

REVEALING WHAT URBAN EARLY CHILDHOOD TEACHERS THINK  
ABOUT MATHEMATICS AND HOW THEY TEACH IT:  
IMPLICATIONS FOR PRACTICE

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ABSTRACT

Hersh (1986) states, “One’s conception of what mathematics is affects one’s conception of how it should be presented. One’s manner of presenting it is an indication of what one believes to be most essential in it.” In this research study, three hundred ninety-seven urban early childhood teachers were given a survey that examined their attitudes toward mathematics and mathematics teaching, their views of mathematics, views of teaching mathematics, and views of children learning mathematics. The purpose of this study was to identify the attitudes and beliefs of early childhood teachers in two urban school districts to determine if mathematics reform efforts made a difference in teachers’ attitudes and beliefs about mathematics and its teaching.

Questionnaires were mailed directly to teachers in one school district and principals distributed questionnaires in the other. Summary scores were calculated for parts of the instrument. The researcher performed descriptive statistics, comparative analysis, and conducted frequency distributions, t-tests, ANOVA, and Pearson Correlations.

Findings revealed that teachers with 30 or more years of teaching experience had more positive attitudes toward mathematics than teachers with 1-3 years of experience. African American teachers had more positive attitudes toward mathematics and its teaching than other ethnic groups. Teachers who held a minor or major in mathematics had more positive attitudes toward mathematics and its teaching than teachers without a minor or major in mathematics. Teachers in District-A favored constructivist learning while teachers in District-B favored rote learning. Both school districts' teachers favored the problem-solving approach to teaching mathematics.

If instruction is to be transformed, reformers need to understand teachers' beliefs about mathematics. Beliefs, which are essential for teachers' development, seldom change without significant intervention (Lappan and Theule-Lubienski, 1994). Therefore, school districts must be informed about the changes necessary for the reform of mathematics teaching and identify and implement through staff developments and other measures what they perceive mathematics to be and how it should be taught.

# CHAPTER I

## INTRODUCTION

Mathematics is at the heart of many successful careers and successful lives (National Council of Teachers of Mathematics [NCTM], 1998a). However, mathematics seems to be the number one academic subject disliked by children (National Urban League, 1999; ERIC Clearinghouse on Rural Education and Small Schools, 1989), and misunderstood by so many--even those in the profession of teaching. A person's understanding of the nature of mathematics predicated that person's view of how teaching should take place in the classroom (Hersh, 1986). It is not, as some may believe, one's opinion of the best way to teach. Hersh (1986) states that "one's conception of what mathematics is affects one's conception of how it should be presented. One's manner of presenting it is an indication of what one believes to be most essential in it.... The issue, then, is not, What is the best way to teach? but, What is mathematics really all about?" (p. 13)

Hersh (1986) also defines mathematics as ideas, not marks made with pencils or chalk, not physical triangles or physical sets, but ideas (which may be represented or suggested by physical objects). He listed three main properties of mathematical activity or mathematical knowledge:

1. Mathematical objects are invented or created by humans.
2. They are created, not arbitrarily, but arise from activity with already existing

mathematical objects, and from the needs of science and daily life.

3. Once created, mathematical objects have properties which are well-determined, which we may have great difficulty discovering, but which are possessed independently of our knowledge of them. (Hersh, 1986, pp. 22-23)

The National Council of Teachers of Mathematics (NCTM) describes a high-quality mathematics education as one that develops mathematical power for all students. It defines mathematical power as the ability to conjecture, explore, and reason logically; to communicate about and through mathematics; to solve nonroutine problems; and to connect ideas within and between mathematics and other intellectual entities.

Mathematical power also involves “the development of personal self-confidence and a disposition to seek, evaluate, and use quantitative and spatial information in solving problems and in making decisions” (p.1). The NCTM believes the best way for all students to develop mathematical power is through “the creation of a curriculum and an environment, in which teaching and learning is to occur, that are very different from much of current practice” (p. 1).

The NCTM also has a strong philosophy regarding how mathematics should be taught. Their conception of mathematical teaching is one in which “students engage in purposeful activities that grow out of problem situations, requiring reasoning and creative thinking, gathering and applying information, discovering, inventing, and communicating ideas, and testing those ideas through critical reflection and argumentation” (Thompson, 1992, p.128). This view is in contrast to the view of mastering concepts and procedures as the end result of instruction. However, the NCTM does not deny the value and place

of mathematical concepts and procedures in the curriculum. The NCTM (1989) proclaims the “value lies in the extent to which it is useful in the course of some purposeful activity” (p. 7). They assert that fundamental concepts and procedures from some branches of mathematics should be known by all students....But instruction should persistently emphasize ‘doing’ rather than ‘knowing that’ (p. 7).

#### Statement of the Problem

Since the 1980’s the NCTM has played a major role in the reformation of mathematics. This organization has developed a set of national standards for improving the quality of education in America. It created professional standards for teaching mathematics as well standards for mathematics curriculum and evaluation in order to guide reform in school mathematics. The Professional Standards for Teaching Mathematics “spells out what teachers need to know to teach toward new goals for mathematics education and how teaching should be evaluated for the purpose of improvement” (NCTM, 1991, p. vii). The Curriculum and Evaluation Standards for School Mathematics

is an operational plan for instruction that details what students need to know, how students are to achieve the identified curricular goals, what teachers are to do to help students develop their mathematical knowledge, and the context in which learning and teaching occur.... Standards have been articulated for evaluating both student performance and curricular programs, with emphasis on the role of evaluative measures in gathering information on which teachers can base subsequent instruction. The standards also acknowledge the value of gathering

information about student growth and achievement for research and administrative purposes. (pp. 1-2).

The problems are several: The researcher questions if mathematics reform efforts have impacted the way early childhood teachers present mathematics in the classroom. Has reform changed or altered early childhood teachers' beliefs and attitudes regarding the teaching of mathematics? Teachers conceptualize as well as conduct mathematics classes in ways not aligned to mathematics reform efforts; and students' mathematics achievement yet lags behind other countries (National Science Foundation, 1996; Sawada, 1999; Thompson, 1992; Valverde & Schmidt, 1997-98). Moreover, students are still anxiety bound with regard to learning mathematics (Le Moyne, College, 1999; Martinez & Martinez, 1996). Mathematics teaching is a national priority in public schooling; as it stands, we do not have enough information on teacher attitudes and beliefs and how these constructs impact student achievement. The researcher's study is a start in looking at urban early childhood teachers' attitudes and beliefs about mathematics and how they perceive mathematics should be taught and learned. These two constructs, attitudes and beliefs, appear to prevent teachers from accepting the mathematics reform efforts as outlined by the National Council of Teachers of Mathematics (NCTM).

Welch (1978) and others describe little change in the way mathematics classes are conducted today than ten to twenty years ago (National Council of Teachers of Mathematics, 1989; National Research Council, 1989; Weiss, 1989). Battista (1999) asks, "How would you react if your doctor treated you or your children with methods that were 10 to 15 years out-of-date, ignored current scientific findings about diseases and

medical treatment, and contradicted all professional recommendations for practice? It is highly unlikely that you would passively ignore such practice” (p. 426). Yet that is exactly what happens with traditional mathematics teaching, which is still our nation’s norm in schools. Perry (1992) in her disgust of the way mathematics is being taught today in so many classrooms states, “We are educating today’s students with the schools of yesterday for the world of tomorrow” (p. 1).

