective efficacy decreases teachers' sense of efficacy, and vice versa.

In addition, teachers' use of instructional strategies may also be influenced by the availability of resources, access to teacher training, and the implementation of specific instructional programs in the schools such as *CRISS* or *SpringBoard*. This research dealt with only one of the factors identified in the literature as influencing teachers' use of instructional strategies.

Other limitations that may have influenced the results were:

1. The length of the TIPS survey was 48-questions. It could have hindered additional teacher participation in the study. This study took place from April 24 through May 28, 2009, which is the time when teachers were about to conclude



the school year in Florida. Many of them had limited time to go on line and complete the 48-questions TIPS, the 12-questions TSES and the five demographic characteristics questions, a total of 65 questions.

2. The online survey format allowed respondents to opt out of the survey unobserved. This encouraged participation among potential respondents (middle-school teachers of mathematics) most interested in contributing to the limited research in mathematics education, which could have created a selection bias. Concurrently, the format discouraged participation among those least interested.
3. The final data-producing sample of teachers of middle school mathematics was self-selected which could have introduced a selection of bias, representing a threat to the external validity of the study. Best & Kahn (1993) cautioned that samples taken from cooperating sites, in this case organization (FCTM) could not be assumed to be representative of the target population. These participants could have characteristics that other teachers did not have such as coming from high morale schools and willingness to try new approaches. Additionally, the self-reported nature of the study had the potential to introduce errors as individuals' strong sense of efficacy may not be well-grounded or authentic, since other factors may have influenced educators' responses.
4. Delineation of reliable knowledge about the relationships between the research variables examined in this study was limited to the findings obtained using the MANOVAs. In addition, the use of only two groups; low self-efficacy versus high self-efficacy for the second research question did not allow the researcher to

conduct Post-hoc tests that might have provided additional information regarding the relationships between the research variables in this study.

5. Male student response rate was low for this survey. Of the 101 participants, twenty-three respondents were male teachers of middle-school mathematics. However, *Levene's Test for Equality of Variances* was used to address the unequal distribution and the results showed no significant violations.
6. The sample in this study was confined to teachers of middle school mathematics affiliated to the Florida Council of Teachers of Mathematics – on a voluntary basis, due to availability. The use of this convenience sample limited the conclusions obtained within this study to the population represented by the sample. This inability to generalize the results to different types of populations was perhaps one of the largest limitations of this study.

### **Recommendations for Future Research**

This study was limited to the respondents who could be reached through email or teachers who received the FCTM newsletter, and were willing to respond to an online survey about self-efficacy and instructional strategies. Participant responses were limited to those teachers of middle school mathematics in the state of Florida who received invitation emails or received the FCTM newsletter. Future studies could address this limitation by conducting onsite surveys where all teachers of middle school mathematics would be accessible.

Findings from this study and other studies related to teacher self-efficacy suggested that teachers with higher self-efficacy scores tend to spend more time using strategies such as direct instruction, collaborative learning, problem-based learning, and

manipulatives and multiple representations (Ashton & Webb, 1996; Bandura, 1997; Chacon, 2005; Pajares, 1992; Pajares & Urdan 2006). Unfortunately none of these studies were reported in the area of mathematics.

To improve generalizability of future findings, future studies should measure self-efficacy scores and the use of instructional strategies of middle school mathematics teachers from different school districts within a state, as well as examining teachers of middle school mathematics from different states. Another possibility would be to conduct a longitudinal study following a teacher sample to see if their self-efficacy scores and instructional strategies change as their years of teaching and amount of training increases.

Future research should include examining data using three groups, low self-efficacy, medium self-efficacy and high self-efficacy, instead of having only two groups, low self-efficacy and high self-efficacy. This would allow the researcher to conduct Post-hoc tests that may provide additional information regarding the relationships between the research variables, teacher self-efficacy and instructional strategies. To accomplish this, a larger sample would be necessary.

The findings of this study also presented unanticipated results that could be explored further. First, although statistical significance was found in teachers' self-efficacy scores depending on race and ethnicity, no conclusions could be drawn from this study due to the small sample size. It would be beneficial to determine if these differences truly exist. Further, it should be determined if these factors extend to other populations of mathematics teachers and how they affect teachers' instruction. Information about the relationship between teacher self-efficacy and race and ethnicity

could assist school districts and teacher education programs to develop training that targets specific areas of low self-efficacy. Increasing teacher self-efficacy may not only affect the use of teacher's instructional strategies but it could also transfer down to the student level by improving student achievement. Studies repeatedly demonstrated that teachers' self-efficacy influenced student performance (Ross, Hogaboam-Gray, Hannay, 2001; Tucker et al. 2005). The literature relating instructional strategies and self-efficacy to interest and student achievement also demonstrated a positive relationship between increased student self-efficacy and student performance (Anjun, 2006; Maier, & Curtin, 2005; Wadsorth, Husman, Duggan, & Pennington, 2007).