For years there has been much discussion about the need to reform mathematical education in the United States. Those who censure current school mathematics instruction argue that not only does “it misrepresent mathematics to the students, but also accounts in large part for their poor performance in national and international assessments” (Thompson, 1992, p.128). Those who advocate mathematics reform maintain that mathematics teaching should not only be about explaining its content, but also about engaging students in the processes of doing mathematics. The following descriptions of mathematics classes were drawn from the National Science Foundation (NSF) case studies (Welch, 1978):

In all math classes that I visited, the sequence of activities was the same. First, answers were given for the previous day’s assignment. The more difficult problems were worked on by the teacher or the students at the chalkboard. A brief explanation, sometimes none at all, was given of the new material, and the problems assigned for the next day. The remainder of the class was devoted to working on homework while the teacher moved around the room answering

questions. The most noticeable thing about math classes was the repetition of this routine. (p. 6)

Many teacher education programs thought that by producing “teacher-proof” curriculum it would solve the problems of mathematics instruction (Thompson, 1992).

Thompson (1992) states:

Thanks to studies of teachers’ thinking and decision making, educators now recognize that how teachers interpret and implement curricula is influenced significantly by their knowledge and beliefs. By recognizing that bringing about changes in what goes on in mathematics classrooms depends on individual teachers changing their approaches to teaching and that these approaches, in turn, are influenced by teachers’ conceptions, mathematics educators have acknowledged the importance of this line of research. (p.128)

The question then, are teachers among the catalyst for transferring a dislike for mathematics and mathematics anxiety down to future generations of students?

Mathematics anxiety is defined as a feeling of intense frustration or helplessness about one’s ability to do mathematics (Smith & Smith, 1998). It is also described as a learned emotional response to one or more of the following:

1. participating in a math class
2. listening to a lecture
3. working through problems
4. discussing mathematics (Le Moyne College, 1999)

Martinez and Martinez (1996) proclaims that “most math anxiety is learned at a very early age—often in elementary school and even sometimes in kindergarten” (p .10). Therefore, preventing mathematics anxiety must begin with the elementary school teacher. Unfortunately, many mathematics teachers are math anxious themselves (Martinez & Martinez, 1996). Whatever the cause for this anxiety, if left untreated; teachers’ anxieties may not only grow, but also infect another generation of students. “Math-anxious teachers produce math-anxious students, and helping teachers confront and control their own fears and feelings of insecurity when faced with numbers is essential if we are to stop the spread of the disease” (Martinez & Martinez, 1996, p. 10). “ To get kids excited about math, you need to tackle their fear of the subject head-on” (Bernstein, 1999). One must create conditions that allow for discovery, where children see what they are learning is real--then mathematics becomes fun (Bernstein, 1999).

#### Rationale for the Study

##### Reformation of Mathematics Education

Educational reform is not a new idea but it has been gaining momentum since the 1950’s. Sputnik 1 in 1957 was a wake-up call in mathematics and in other areas for the United States (Perry, 1992). In 1958, Congress passed the National Defense Education Act (NDEA) in response to the launching of the Sputnik satellite by the Soviet Union (Fruehling, 1993-96; Powell, 1993-96; Tatarewicz, 1993-96; U.S. Department of Education, 1998, 1999a, 1999b). “To help ensure that highly trained individuals would be available to help America compete with the Soviet Union in scientific and technical fields, the NDEA included support for loans to college students, the improvement of

science, mathematics, and foreign language instruction in elementary and secondary schools, graduate fellowships, foreign language and area studies, and vocational-technical training” (U.S. Department of Education, 1999b, p. 2). (The Soviet Union launched several Sputniks from 1957 to 1961. “The official name of the satellite was *Iskustvennyi Sputnik Zemli* [fellow world traveler of the earth]” [Tatarewicz, 1993-96].)

To continue this fight of power, the United States also passed the Elementary and Secondary Act (ESEA) in 1965. It was a federal commitment to financing public education. This commitment expanded enormously, especially in educational opportunities for disabled, poor and black children (Powell, 1993-96; American Speech-Language-Hearing Association [ASHA], 1999). As amended, it has become “the single largest Federal law supporting educational programs in local school districts” (ASHA, 1999, p. 1). The Improving America’s School’s Act was the 1994 reauthorization of the ESEA. This improvement act “reflected a bipartisan effort to raise academic expectations for all children by helping states and school districts to set high standards and establish goals for improving student achievement” (ASHA, 1999, p. 1).

The National Science Foundation (NSF) established in 1950 by the National Science Foundation Act also rose to the call for reform in science and mathematics (U.S. Department of Education, 1998; National Science Foundation, 1999). It is an independent U.S. government agency responsible for promoting science (including mathematics) and engineering through programs that invest over \$3 billion per year in about 20,000 research and education projects in science and engineering (National Science Foundation, 1999a). The NSF provides funds through grants, contracts, and

cooperative agreements. This federal program accounts for about 20 percent of federal support to academic institutions for basic research in these areas (National Science Foundation, 1999b).

According to Haury (1993), the U.S. Department of Education and the National Science foundation together endorses mathematics and science curriculum that “promote active learning, inquiry, problem solving, cooperative learning, and other instructional methods that motivate students” (p. 1). The National Council of Teachers of Mathematics (NCTM) also advocates this approach.

The impact from the 1950’s is also evident at the beginning of the 21<sup>st</sup> Century in the National Education Goals. The Nation as in the past continues to hold fast to its commitment to make big strides in the scientific and technological world. In 1989, the governors of the U.S. adopted six goals that were incorporated into the Goals 2000: Educate America Act and the Goals 2000 legislation inevitably defined eight goals (U.S. Department of Education, 1999c). The American 2000 National Education Goals 3 and 5 deals with student achievement in mathematics and science. The eight goals state, by the year 2000:

1. School Readiness: All children in America will start school ready to learn.
2. School Completion: The high school graduation rate will increase to at least 90 percent.
3. Student Achievement and Citizenship: American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter-including English, mathematics, science, foreign languages,

civics and government, economics, arts, history, and geography -[and leave school] prepared for responsible citizenship, further learning, and productive employment.

4. **Teacher Education and Professional Development:** The nation's teaching force will have access to programs for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to...prepare... students for the next century.
5. **Mathematics and Science:** U.S. students will be first in the world in science and mathematics achievement.
6. **Adult Literacy and Lifelong Learning:** Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.
7. **Safe, Disciplined, and Alcohol- and Drug-Free Schools:** Every school in America will be free of drugs, violence, and the unauthorized presence of firearms and alcohol and will offer a disciplined environment conducive to learning.
8. **Parental Participation:** Every school will promote partnerships that will increase parental involvement and participation in promoting the social, emotional, and academic growth of children. (U.S. Department of Education, 1999c, p. 1)

The rationale for educational reform also dealt with U.S. high school graduates not being able to perform entry level tasks in the workplace of technology and

information services. “International studies show the United States to be well down the educational list by almost every measure” (Perry, 1992). Perry (1992) also claims that:

...the United States has steadfastly held to the structure of the industrialized society of the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. We still train our students to passively accept the information given and to react with a uniform feedback method. In the industrialized society, workers were to perform, not think. In the technological society, critical thinking is the expectation; team problem solving is the norm. We have even held onto a remnant of the agrarian society—the summer recess during which students would help on the farm. The conclusion is obvious. [Worth stating again,] We are educating today’s students with the schools of yesterday for the world of tomorrow. (p. 1)

The current movement to reform mathematics education began in the 1980’s. National reports such as An Agenda for Action, 1980; A Nation at Risk, 1983; and A Report on the Crisis in Mathematics and Science Education, 1984, focused their attention on an impending crisis in education, particularly in mathematics and science (Edwards, 1994). In 1983 President Ronald Reagan appointed a National Commission on Excellence in Education (Brickman, 1993-96; Battista, 1999). The Commission’s report, A Nation at Risk (1983), combined with a predicted shortage of teachers in some fields, particularly in mathematics, for the late 20<sup>th</sup> century raised national awareness of the need to attract large numbers of high-quality teacher applicants and to improve their education and training. This reform movement was also “in response to the documented failure of traditional methods of teaching mathematics, to the curriculum changes necessitated by

the widespread availability of computing devices, and to a major paradigm shift in the scientific study of mathematics learning” (Battista, 1999, p. 426).

According to Battista (1999), the most noticeable element of reform has been the attempt by schools and teachers to implement the recommendations given in the Curriculum and Evaluation Standards for School Mathematics, published by the National Council of Teachers of Mathematics (NCTM) in 1989. “Reform recommendations in this and related documents deal with how mathematics is taught, what mathematics is taught, and, at a more fundamental level, the very nature of school mathematics” (Battista, 1999, p. 426).

The NCTM *Standards* “provide specifications for curriculum and instruction that call for significant change from current practice—both in content and in pedagogy” (Reys, Robinson, Sconiers, & Mark, 1999, p. 455). “The National Science Foundation provided major funding to establish projects for the development, piloting, and refinement of *Standards*-based mathematics programs” (Reys, Robinson, Sconiers, & Mark, 1999, p. 456). The Foundation provided funding for mathematics curriculum development projects at all levels and for numerous “large-scale systemic change projects to enhance teacher knowledge and skills and to prepare the way for the implementation of proposed reforms” (Schoen, Fey, Hirsch, & Coxford, 1999, p. 444).

With the publication of the Curriculum and Evaluation Standards for School Mathematics, the Mathematics Sciences Education Board (MSEB) urged “**that school mathematics programs be revised and updated to reflect the NCTM ‘Standards,’**

develop students' mathematical power, use calculators and computers throughout, feature relevant applications, and foster active student involvement" (Edwards, 1994, p. 1).

In the reform of mathematics, contrary to popular beliefs by laypersons, basic computation is not ignored. Children must still have a mastery of the basic operations of addition and multiplication. However, learning basic facts is not a prerequisite for solving problems. Learning the facts becomes a necessity to solve problems that are relevant, meaningful, and interesting to the student learners (Curcio, 1999). "Basic facts are learned effortlessly by meaningful repetition in the context of games and activities rather than by meaningless rote memorization. By encountering a variety of contexts and tasks, learners have opportunities to develop and apply thinking strategies that support and complement learning the basic facts" (Curcio, 1999, p. 282).

In connecting school mathematics with everyday living situations, mathematics reform has augmented the scope of pencil-and-paper computation to include estimation and mental computation. Moreover, if students are to be judicious users of technology, such as calculators, they must have a sense of whether computational results are reasonable rather than simply accept calculator or computer output. With such availability of technology, learners are faced with deciding when the use of technology is appropriate. Curcio (1999) states that "the proper instructional use of technology does not paralyze learners but in reality *liberates* learners so that they can focus on the essence of a problem" (p. 282). Technology is also used to build computation skills in the context of solving problems and while analyzing patterns as learners engage in meaningful, relevant tasks.

Mathematics reform also does not advocate “close to correct answers” as the norm--as some may think. When a problem requires an estimate rather than an exact answer, a reasonable estimate is good enough. Nonetheless, if a problem requires an exact answer, being almost correct is wrong (Curcio, 1999).

Another feature in the mathematics reform efforts occurs in its curricula. Reform efforts supports the idea that the curricula should contain problems that can be solved in more than one way. More than one way problem solving is included because of the awareness that learners bring different perspectives to solving problems. This situation is “analogous to solving real-world, open-ended problems for which more than one right way is possible to get an answer” (Curcio, 1999, 283). Lappan (1999) declares that mathematics outside of school arises from context that often has ambiguous elements. There are no labels at the top of pages giving clues, such as “Dividing Decimals by

Lappan (1999) goes on to explain that adults in numerous fields have to: develop the problem that needs solving, make the measures or collect the data that might be needed, put together a strategy for attacking the problem, carry out the strategy, and then ask if the solution makes sense in the real context of the problem. If not, they try again” (p. 3).

What counts in the real world are good solutions as well as clever and creative strategies.

Supporters of reform know that teaching is a very complicated, complex activity. Instructional decisions regarding grouping students; designing problems and tasks; and “presenting appropriate, worthwhile mathematics are determined on the basis of teacher’s

knowledge of the learning process, learner's needs and interests, and a firm understanding of the mathematics to be taught" (Curcio, 1999, 283).

Curcio (1999) says that the teacher's traditional role, as a dispenser of information *should not* exist anymore. This type teaching imposes ways of doing mathematics and ways of thinking about mathematics that may not make sense to learners. She states that students are not empty vessels waiting to be filled with information, but rather are products of experiences on which knowledge and skills are built. "Although teachers are the content experts in the classroom, they learn about their students' insights and level of understanding by listening carefully to learners' interpretations and explanations" (Curcio, 1999, 283), which is nothing more than classroom discourse. In other words, teachers use what they learn about students in planning for instruction--which rarely occurs in the teacher's role as a dispenser of information. In short, learning does not mean simply receiving and remembering a transmitted message; instead, "educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding" (Mathematical Sciences Education Board, 1989, p. 58). When educators begin to see learning as knowledge construction, they change their thinking about curriculum, instruction, and assessment, developing more powerful approaches to connecting thinking and mathematics and designing more mathematically significant instructional learning experiences.

Textbooks identified as "Standards-based" (textbooks aligned to the principles of the NCTM Standards for the teaching of mathematics) do not necessarily support the mathematics reform efforts. Just because it walks like a duck, does not mean it is a

duck—so to speak. Textbooks are not all created equal. “A criterion for judging materials that purport to support reform in school mathematics is that the rigor, depth, and logic of mathematics are preserved while problem solving, communication, reasoning, and connections within and beyond mathematics are highlighted” (Curcio, 1999, 283). Many publishers of new textbooks and new curricula may claim to support the reform efforts, but in actuality they are deceptively attempting to fulfill the goals of reform. Curcio (1999) believes that “textbooks that superficially treat mathematics in the interest of making connections with literature, history, and science do a disservice to students and to reform efforts” (p. 283). Therefore, it can be said that teachers who subscribe to solely following one mathematics source are doing a disservice to their students’ mathematics learning.