Second, due to the small sample size, the significant differences in the self-efficacy scores depending on type of the teachers' certificate were inconclusive. Therefore, this subject matter should be re-examined in future studies. In this research, teachers holding an elementary teaching certificate reported the highest self-efficacy scores and middle school teachers reported lower self-efficacy scores. It would be advantageous to determine if these differences could be generalized to other populations of mathematics teachers and to establish the reason for these variations.

Another area for future research could be the use of technology aided instruction. Interestingly, this study indicated that teachers in the lower self-efficacy group preferred to use technology more often than teachers in the high self-efficacy group. This could be for different reasons. One reason could be that they felt more comfortable with the technology than other methods of instruction, due to teacher age and instruction received during their teacher education experiences. They could also be reinforced to include technology more frequently, simply through using it. Another reason could be that since

these teachers self-reported less use of other methods of instruction such as direct instruction, problem-based learning, or collaborative learning, they used technology aided instruction to compensate for instructional shortcomings in other areas. According to Pajares and Urdan (2006), few studies have explored the role of self-efficacy in teaching with technology. Therefore, this area may be worth investigating.

This study examined demographic characteristics (gender, race and ethnicity, level of education, type of certificate, and years of experience) and teachers' scores in the TSES. However, future research could include participants' college majors and compare it to TSES and TIPS. It is possible that teachers' college major influenced their use of instructional strategies especially their use of technology. Additionally, teachers entering the teaching profession after working in other fields bring a different set of skills and dispositions that were not examined in this study.

Finally, additional research will be needed to determine the effectiveness of the instructional strategies in increasing student achievement. The majority of the studies that compared the use and effect of instructional strategies generalized their results across all subject areas (Au, 2007; Baker, Gersten, & Lee, 2002; Vogler, 2002). Research suggested that further analyses of the effect of empirically validated strategies on specific subject areas were needed (Marzano, Pickering & Pollock, 2001). The results from this study indicated that both low and high efficacy groups preferred similar strategies and their mean use was different. However, this research did not investigate the effectiveness of these strategies.

## **Implications for Practice**

The majority of studies examining teacher self-efficacy and instructional strategies research investigated areas other than mathematics or generalized results across subject areas. The literature identified the need for more research in the area of math instruction, specifically identifying effective instructional strategies and research that examines what effective teachers do to increase student learning (Foundations of Success, 2008). This study suggested that even among a seemingly homogenous sample, some demographic characteristics may possibly affect self-efficacy scores of middle school teachers of mathematics. The findings also suggested that teachers with higher self-efficacy scores are more likely to use strategies such as direct instruction, communication and study skills, and problem-based learning than teachers with lower self-efficacy scores during a five-period day.

Self-efficacy was a factor that affected academic performance by influencing teachers as well as students. Self-efficacy research in the area of mathematics consistently demonstrated a positive relationship between mathematics self-efficacy and students' mathematics performance (Anjum, 2006; Del Siegle & McCoach, 2007; Stansberry, 2001; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). Self-efficacy also impacted teacher motivation, persistence, instructional strategies and goals (Pajares, 2006), as well as their beliefs about the factors contributing to academic success (Bandura 1997; Pajares, 2006; Ross, Hagaboam-Gray, Hannay, 2001).

The researcher investigated teachers' self-efficacy and its relationship to teachers' instructional strategies among teachers of middle school mathematics. The results of this study demonstrated self-efficacy scores may influence teachers' instructional strategies.

Teachers with higher self-efficacy scores tended to use direct instruction, problem-based learning, communication and study skills, manipulatives and multiple representations, and collaborative learning more often than teachers with lower self-efficacy scores. These were strategies that were identified in the literature as being effective having high effect sizes in mathematics instruction (Haas, 2002). School districts and school administrators may use this information to add professional development opportunities for middle school mathematics teachers. Increasing teacher self-efficacy could assist in developing teacher capacity that could result in the use of instructional strategies associated with increased student achievement.

Demographic characteristics were important factors in this study. Race and ethnicity and type of teaching certificate could potentially affect self-efficacy scores. In addition, years of teaching and level of education approached near significant levels in the total teacher self-efficacy scores and education reached a significant level in efficacy of student engagement. School districts may use this information to provide added support and training that could eliminate such differences to ensure that all teachers were prepared to provide students high quality of instruction through the instructional methods used in their classrooms.

Teacher self-efficacy was related to important skills teachers need to motivate their students and to use effective instructional methods. These attributes are important when working with students who are not meeting grade level expectations. The understanding gained from self-efficacy research would assist administrators in finding additional training options. By increasing teacher efficacy, school administrators or mentors could help teachers enhance in areas such as organization, enthusiasm, openness

to new ideas and use of complex teaching strategies, and to adapt to change and stress that arises in mathematics classrooms.