Furthermore, “textbooks should not drive instruction. Rather, other materials that support the standards, such as manipulatives and courseware, must be developed, in addition to new textbooks” (NCTM, 1989, 252).

Researchers have conducted considerable amount of research on current instructional reforms in mathematics in support of the NCTM Standards (Bouck & Wilcox, 1996; Griffin, Case, & Seigler, 1994; Hiebert & Carpenter, 1992; Hiebert & Wearne, 1993; Knapp, Adelman, Marder, McCollum, Needels, Shields, Turnball, & Zucker, 1993; Sigurdson & Olsen, 1994). For example, success in reform classrooms has been extensively documented by the Quantitative Understanding: Amplifying Student Achievement and Reasoning project, known as QUASAR. This is a middle school project funded by the Ford Foundation and housed at the University of Pittsburgh (Silver

& Lane, 1995; Silver & Stein, 1996; Stein & Lane, 1996). The project demonstrates ways of teaching low socioeconomic or economically disadvantaged children how to acquire mathematical thinking and reasoning skills.

### *Early Childhood Mathematics Teaching*

The American 2000 National Goals, Goal 1, focuses directly on the early childhood years. This goal states, “By the year 2000, all children in America will start school ready to learn” (U.S. Department of Education, 1999c, p. 1). Early childhood teachers believe that from the time of birth, all children are ready to learn. However, what they do or do not do as individuals, educators, and collectively as society can impede a child’s success in learning (Bredekamp et al., 1992).

Morrison (1997) describes an early childhood professional as being one who is well paid and knowledgeable in his field of study. The early childhood professional is one who makes informed intelligent decisions regarding the education of those in his care. This professional assesses children’s strengths and needs in order to plan the proper match of successful learning experiences. The early childhood professional develops and uses age appropriate mathematics curricula for young children based upon theories and practices of early childhood education. The early childhood professional is capable of organizing instruction, creating a learning environment, and offering learning experiences that are relevant and of interest to the children. Since early childhood professionals continuously interact with children, they must provide them with care, emotional support, and guidance, in addition to instruction. This professional is also responsible for teaching socialization skills. Overall, the early childhood professional is a decision-maker,

constantly making a range of decisions about children, materials, activities, and goals (Morrison, 1997).

Children enter school with a large amount of natural curiosity, but that curiosity can be overtaken by skepticism if teachers fail to show them how their studies are relevant. This presents a challenge particularly for those who teach early mathematics. Waite-Stupiansky and Stupiansky (1998) argue this is “because mathematics is sometimes taught by teachers—and viewed by students—as a collection of discrete, isolated topics that bear little relationship to the real world. But math is much more than a hierarchical series of topics and skills to be mastered” (p. 76). Each idea can be related to other ideas both within and outside of mathematics, and these ideas can be connected to children lives both in and out of the classroom. Its practical applications can be replicated on a smaller scale in the classroom. This is where the early childhood classroom teacher must demonstrate ones expertise in delivery of instruction—in other words expertise in teaching. The teacher must create a context where math is relevant to the learner. Waite-Stupiansky and Stupiansky (1998) state the “connections become meaningful because children can ‘hook into’ new math concepts by connecting them to knowledge they already have” (p. 76)--which is the essence of theory that children develop their intelligence through active learning in contrast to the view that teachers or others transmit knowledge to students” (Morrison, 1997, p. 527). Constructivism will be discussed in detail later in this paper.

The NCTM describes teaching as “a complex interaction between the teacher, the content being taught, and the students” (NCTM, 1991, p. 189). Merriam-Webster, Inc.,

(1999) defines teaching as the imparting of information (knowledge) or skill so that others may learn. Waite-Stupiansky and Stupiansky (1998) declare there are two types of mathematical knowledge—“procedural and conceptual.” Procedural knowledge includes algorithms and formulas used to solve mathematical problems. Conceptual knowledge provides the reasons “why” these formulas work. They proclaim one without the other leads to senseless memorizing or reinventing formulas for every problem. Students who know why they “invert and multiply” when dividing fractions are using conceptual knowledge. Applying the rule is the procedural knowledge.

In the traditional early childhood mathematics classroom, instruction (teaching) is the same every day. The teacher shows the class several examples of how to solve a particular type problem and then have the students regurgitate the method in practice--as classwork and homework. The National Research Council (1989) calls this type learning produced by such instruction as “mindless mimicry mathematics” (p.44). This type of instruction only lead students to learning procedural knowledge. The NCTM (1991) advocates the following classroom image of mathematics teaching for elementary and secondary teachers’ proficiency:

- select mathematical tasks to engage students’ interests and intellect;
- provide opportunities to deepen students’ understanding of the mathematics being studied and its applications;
- orchestrate classroom discourse in ways that promote the investigation and growth of mathematical investigations;

- use, and help students to use, technology and other tools to pursue mathematical investigations;
- seek, and help students to seek, connections to previous and developing knowledge; and,
- guide individual, small-group, and whole-class work.

In short, the classroom environment should be one where “teachers provide students with numerous opportunities to solve complex and interesting problems; to read, write, and discuss mathematics; and to formulate and test the validity of personally constructed mathematical ideas so that they draw their own conclusions” (Battista, 1999, p. 427). Students make use of demonstrations, drawings, and real-world objects—as well as formal mathematical and logical arguments—to convince themselves and others of the validity of their solutions. Instead of students imitating what they have seen and heard, students understand what they are doing. They make relevant connections to the real world. Relevancy, called “mathematics connections” in the NCTM’s Standards, is one of the four process standards--along with problem solving, communicating, and reasoning—advocated by the NCTM for grades K-12.

What appears to be at the heart of the Standards is classroom discourse. Classroom discourse is described as ways of representing, thinking, and talking, agreeing and disagreeing. The NCTM (1991) states:

Discourse of a classroom...is central to what students learn about mathematics as a domain of human inquiry with characteristic ways of knowing. Discourse is both the way ideas are exchanged and what the ideas entail: Who

talks? About what? In what ways? What do people write, what do they record and why? What questions are important? How do ideas change? Whose ideas and ways of thinking are valued? Who determines when to end a discussion? The discourse is shaped by the tasks in which students engage and the nature of the learning environment; it also influences them.

Discourse entails fundamental issues about knowledge: What makes something true or reasonable in mathematics? How can we figure out whether or not something makes sense? That something is true because the teacher or the book says so is the basis for much traditional classroom discourse. (p. 34)

In the early childhood classroom that the NCTM advocates, students talk to one another, make conjectures and reason with others about mathematics; ideas and knowledge are developed collaboratively, “revealing mathematics as constructed by human beings within an intellectual community” (p. 34). The teacher’s role is to initiate and orchestrate this type discourse and to use it skillfully to nurture student learning.