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## **APPENDIX A**

### **SurveyMonkey Teachers' Sense of Efficacy Scale Survey (TSES)**



## Self-Efficacy and Instructional Practices

### Introduction

Thank you for taking the time to complete this survey!

The information you provide is strictly confidential.

The next two pages include the Voluntary Consent Form required to conduct research.

Please click "I agree" to proceed

## Voluntary Consent Form

Institutional Review Board for the Protection of Human Subjects  
Lynn University  
3601 N. Military Trail Boca Raton, Florida 33431

**THIS DOCUMENT SHALL ONLY BE USED TO PROVIDE AUTHORIZATION FOR VOLUNTARY CONSENT**

**PROJECT TITLE:** Self-Efficacy and Instruction in Mathematics  
**Project IRB Number:** 2009-011  
**Lynn University 3601 N. Military Trail Boca Raton, Florida 33431**

I J. Patricia Ordóñez-Feliciano, M. Ed., am a doctoral student at Lynn University. I am studying Global Leadership, with a specialization in Educational Leadership. One of my degree requirements is to conduct a research study. I am also an Assistant Principal and former mathematics department chairperson in the School District of Palm Beach County.

**DIRECTIONS FOR THE PARTICIPANT:** You are being asked to participate in my research study. Please read this carefully. This form provides you with information about the study. The Principal Investigator (J. Patricia Ordóñez-Feliciano, M. Ed) will answer all of your questions. Ask questions about anything you don't understand before deciding whether or not to participate. You are free to ask questions at any time before, during, or after your participation in this study. Your participation is entirely voluntary and you can refuse to participate without penalty or loss of benefits to which you are otherwise entitled. You acknowledge that you are at least 21 years of age, and that you do not have medical problems or language or educational barriers that precludes understanding of explanations contained in this authorization for voluntary consent.

**PURPOSE OF THIS RESEARCH STUDY:** The study explores the relationship between teacher level of self-efficacy and their instructional strategies. This study will compare the use of instructional strategies by teachers with different levels of self-efficacy. Approximately 350 middle school mathematics teachers who are members of the Florida Council of Teachers of Mathematics (FCTM) have been invited to participate in this study. Participants must be employed in a Florida school and be full time middle school mathematics teachers.

**PROCEDURES:** To complete the survey, you first have to agree to this voluntary consent form by clicking the "I Agree" button at the end of this form. You have the options either to complete the survey in a location of your choosing or to choose not to participate by clicking "Exit This Survey". If you agree to participate after reading this consent form, then you may proceed to the Teachers' Sense of Efficacy Scale (TSES) survey. After you complete the online Teachers' Sense of Efficacy Scale, you will take the online Teachers' Instructional Practices Survey (TIPS) and the teacher demographic characteristics survey. The three surveys have a total of 65 questions and will take approximately 15 minutes. You will submit your questionnaires by clicking on "submit" at the end of the surveys.

You are in a secure website. SurveyMonkey.com uses Secure Socket layer (SSL) encryption for both the survey link and survey pages during transmission to ensure confidentiality and survey security. SurveyMonkey does not record personal identification information which includes your email address and IP address. If needed, you will be advised of the type of browser and version necessary for proper encryption on the consent form.

**POSSIBLE RISKS OR DISCOMFORT:** This study involves minimal risk. In addition, participation in this study requires a minimal amount of your time and effort.

**POSSIBLE BENEFITS:** There may be no direct benefit to you in participating in this research. But knowledge may be gained which may help mathematics education. Understanding the relationship between self-efficacy and instructional strategies could assist school administrators and teacher educators by providing additional training options for teachers, which ultimate could be used to improve student performance.

## Voluntary Consent Form

**FINANCIAL CONSIDERATIONS:** There is no financial compensation for your participation in this research. There are no costs to you as a result of your participation in this study.

**CONFIDENTIALITY:** Every effort will be made to maintain confidentiality. Your identity in this study will be confidential. The Teachers' Sense of Efficacy Scale, the Teachers' Instructional Practices Survey and the Teacher Demographics Survey will be confidential. You will not be identified and data will be reported as "group" responses. Participation in this study is voluntary and agreeing to the consent form will constitute your informed consent to participate in the study. Your email address, IP address, and individual responses will not be identified nor tracked as part of data collection. Confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

The results of this study may be published in a dissertation, scientific journals or presented at professional meetings. However, individual privacy will be maintained in all publications or presentations resulting from this study.