The NCTM (1991) lists the following ways a mathematics teacher should orchestrate discourse:

- posing questions and tasks that elicit, engage, and challenge each student’s thinking;
- listening carefully to students’ ideas;
- asking students to clarify and justify their ideas orally and in writing;
- deciding what to pursue in depth from among the ideas that students bring up during a discussion;

- deciding when and how to attach mathematical notation and language to students' ideas;
- deciding when to provide information, when to clarify an issue, when to model, when to lead, and when to let a student struggle with a difficulty;
- monitoring students' participation in discussions and deciding when and how to encourage each student to participate. (p. 35)

Currently, the NCTM is in the process of updating its Standards in order to enhance mathematics education. One of the most apparent changes is in the title, Principles and Standards for School Mathematics. The principles are built on positions and ideas included in their previous Standards documents. The six statements of principle are (NCTM, 1999):

- 1. Equity Principal:** Mathematics instructional programs should promote the learning of mathematics by *all* students.
- 2. Mathematics Curriculum Principle:** Mathematics instructional programs should emphasize important and meaningful mathematics through curricula that are coherent and comprehensive.
- 3. Teaching Principle:** Mathematics instructional programs depend on competent and caring teachers who teach all students to understand and use mathematics.
- 4. Learning Principle:** Mathematics instructional programs should enable all students to understand and use mathematics.
- 5. Assessment Principle:** Mathematics instructional programs should include

assessment to monitor, enhance, and evaluate the mathematics learning of all students and to inform teaching.

- 6. Technology Principle:** Mathematics instructional programs should use technology to help students understand mathematics and should prepare them to use mathematics in an increasingly technological world. (p. 262)

National organizations such as the National Association for the Education of Young Children (NAEYC), along with the NCTM, are calling for schools to place greater emphasis on: developmentally appropriate practices for early childhood children; active learning; conceptual learning that leads to understanding along with acquisition of basic skills; meaningful, relevant learning experiences; interactive teaching and cooperative learning; and, a broad range of relevant content, integrated across traditional subject matter divisions (Bredenkamp, Knuth, Kunesh, & Shulman, 1992).

Developmentally appropriate practices for early childhood children encourage the exploration of a wide variety of mathematical ideas. This is done in such a way that children “retain their enjoyment of, and curiosity about, mathematics. It incorporates real-world contexts, children’s experiences, and children’s language in developing ideas” (NCTM, 1989, p. 16). This type classroom recognizes that children need ample time to construct sound understandings and develop the ability to reason and communicate in a mathematical way. “It looks beyond what children appear to know to determine how they think about ideas. It provides repeated contact with important ideas in varying contexts throughout the year and from year to year” (NCTM, 1989, p. 16). The NCTM (1989) discloses:

Programs that provide limited developmental work, that emphasize symbol manipulation and computational rules, and that rely heavily on paper-and-pencil worksheets do not fit the natural learning patterns of children and do not contribute to important aspects of children's mathematical development. (p. 16)

An appropriate mathematics program for children that reflects the NCTM Standards' overall goals must also build beliefs within children about what mathematics is, about what it means to know and do mathematics, and about their views of themselves as mathematics learners. According to the NCTM (1989), the beliefs that young children form influence not only their thinking and performance during this time in their lives, but also their attitude and decisions about studying mathematics later on in their lives. "Beliefs also become more resistant to change as children grow older. Thus, affective dimensions of learning play a significant role in, and must influence, curriculum and instruction" (NCTM, 1989, p. 17).

Good early childhood mathematics programs must teach all which has been mentioned. Teachers cannot be satisfied teaching mathematical techniques alone--procedural knowledge (Lappan, 1999). Lappan (1999) sums it up best. He states teachers have to teach the reasoning, the understanding, the flexibility, as well as perseverance. It yields very disappointing results when one focuses on the basics until students master them before moving on to solving interesting problems. The heart of a successful mathematics program must focus on good, challenging problems that motivate students to acquire skills—skills that will in turn open doors to new insights into mathematics problems. Such "experiences will prepare our students to work in a

technological and complex world that offers no easy answers. They will prepare them to be citizens who understand and can harness the power of science and technology” (p. 3).

### *Early Childhood and Mathematics Learning*

Teacher effectiveness is defined as “how well teachers are able to promote learning in their students” (Morrison, 1997, p. 533). Learning is defined as the act or process of acquiring knowledge or skill (Lycos, Inc., 1999). In the past, school mathematics has been seen as a set of computational skills and mathematics learning has been seen as progressing through carefully scripted schedules of acquiring those skills (Battista, 1999). According to the traditional view, students acquire mathematical skills by mimicking demonstrations by the teacher and textbooks. Battista (1999) states they acquire mathematical concepts by “absorbing” teacher and textbook communications. Cartwright (1999) says that good early childhood teachers know that the important thing is not what students study, but how they learn. “Good teachers know the value of a child’s innate curiosity and deep satisfaction in the learning process” (p. 5). She states no school should dampen a child’s interest and joy in learning; and that children soon know the value of firsthand experience. Einstein said, “Learning is experience. The rest is

Cartwright, 1999, p. 5).

Morrison (1997) states the following regarding teacher effectiveness and student learning:

Teachers’ beliefs about their ability to teach effectively and about the ability of their students to learn effect the outcomes of teaching. Teachers who believe in themselves and their abilities as teachers and who believe their students can learn

generally have students who achieve well. This dimension of teaching is called **teacher efficacy**. Research shows that teachers who are high in a sense of efficacy are ‘more confident and at ease within their classrooms, more positive (praising, smiling) and less negative (criticizing, punishing) in their interactions with students, more successful in managing their classrooms as efficient learning environments, less defensive, more accepting of student disagreement and challenges, and more effective in stimulating achievement gains.’ Furthermore, effective teachers are more committed to teaching and are more likely to use effective motivational strategies with exceptional students.... (p. 8)

All current major scientific theories describing students’ mathematics learning agree that “mathematical ideas must be personally *constructed* by students as they try to make sense of situations (including, of course, communications from others and from textbooks)” (Battista, 1999, p. 429). The NCTM’s Curriculum and Evaluation Standards for School Mathematics (1989) characterizes what it means to learn mathematics:

Knowing mathematics means being able to use it in purposeful ways. To learn mathematics, students must be engaged in exploring, conjecturing, and thinking rather than only in rote learning of rules and procedures.

Mathematics learning is not a spectator sport. When students construct personal knowledge derived from meaningful experiences, they are much more likely to retain and use what they have learned. This fact underlies teachers’ new role in providing experiences that help students make sense of mathematics, to view and use it as a tool for reasoning and problem

solving. (p. 5)

The constructivist, unlike the behaviorist, “views knowledge as a constructed entity made by each and every learner through a learning process” (Wilhelmsen, 1998, p. 1). Thus, knowledge cannot be transmitted from one person to the other, “it will have to be (re) constructed by each person” (Wilhelmsen, 1998, p. 1). This means that the view of knowledge differs from the “knowledge as given and absolute” which is the view of behaviorism (Wilhelmsen, 1998).