All the data gathered during this study will be kept strictly confidential by the researcher. Data will be collected using Secure Socket layer (SSL) encryption from SurveyMonkey.com and will be stored in a password protected computer at the home of the primary researcher. Hard copies of survey results will be stored in locked files and destroyed after five years. All information will be held in strict confidence and will not be disclosed unless required by law or regulation.

**RIGHT TO WITHDRAW:** You are free to choose whether or not to participate in this study. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate.

**CONTACTS FOR QUESTIONS/ACCESS TO CONSENT FORM:** Any further questions you have about this study or your participation in it, either now or any time in the future, will be answered by J. Patricia Ordóñez-Feliciano, M. Ed., (Principal Investigator) who may be reached at: [REDACTED] and Dr. Adam Kosnitzky, faculty advisor who may be reached at: (305) 389-4800. For any questions regarding your rights as a research subject, you may call Dr. Farideh Farazmand, Chair of the Lynn University Institutional Review Board for the Protection of Human Subjects, at [REDACTED]. If any problems arise as a result of your participation in this study, please call the Principal Investigator (J. Patricia Ordóñez-Feliciano) and the faculty advisor (Dr. Adam Kosnitzky) immediately. Please print off a copy of this consent form for your records.

**INVESTIGATOR'S AFFIDAVIT:** I hereby certify that a written explanation of the nature of the above project has been provided to the person participating in this project. A copy of the written documentation provided is attached hereto. By the person's consent to voluntarily participate in this study, the person has represented that he/she is at least 21 years of age, and that he/she does not have a medical problem or language or educational barrier that precludes his/her understanding of my explanation. Therefore, I hereby certify that to the best of my knowledge the person participating in this project understands clearly the nature, demands, benefits, and risks involved in his/her participation.

J. Patricia Ordonez-Feliciano  
Signature of Investigator

Date of IRB Approval: 4/9/2009  
Expiration Date: 4/9/2010

If you wish to participate, you MUST click "I Agree", otherwise click "Exit this Survey" if you do not wish to participate in this study.

## Teachers' Sense of Efficacy Scale

### Teacher Beliefs

Directions: This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. Please indicate your opinion about each of the statements below. Your answers are confidential.

#### 1. How much can you do to control disruptive behavior in the classroom?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 2. How much can you do to motivate students who show low interest in school work?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 3. How much can you do to get students to believe they can do well in school?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 4. How much can you do to help your students value learning?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 5. To what extent can you craft good questions for your students?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 6. How much can you do to get children to follow classroom rules?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 7. How much can you do to calm a student who is disruptive or noisy?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 8. How well can you establish a classroom management system with each group of students?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

#### 9. How much can you use a variety of assessment strategies?

Select one

(1) Nothing	(2)	(3) Very Little	(4)	(5) Some Influence	(6)	(7) Quite A Bit	(8)	(9) A Great Deal
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**10. To what extent can you provide an alternative explanation or example when students are confused?**

Select one      (1) Nothing      (2)      (3) Very Little      (4)      (5) Some Influence      (6)      (7) Quite A Bit      (8)      (9) A Great Deal

                                              

**11. How much can you assist families in helping their children do well in school?**

Select one      (1) Nothing      (2)      (3) Very Little      (4)      (5) Some Influence      (6)      (7) Quite A Bit      (8)      (9) A Great Deal

                                              

**12. How well can you implement alternative strategies in your classroom?**

Select one      (1) Nothing      (2)      (3) Very Little      (4)      (5) Some Influence      (6)      (7) Quite A Bit      (8)      (9) A Great Deal

                                              

*Note. Teachers Sense of Efficacy Scale (TSES) by Tschannen-Morgan & Hoy, 2001. Retrieved from <http://www.coe.ohio-state.edu/ahoy/researchinstruments.htm>. Adopted with permission.*

**APPENDIX B**

**Permission Letter from Dr. Anita Woolfolk Hoy**

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

Anita Woolfolk Hoy, Ph.D.

Professor  
Psychological Studies in Education

Dear Patricia Ordonez-Feliciano,

You have my permission to use the *Teachers' Sense of Efficacy Scale* in your research. A copy of both the long and short forms of the instrument as well as scoring instructions can be found at:

<http://www.coe.ohio-state.edu/ahoy/researchinstruments.htm>

Best wishes in your work,

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

Anita Woolfolk Hoy, Ph.D.  
Professor

College of Education  
29 West Woodruff Avenue  
Columbus, Ohio 43210-1177

[www.coe.ohio-state.edu/ahoy](http://www.coe.ohio-state.edu/ahoy)

Phone

FAX

## **APPENDIX C**

### **SurveyMonkey Teachers' Instructional Practices Survey (TIPS)**



## Self-Efficacy and Instructional Practices

### Teachers' Instructional Practices Survey

For each of the following statements, please select the choice that best indicates the number of times you use this teaching method, given five typical class periods. For example, if you use this teaching method during every period, please select 5 from the dropdown box. If you never use this method, please select 0.

#### Cooperative Learning

1. I collaborate with the whole class in finding a solution to a problem.

2. I allow students to engage in cooperative problem solving.

3. I allow students to discuss solutions to algebra problems with peers.

4. I allow students to begin homework in class with peer assistance.

5. I pair students to work as peer tutors.

6. I reward group performance in the cooperative setting.

7. I assign students to work in homogeneous groups.

8. I assign students to work in heterogeneous groups.

9. I encourage students to use mathematics vocabulary terms in class discussions.

10. I have students describe their thought processes orally or in writing during problem solving.

11. I require students to share their thinking by conjecturing, arguing, and justifying ideas.

12. I have students write about their problem solving strategies.

## Self-Efficacy and Instructional Practices

13. I encourage students to ask questions when difficulties or misunderstandings arise.

 

14. I encourage students to explain the reasoning behind their ideas.

 

15. I use reading instructional strategies to help students with comprehension.

 

16. I provide students with study skills instruction.

 

17. I have students use calculators during tests or quizzes (given five typical test or quiz administrations).

 

18. I have students use calculators for problem solving instruction and activities.

 

19. I have students use calculators to help them develop problem-solving strategies.

 

20. I have students use calculators for computations.

 

21. I have students use graphing calculators to explore linear relationships.

 

22. I have students use computer spreadsheets, such as Microsoft Excel, for problem solving instruction.

 

23. I assign students to use calculators as a requirement for class participation.

 

24. I use computer software to provide practice opportunities.

 

25. I have students create their own rules in new problem solving situations.

 

26. I draw mathematical concepts from "real-life" situations.

## Self-Efficacy and Instructional Practices

27. I have students pursue open-ended and extended problem solving projects.

 

28. I create problems from the interests of individual students.

 

29. I recognize many alternative problem-solving practices.

 

30. I emphasize the problem solving process, rather than the solution.

 

31. I anchor problem solving skills instruction within situations meaningful to the students.

 

32. I encourage students to experiment with alternative methods for problem solving.

 

33. I have students use cubes or blocks to represent algebraic equations.

 

34. I illustrate mathematical concepts for students with pictures.

 

35. I teach students to represent algebraic equations with graphs.

 

36. I teach students to represent problems with tables.

 

37. I teach students to represent problems with charts to break information into smaller pieces.

 

38. I emphasize the use of multiple representations: words, tables, graphs, and symbols.

 

39. I provide math games for students to practice algebraic skills.

 

40. I use diagrams to help students learn to solve equations.

## Self-Efficacy and Instructional Practices

41. I grade homework and provide feedback.

 

42. I close instruction by reviewing concepts with students, emphasizing comparisons to previously covered concepts.

 

43. When providing feedback, I target incorrect responses and error patterns.

 

44. I identify a new skill or concept at the beginning of instruction and provide a rationale for learning it.

 

45. I provide graduated sequence of instruction, moving students from concrete to abstract concepts in defined steps.

 

46. I require students to indicate a one-step-at-a-time process in working equations.

 

47. I use pre-worked examples to introduce or reinforce topics.

 

48. When assigning practice work, I ensure that the majority of the problems review previously covered material.

 

*Note. Teachers' Instructional Practices Survey by Haas, 2002. The influence of teaching methods on student achievement on Virginia's end of course standards of learning test for Algebra I. (2002). Retrieved from <http://scholar.lib.vt.edu/theses/available/etd-10062002-202857>. Adopted with permission.*

## **APPENDIX D**

### **Permission Letter from Dr. Matthew Haas**

From: Matthew Haas [REDACTED] Sent: Thu 9/25/2008 1:43 PM  
To: Patricia Ordonez  
Cc:  
Subject: RE: Permission to use Research Instrument  
Attachments:

Hello Patricia:

You certainly have permission. Thanks for asking, and I wish you the best in your work!

Matt Haas

Albemarle High School

---

**From:** Patricia Ordonez  
**Sent:** Tuesday, September 23, 2008 9:35 AM  
**To:** Matthew Haas  
**Subject:** Permission to use Research Instrument

Dr. Haas,

I would like to thank you for taking the time to speak with me about the instrument you developed and validated in your dissertation, "The Influence of Teaching Methods on Student Achievement on Virginia's End of Course Standards of Learning Test for Algebra 1". I am currently completing my Ph. D. through Lynn University in Boca Raton, Florida. My dissertation topic is "Self-efficacy and Instruction in Mathematics". I will be exploring the relationship between mathematics teachers' self-efficacy and their use of instructional strategies. I am considering using the instrument you developed in your dissertation for my study. Therefore, I am requesting permission to use your instrument.