According to Ryder (1999), constructivism is an approach to teaching and learning based on the premise that cognition (learning) is the result of "mental construction." In other words, students learn by fitting new information together with what they already know. Constructivists believe that learning is affected by the context in which an idea is taught as well as by students' beliefs and attitudes (Ryder, 1999).

This “constructivist” view comes from Jean Piaget and from others, such as Lev Semenovich Vygotsky, Jerome Bruner, and Maria Montessori. This approach is used in programs such as the Reggio Emilia Approach, the Montessori model, High/Scope, and Project Construct, all of which attempt to connect brain function to psychology. Using Jean Piaget as a mentor, most current constructivists

.... would say that constructivists believe that humans construct their own knowledge. This view implies that knowledge isn't something external that needs to be internalized by the learner, nor is it something innate that unfolds as the organism matures. Instead, constructivists contend that the developing learner constructs knowledge through ongoing **interactions** with the environment. The

role of education is therefore to provide an environment that stimulates and supports the learner in this process.” (Loeffler, 1992, p.101)

A major theme in the theoretical framework of Bruner is that learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge (Bruner, Goodnow, & Austin, 1956). The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. Cognitive structure (i.e., schema, mental models) provides meaning and organization to experiences and allows the individual to "go beyond the information given" (Bruner et al., 1956). In regards to instruction, the teacher should try and encourage students to discover principles by themselves. The teacher and student should engage in an active dialogue (i.e., Socratic learning) (Bruner et al., 1956). The task of the teacher is to translate information to be learned into a format appropriate to the learner's current state of understanding. Curriculum should be organized in a spiral manner so that the student continually builds upon what they have already learned (Bruner et al., 1956; Ryder, 1999).

Constructivist concepts compared to behaviorist concepts reveal significant differences in basic assumptions/beliefs about knowledge and learning (Ryder, 1999): in the cognitive/constructivist perspective, knowledge is active, situated in lived worlds; individuals construct knowledge; meaningful learning is useful and retained, building on what the learner already knows; and the teacher's role is coach, is mediator, and strategic. In the behavioral perspective, knowledge is inert; individuals are passive recipients of knowledge; learning occurs with programmatic, repeated activities; and the teacher's role

is authoritative, and directive. Ryder (1999) says that today's cognitive revolution has replaced behaviorism as the “prevailing paradigm.” Behaviorism is a simple, elegant scientific theory that has both methodological and intuitive appeal. But humans are more complicated than behaviorism allows... (Bruer, 1993). Although most teachers use varied strategies, their basic assumptions make an enormous difference in life, such as in the classroom. Ryder (1999) proclaims that the classroom environment, expectations, selection and creation of instruction, and assessment are guided by implied or known teacher assumptions/beliefs. The Math Forum (1998) had this to say about constructivism and student learning:

Students need to construct their own understanding of each mathematical concept, so that the primary role of teaching is not to lecture, explain, or otherwise attempt to “transfer” mathematical knowledge, but to create situations for students that will foster their making the necessary mental constructions. A critical aspect of the approach is a decomposition of each mathematical concept into developmental steps following a Piagetian theory of knowledge based on observation of, and interviews with students as they attempt to learn a concept. (p. 1)

Constructivist teaching is also based on recent research about the human brain and what is known about how learning occurs. Caine and Caine (1991) as well as Ryder (1999) suggest that brain-compatible teaching is based on 12 principles:

1. The brain is a parallel processor. It simultaneously processes many different types of information, including thoughts, emotions, and cultural knowledge. Effective teaching employs a variety

of learning strategies.

2. Learning engages the entire physiology. Teachers can't address just the intellect.
3. The search for meaning is innate. Effective teaching recognizes that meaning is personal and unique, and that students' understandings are based on their own unique experiences.
4. The search for meaning occurs through “patterning”. Effective teaching connects isolated ideas and information with global concepts and themes.
5. Emotions are critical to patterning. Learning is influenced by emotions, feelings, and attitudes.
6. The brain processes parts and wholes simultaneously. People have difficulty learning when either parts or wholes are overlooked.
7. Learning involves both focused attention and peripheral perception. Learning is influenced by the environment, culture, and climate.
8. Learning always involves conscious and unconscious processes. Students need time to process “how” as well as “what” they've learned.
9. We have at least two different types of memory: a spatial memory system, and a set of systems for rote learning. Teaching that heavily emphasizes rote learning does not promote spatial, experienced learning and can inhibit understanding.

10. We understand and remember best when facts and skills are embedded in natural, spatial memory. Experiential learning is most effective.
11. Learning is enhanced by challenge and inhibited by threat.  
The classroom climate should be challenging but not threatening to students.
12. Each brain is unique. Teaching must be multifaceted to allow students to express preferences. (Caine & Caine, 1991, pp.80-87; Pathways, 1998, p. 1)

These 12 principles are in line with the NCTM's Standards and recommendations for school mathematics reform.

Constructivism definitely impacts learning. In *curriculum*, constructivism emphasizes hands-on problem solving. In *instruction*, teachers tailor their teaching strategies to student responses and encourage students to analyze, interpret, and predict information. Teachers heavily utilize open-ended questions and promote extensive discussion among learners. In *assessment*, assessment becomes a part of the learning process so that students play a larger role in judging their own progress (On Purpose Associates, 1998).

The mathematical ideas that children acquire in grades K-4 form the basis for all further study of mathematics (NCTM, 1989). Early childhood education comprises four of these impressionable years. "Although quantitative considerations have frequently dominated discussions in recent years, qualitative considerations have greater

significance. Thus, how well children come to understand mathematical ideas is far more important than how many skills they acquire” (NCTM, 1989, p. 16). The success of future mathematics programs depend largely on the quality of the foundation that is established during the first five years of school (NCTM, 1989).

#### Definition of Terms

For the purpose of this research study, the following definitions of terms are used. Definitions are also presented as needed in the various sections of this paper, as well as, in Appendix A.

1. Attitude—Attitude is “a relatively enduring system of affective, evaluative reactions based upon and reflecting the evaluative concepts or beliefs which have been *learned* about the characteristics of a social object or class of social objects” (Shaw & Wright, 1967, p. 10). It is a covert or implicit response as an affective reaction. Attitude is also defines it as a manner, disposition, feeling, position, etc., with regard to a person or thing; tendency or orientation, esp. of the mind: a negative attitude; group attitudes (Lycos, Inc., 1999). In this study we will examine the attitudes toward mathematics and its teaching—the social object.

2. Beliefs—A belief is the acceptance of the truth or actuality of anything without certain proof. It is a mental conviction--that which is believed; an opinion or conviction. It is a tenet. (Lycos, Inc., 1999). Beliefs are largely cognitive in nature, and are developed over a relatively long period of time (McLeod, 1992, p. 579). Beliefs are used to describe a wide range of affective responses to mathematics (McLeod, 1992).

3. Conceptions—The American Heritage Dictionary (1996) defines conception as something conceived in the mind: a concept, plan, design, idea, or thought (p. 390). “Microsoft Word’s” internal dictionary lists the following synonyms for conceptions: thought, impression, representation, interpretation, explanation, version, understanding, exposition, and philosophy.