Thank you once again for your time.

***Patricia Ordonez-Feliciano***

## **APPENDIX E**

### **SurveyMonkey Teacher Demographic Characteristics Survey**

## Self-Efficacy and Instructional Practices

### Teacher Demographic Information

Please complete the following statements.

#### 1. Gender

1. Male

2. Female

#### 2. Race

1. White

3. Hispanic or Latino

5. American Indian or Alaska Native

2. Black or African American

4. Asian

6. Native Hawaiian or Pacific Islander

#### 3. Number of years teaching mathematics

0-5

6-10

11-15

16-20

21 or more

#### 4. Type of teaching certificate

1. Elementary Education (K-6)

3. Mathematics (High 6-12)

2. Mathematics (Middle 5-9)

4. Other

#### 5. Highest level of education achieved

1. Bachelors

2. Masters

3. Educational Specialist

4. Doctorate



**APPENDIX F**

**Voluntary Consent Form**

**Institutional Review Board for the Protection of Human Subjects**  
**Lynn University**  
**3601 N. Military Trail Boca Raton, Florida 33431**  
**THIS DOCUMENT SHALL ONLY BE USED TO PROVIDE AUTHORIZATION**  
**FOR VOLUNTARY CONSENT**

**PROJECT TITLE: Self-Efficacy and Instruction in Mathematics**

Project IRB Number: 2009-011 Lynn University 3601 N. Military Trail Boca Raton, Florida 33431

I J. Patricia Ordóñez-Feliciano, M. Ed., am a doctoral student at Lynn University. I am studying Global Leadership, with a specialization in Educational Leadership. One of my degree requirements is to conduct a research study. I am also an Assistant Principal and former mathematics department chairperson in the School District of Palm Beach County.

**DIRECTIONS FOR THE PARTICIPANT:** You are being asked to participate in my research study. Please read this carefully. This form provides you with information about the study. The Principal Investigator (J. Patricia Ordóñez-Feliciano, M. Ed) will answer all of your questions. Ask questions about anything you don't understand before deciding whether or not to participate. You are free to ask questions at any time before, during, or after your participation in this study. Your participation is entirely voluntary and you can refuse to participate without penalty or loss of benefits to which you are otherwise entitled. You acknowledge that you are at least 21 years of age, and that you do not have medical problems or language or educational barriers that precludes understanding of explanations contained in this authorization for voluntary consent.

**PURPOSE OF THIS RESEARCH STUDY:** The study explores the relationship between teacher level of self-efficacy and their instructional strategies. This study will compare the use of instructional strategies by teachers with different levels of self-efficacy. Approximately 350 middle school mathematics teachers who are members of the Florida Council of Teachers of Mathematics (FCTM) have been invited to participate in this study. Participants must be employed in a Florida school and be full time middle school mathematics teachers.

**PROCEDURES:** To complete the survey, you first have to agree to this voluntary consent form by clicking the "I Agree" button at the end of this form. You have the options either to complete the survey in a location of your choosing or to choose not to participate by clicking "Exit This Survey". If you agree to participate after reading this consent form, then you may proceed to the *Teachers' Sense of Efficacy Scale (TSES)* survey. After you complete the online *Teachers' Sense of Efficacy Scale*, you will take the online *Teachers' Instructional Practices Survey (TIPS)* and the *teacher demographic characteristics survey*. The three surveys have a total of 65 questions and will take approximately 15 minutes. You will submit your questionnaires by clicking on "submit" at the end of the surveys.

You are in a secure website. SurveyMonkey.com uses Secure Socket layer (SSL) encryption for both the survey link and survey pages during transmission to ensure confidentiality and survey security. SurveyMonkey does not record personal identification information which includes your email address and IP address. If needed, you will be advised of the type of browser and version necessary for proper encryption on the consent form.

**POSSIBLE RISKS OR DISCOMFORT:** This study involves minimal risk. In addition, participation in this study requires a minimal amount of your time and effort.

**POSSIBLE BENEFITS:** There may be no direct benefit to you in participating in this research. But knowledge may be gained which may help mathematics education. Understanding the relationship between self-efficacy and instructional strategies could assist school administrators and teacher educators by providing additional training options for teachers, which ultimate could be used to improve student performance.

**FINANCIAL CONSIDERATIONS:** There is no financial compensation for your participation in this research. There are no costs to you as a result of your participation in this study.

**CONFIDENTIALITY:** Every effort will be made to maintain confidentiality. Your identity in this study will be confidential. The Teachers' Sense of Efficacy Scale, the Teachers' Instructional Practices Survey and the Teacher Demographics Survey will be confidential. You will not be identified and data will be reported as "group" responses. Participation in this study is voluntary and agreeing to the consent form will constitute your informed consent to participate in the study. You email address, IP address, and individual responses will not be identified nor tracked as part of data collection. Confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

The results of this study may be published in a dissertation, scientific journals or presented at professional meetings. However, individual privacy will be maintained in all publications or presentations resulting from this study.

All the data gathered during this study will be kept strictly confidential by the researcher. Data will be collected using Secure Socket layer (SSL) encryption from SurveyMonkey.com and will be stored in a password protected computer at the home of the primary researcher. Hard copies of survey results will be stored in locked files and destroyed after five years. All information will be held in strict confidence and will not be disclosed unless required by law or regulation.

**RIGHT TO WITHDRAW:** You are free to choose whether or not to participate in this study. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate.

**CONTACTS FOR QUESTIONS/ACCESS TO CONSENT FORM:** Any further questions you have about this study or your participation in it, either now or any time in

the future, will be answered by J. Patricia Ordóñez-Feliciano, M. Ed., (Principal Investigator) who may be reached at: [REDACTED] and Dr. Adam Kosnitzky, faculty advisor who may be reached at: [REDACTED]. For any questions regarding your rights as a research subject, you may call Dr. Farideh Farazmand, Chair of the Lynn University Institutional Review Board for the Protection of Human Subjects, at [REDACTED]. If any problems arise as a result of your participation in this study, please call the Principal Investigator (J. Patricia Ordóñez-Feliciano) and the faculty advisor (Dr. Adam Kosnitzky) immediately.

Please print off a copy of this consent form for your records.

**INVESTIGATOR'S AFFIDAVIT:** I hereby certify that a written explanation of the nature of the above project has been provided to the person participating in this project. A copy of the written documentation provided is attached hereto. By the person's consent to voluntarily participate in this study, the person has represented that he/she is at least 21 years of age, and that he/she does not have a medical problem or language or educational barrier that precludes his/her understanding of my explanation. Therefore, I hereby certify that to the best of my knowledge the person participating in this project understands clearly the nature, demands, benefits, and risks involved in his/her participation.

[REDACTED]

Signature of Investigator

Date of IRB Approval: 4/9/2009  
Expiration Date: 4/9/2010

If you wish to participate, you MUST click "I Agree", otherwise click "Exit this Survey" if you do not wish to participate in this study.

**APPENDIX G**

**Request to Collect Data through FCTM Website**

January 13, 2009

Dr. Denisse Thompson, FCTM President  
Executive Board Members, FCTM

Dear Dr. Thompson and Executive Board Members,

I am a Ph. D. student at Lynn University in Boca Raton, Florida. I am writing to request your help to conduct research in an area that I believe will help mathematics education. As a mathematics instructional leader and assistant principal, I am frequently assisting teachers with the challenge of selecting the instructional strategies that best fit their students' needs. The literature revealed that not much research was done to identify factors that influence teachers' selection of strategies and it also highlighted the need for more research. As a result, my study focuses on one of these factors, self-efficacy.

I will examine the relationship between mathematics teachers' level of self-efficacy and their use of instructional strategies. I will measure self-efficacy using the Teachers' Sense of Efficacy Scale (TSES) and instructional strategies using the Teachers' Instructional Practices Survey (TIPS), both will be available online.

I am contacting you to seek permission to survey middle school teachers in April. If you grant this permission, I will provide Dr. Thompson, FCTM President with the copy of the invitation to participate in my research. This invitation will be included in the FCTM Newsletter and also given to Regional Directors for it to be disseminated to local affiliates. The link to the survey will be posted in the FCTM Website for two weeks. Teachers will complete the survey electronically and confidentiality will be maintained. Participants' email address, IP address, and individual responses will not be identified nor tracked as part of data collection. I will share the results of this study with FCTM.

Thank you for considering my request. If you grant permission, please send the written approval to me at 3002 Hamblin Way, Wellington, Florida, 33414. If you have any questions or concerns, please call me at [REDACTED]. I believe this research will benefit teacher educators and school administrators by providing additional training options for teachers and it will also offer teachers valuable information, which ultimately could be used to improve student performance.

[REDACTED]  
J. Patricia Ordonez-Feliciano  
Ph. D. Candidate  
Lynn University

Adam Kosnitzky, Ph. D.  
Dissertation Chair  
Lynn University

## **APPENDIX H**

### ***Permission Letter from FCTM President***



**Florida Council of Teachers of Mathematics**  
AFFILIATED WITH NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

February 9, 2009

J. Patricia Ordonez-Feliciano  
[REDACTED]

Dear Ms. Ordonez-Feliciano:

I am responding to your request for assistance from the Florida Council of Teachers of Mathematics (FCTM) to solicit participants for your research on self-efficacy and instruction in mathematics. After discussion with the Board of Directors, we have agreed to provide the following assistance:

- The President will mention your research in the President's message in the upcoming issue of *Dimensions in Mathematics*, the official journal of the Council, and encourage teachers to participate.
- The President will mention your research in the President's message in the Spring issue of *Additional Dimensions*, the Council's newsletter, and again encourage teachers to participate.
- Our webmaster will place a link to the survey on FCTM's website (fctm.net) so that participants can complete the survey. You will send the necessary information to me and I will communicate that information to FCTM's webmaster.
- As President, I will send an electronic invitation to participate, which you will provide, to each of our 14 Region Directors and request that they send this invitation to FCTM members in their respective regions.