4. Early Childhood—The National Association for the Education of Young Children (NAEYC) “defines early childhood as birth through age eight” (Bredekamp & Rosegrant, 1992, p. 10).

5. Early Childhood (EC) Teacher—An Early Childhood teacher is a certified teacher who teaches three- to eight- year-olds. This person is a teacher of the PreK-3 grades. A 1976 Federal/State Desegregation order defined EC as Kindergarten-3<sup>rd</sup> grade. Pre-Kindergarten was added in the 1980’s. (District A-ECE Department, personal communication, March 16, 1999)

#### *Types of Early Childhood Teachers*

Bilingual—A Bilingual teacher is one who possesses bilingual certification, which includes the following characteristics: (1) Coursework in methods and strategies to teach English language arts, and second language arts, second language acquisition theory, and ESL methodology. (2) Fluent in English and another language as demonstrated by the successful completion of a language proficiency exam. The bilingual education teacher is responsible for teaching in two languages in order to promote literacy in both languages. (District A-Multilingual Education Department, personal communication, March 19, 1999)

Classroom—A classroom teacher is a certified teacher who is responsible for teaching a group of young children. This person holds a baccalaureate or master's degree and has fulfilled teacher requirements for the state. (Hildebrand, 1992)

English as a Second Language (ESL)—English as a Second Language is the term for the use of language acquisition methodologies and instructional strategies to teach English to speakers of other languages. The larger participating school district prefers the term English for Speakers of Other Languages (ESOL). An **ESL teacher** instructs in this type program. (District A-Multilingual Education Department, personal communication, March 19, 1999)

Mixed-Age—Mixed-age programs are free of rigid structures such as fixed ability groups, grade level, retentions and promotions that impede continuous learning. These programs take into account the variations in child development so that all students will be successful and no students will be retained or placed in transition classes. These programs accommodate the broad range of student needs, their learning rates and styles, and their knowledge, experiences, and interests to facilitate continuous learning. They achieve this through an integrated curriculum incorporating a variety of instructional models, strategies, and resources. The teacher of such a program is called a **mixed-age teacher**. The larger participating school district has 23 schools with this program, of which five are part of this research study. The smaller participating school district has no mixed-aged program. (District A-ECE Department, personal communication, March 18, 1999)

Special Education—Special education encompasses direct instructional activities or special learning experiences designed primarily for students identified as having exceptionalities in one or more aspects of the cognitive process or as being underachievers in relation to the general level or model of their overall abilities. Such services are usually directed at students who are physically handicapped, emotionally handicapped, mentally retarded, and those students with learning disabilities (Garwood & Hornor, 1991). The **special education teacher** provides these services.

In the participating school districts, all students with disabilities enjoy the right to a free appropriate public education, which may include instruction in the regular classroom, instruction through special teaching, or instruction through approved contracts. The Texas Education Code (TAC 11.1052, 11.10, 21.503 [b]) defines a student with a disability as a student between the ages of 3 and 21 inclusive with one or more disabilities (physical disability, mental retardation, emotional disturbance, learning disability, autism, speech disability, traumatic brain injury, visual or auditory impairment) that prevent the student from being adequately or safely educated in the public schools without the provision of special services. (District A-Special Education Department, personal communication, March 30, 1999)

A Resource teacher is also a special education teacher. This person assists the regular classroom teacher with students who have been diagnosed as special education, but who attend regular classes. Students in a Resource Room may be

identified under any eligibility criteria. They are students who need 30 minutes to 3 hours of special education instruction (according to their Individual Education Plan, IEP) and with modifications can function in regular education the rest of the school day. The curriculum emphasizes the development of reading/language arts and math skills. Direct instruction in the core areas (as defined in their IEP) is provided by special education personnel. Resource Instructional Support is also provided to assist students. (District A-Special Education Department, personal communication, March 30, 1999; District B has no Resource Rooms.)

Talented and Gifted (TAG)—The Talented and Gifted Program (TAG) is primarily for students in grades K-8 and is designed to encourage and nurture those students who have been identified as talented or gifted by a local school Assessment, Review and Exit (ARE) committee. The TAG teacher teaches in such a capacity. The participating school district uses the definition of a talented or gifted student as approved by the Texas 74th session of Legislature G/T Section 29.121:

A gifted and talented student means a child or youth who performs at or shows the potential for performing at a remarkably high level of accomplishment when compared to others of the same age, experience, or environment and who exhibits high performance capability in an intellectual, creative or artistic area; possesses an unusual capacity for leadership; or excels in a specific academic field. However, the definition does not apply to students who demonstrate potential in areas relating to physical abilities. (Texas Education Code 21.651)

The TAG program is available in all K-8 neighborhood schools in the participating school districts. In addition, the larger school district in this study has three magnet schools for talented and gifted students that serve identified students from across the school district. These magnet schools are not any of the randomly chosen schools for this research study. (District A-Talented and Gifted Department, personal communication, March 19, 1999)

6. Mathematics—“Mathematics is a broad-ranging field of study in which the properties and interactions of idealized objects are examined. Whereas mathematics began merely as a calculational tool for computation and tabulation of quantities, it had blossomed into an extremely rich and diverse set of tools, terminologies, and approaches which range from the purely abstract to the utilitarian” (Weisstein, 1999, p. 1142). Often, people equate mathematics with arithmetic. Arithmetic is concerned with numbers. When considering the mathematics curriculum, many people focus on computational skills and believe that they constitute the full set of competencies that students must have in mathematics. Traditionally, the major emphasis of the K-8 mathematics curriculum has been to teach children arithmetic--how to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages. Mathematics involves more than computation. Mathematics is a study of patterns and relationships; a science and a way of thinking; an art, characterized by order and internal consistency; a language, using carefully defined terms and symbols; and a tool. Teachers and other educators working together to improve mathematics education must explore a broader scope of mathematics. Mathematics should include experiences that help students to shift their thinking about

mathematics and define mathematics as a study of patterns and relationships; a science and a way of thinking; an art, characterized by order and internal consistency; a language, using carefully defined terms and symbols; and a tool. (Cook, 1995)

7. Urban—The American Heritage Dictionary of the English Language (1996) defines urban as of, relating to, or located in a city. The U.S. Census Bureau (1999) defines urban as all population and territory within the boundaries of urbanized areas and the urban portion of places outside of urbanized areas that have a decennial census population of 2,500 or more.

Urbanized Area—An area identified by the Census Bureau that contains a central place and the surrounding, closely settled incorporated and unincorporated area, that has a combined population of at least 50, 000 (U.S. Census Bureau, 1999).