The above assistance is contingent on our receipt of a copy of your university's IRB approval letter. Please be aware that our website does not have a password-protected section, so we have no control over who might find the survey link and choose to complete it. Also, as President, I must request that you send materials to me rather than directly to the Region Directors and I will forward those materials to them. Although web addresses for the members of the Board of Directors are on FCTM's website, the Council's policy is that names and addresses of our members are not made public.

After your research is completed, we hope that you might write a brief summary of your research and share it with the Council's members through *Dimensions in Mathematics*.

I trust this letter contains the information you need for your institution's IRB committee. If there is further information you need, please feel free to contact me at [REDACTED] or via phone [REDACTED].

Sincerely,  
[REDACTED]

Denisse R. Thompson, Ph.D.  
President, 2008-2009



## **APPENDIX I**

### **Invitation Distributed to FCTM Members**



## ATTENTION

### MIDDLE SCHOOL MATHEMATICS TEACHERS

#### Self-Efficacy and Instruction in Mathematics Research Study

Dear Middle School Mathematics Teachers,

As a result of the No Child Left Behind Act (NCLB), mathematics teachers face unprecedented challenges to bring all students to proficiency levels. Selecting and using the research-based strategies best suited for our students is a key factor. Therefore, I am studying the relationship between teacher self-efficacy and use of instructional strategies among middle school mathematics teachers.

I am asking you to complete a **brief online survey**. The information you provide will assist in determining how teachers' beliefs relate to the strategies implemented in the classroom. Understanding this relationship could assist you with **valuable information towards facilitating your choice of instructional strategies**.

Log on to the Florida Council Teachers of Mathematics (FCTM) Website:

**<http://www.fctm.net/>**

click on *Self-Efficacy and Instruction Research Study*

Information collected through this online survey will be **confidential**. No identifying information will be tracked as part of the data collection. The results of this study will be available through FCTM. If you have any questions or need assistance, please e-mail me at [REDACTED] or call me at [REDACTED]

Thank you. I truly appreciate your participation in this study!

Respectfully,

J. Patricia Ordonez-Feliciano  
Ph. D. Candidate  
Lynn University  
Boca Raton, Florida

**APPENDIX J**

**Lynn University IRB Approval Letter**



Lynn University

**Principal Investigator:** Juana Patricia Ordonez-Feliciano  
**Project Title:** Self-Efficacy and Instruction in Mathematics

**IRB Project Number:** 2009-011 REQUEST FOR EXPEDITED REVIEW of Application and Research Protocol for a New Project

**IRB Action by the IRB Chair or Another Member or Members Designed by the Chair**

Expedited Review of Application and Research Protocol and Request for Expedited Review (FORM 3): Approved  Approved; w/provision(s) \_\_\_

COMMENTS:

Consent Required: No \_\_\_ Yes  Not Applicable \_\_\_ Written  Signed \_\_\_

Consent forms must bear the research protocol expiration date of 4/9/2010

Application to Continue/Renew is due:

- 1) For an Expedited IRB Review, one month prior to the due date for renewal
- 2) Other:

Name of IRB Chair: Farideh Farazmand

Signature of IRB Chair \_\_\_\_\_ Date: 4/9/09

Cc. Dr. Kosnitzky

Institutional Review Board for the Protection of Human Subjects  
Lynn University  
3601 N. Military Trail Boca Raton, Florida 33431

## **APPENDIX K**

### **Encryption Verification (SSL) from SurveyMonkey**

Account Summary

Billing

Transfer Survey

Event Log

## Account Summary

### Account Details

Account Type: Professional Monthly Account

Upgrade to Annual No

Subscription Renewal: Enabled (On 03/07/09, your subscription will automatically renew.)

Cancel Renew

Responses this Month: 2



Tired of paying response overage charges? [Upgrade to an annual subscription](#) and get UNLIMITED responses for FREE! You'll also receive a 2 month discount!

SSL Enabled: Option is available for your surveys

### Login Settings

User Name: pordonez-feliciano



Password: \*\*\*\*\*



Contact Email: [REDACTED]



### Preferences

024L4457364  
03/15/10 39800

#ffgroup