#### Purpose and Research Questions

The reform of school mathematics curricula and instruction has replaced the behavior approach, which is an “outdated and simplistic behaviorist learning theory that has dictated the course of mathematics [and learning in general] for more than 40 years” (Battista, 1999, p. 428). This behavior approach to learning is also known as the “factory  
Caine & Caine, 1991; Schlechty, 1990). “It is an approach predicated on the beliefs that what we learn can be reduced to specific, readily identifiable parts and that equally identifiable rewards and punishments can be used to ‘produce’ the desired  
Caine & Caine, 1991, p. 15). B. F. Skinner is considered the “grandfather of

Behavioral approaches, by ignoring the power and vitality of the inner life of students and their capacity to create personally and intellectually relevant meanings, have interfered with the development of more challenging and fulfilling approaches to learning and teaching, according to Caine and Caine (1991). Battista (1999), in agreement, states that mathematics education is struggling to emerge from an era in which the prevailing views of mathematics and learning have been mutually reinforcing school mathematics as a set of computational skills and following carefully scripted curricula for acquiring those skills. These skills have been received by imitating demonstrations by the teacher and the textbook. Even more tragic is the fact that, by teaching to the test, educators actually deprive students of the opportunity for meaningful learning (Caine & Caine, 1991).

According to the NCTM, the view in this day and time should emphasize problem solving, where students use higher order thinking to find solutions to problems. In the problem solving approach to learning mathematics, the problem solving process is more important than getting the correct answer. Education's general objective is to improve learning and teaching. "More specifically, we want to see the emergence of learners who can demonstrate a high level of basic competence, as well as deal with complexity and change" (Caine & Caine, 1991, p. 7). Surface knowledge involves memorization of facts and procedures, is what education traditionally produces—not to say some is not important. However, meaningful knowledge is anything that makes sense to the learner; and it is crucial for success in the 21<sup>st</sup> century (Caine & Caine, 1991).

Morrison (1997) states that “teaching efficacy stems from teachers’ beliefs and attitudes...” (p. 9), as well as from influences from the community, school, and classroom’s conditions. With this in mind, this study examines early childhood teachers’ attitudes and beliefs about mathematics teaching and learning in an urban school district. It seek to answer the following five questions:

1. What are urban early childhood teachers’ general attitudes toward mathematics?
2. What are urban early childhood teachers’ views of mathematics? Do urban teachers’ views of mathematics lean more toward the: **a. Platonist view**—mathematics is exact and certain truth; **b. Instrumental view**—mathematics is facts and rules, not creative; or **c. Problem Solving view**— mathematics is a problem solving approach, providing many answers and exploring patterns versus employment of routine tasks (Ernest, 1988; Ernest 1996). The NCTM endorses the problem solving approach.
3. What are urban early childhood teachers’ attitudes toward teaching mathematics?
4. What are urban early childhood teachers’ views of teaching mathematics?
  - a. Basic Skills Practice**—basic skills vs. calculator, other emphasis
  - b. Problem Solving View**—problem solving aim vs. routine tasks
  - c. Discovery (Active) View**— need to be told vs. can/should discover
  - d. Teacher Designed Curriculum**—children's needs, differences and preferences are accommodated; one text is not followed for all abilities, the mathematics curriculum is differentiated for individual needs and differences
  - e. Text Driven Curriculum**-- mathematics is taught by following the text or syllabus exactly

- f. **Many Methods Encouraged**—teacher’s unique method vs. many methods; or,
  - g. **Cooperative Learning View**—isolated vs. cooperative learning. (Ernest 1996)
5. What are urban early childhood teachers’ views of children learning mathematics?
- a. **Rote Learning**—mathematics is remembering facts, rules, learning by rote
  - b. **Constructivist View (Previous Knowledge Respected)** —transmission (transference) vs. building on existing knowledge
  - c. **Role of Errors**—careless errors vs. answers over emphasized.

In other words, the problem solving process is more important than getting the correct answer. The learner will receive partial credit for his “process” efforts when he does not get the correct answer. The learner focuses on the essence of the problem while he attempts to come up with the solution. When answers are over emphasized the learner receives no credit for his incorrect answer, or process efforts. Or,

- d. **Choice and Autonomy**—imposed order and tasks vs. child choice (centered) and direction. (Ernest, 1996)

#### Significance of the Study

In a mathematics classroom, teachers act as agents of particular cultures, bringing with them specific beliefs and concepts about how an academic subject should be taught. This is known as their philosophy with regard to the subject. Within the context of the classroom “they make judgments and choices about aspects of that culture to which their pupils will be introduced--in this case, what mathematics will be taught, to whom, and how” (Nickson, 1992, p. 102). Thom (1972) suggests that all mathematical pedagogy

rests on a philosophy of mathematics, regardless of how poorly it may be defined or articulated.

Thompson (1992) proclaimed that what a teacher considers to be appropriate goals of a mathematics program, ones own role in teaching, the students' role, appropriate classroom activities, good instructional approaches and emphases, legitimate mathematical procedures, and desirable outcomes of instruction are all part of the teacher's conception of mathematics teaching. He believes that differences in teachers' conceptions of mathematics appear to be related to differences in their views about mathematics teaching. This ranges from differences in locus of control in teaching, how they perceive students learn and understand mathematics, to their perceptions of the purpose of lesson planning.

Fenstermacher (1980) argued that transforming teachers' beliefs requires knowledge of current beliefs. He felt the best way to ascertain this knowledge is through descriptive studies of teaching that includes attention to teacher's mental states and cognitive processes. Thus, this study may help teachers reflect on their beliefs and classroom practices. Greene (1978) argues that something needs to be done to empower teachers to reflect upon their own life situations, to speak out in their own ways about the "lacks that must be repaired; the possibilities to be acted upon in the name of what they deem decent, humane, and just" (p.71). Thompson (1984) observed that the extent to which "experienced teachers' conceptions are consistent with their practice depends in large measure on the teachers' tendency to reflect on their actions—to think about their actions vis-à-vis their beliefs, their students, the subject matter, and the specific context

of instruction” (p. 139). He acknowledged that all tensions and conflicts between beliefs and practice will not be resolved through reflection, but “it is by reflecting on their views and actions that teachers gain an awareness of their tacit assumptions, beliefs, and views, and how these relate to their practice. It is through reflection that teachers develop coherent rationales for their views, assumptions, and actions, and become aware of viable alternatives” (p. 139). Ernest (1988) also recognized the central role reflection plays on teaching when he noted that by teachers reflecting on the effect of their actions on students, they develop a sensitivity for context that enables them to select and implement situational appropriate instruction in accordance with their own views and models of teaching. This researcher hopes this study will stimulate teachers’ thinking and improve the process of schooling. Hence, to help teachers to reflect upon their teaching could help students become more aware of their own learning. As a result, this study will also look at teachers’ cognition to see what they think about when they are teaching. This study may also help teachers identify their conceptions of mathematics and possibly stimulate how these conceptions affect teaching and student learning. John Dewey stated:

The teacher is not in the school to impose certain ideas or form certain habits in the child, but is there as a member of the community to select influences which shall affect the child and to assist him in properly responding to these influences. (Hendrick, 1997, p. 75)

This study may influence educational policy--teacher education programs, staff development, and training. This study will show a need to include teachers’ attitudes,

beliefs, and knowledge of mathematics into teacher educational programs with hopes of improving student achievement in mathematics. Furthermore, this study may indicate a need for ongoing support of teacher education programs. “We need a model of staff development that is theoretically based. We must have training, then follow-up observation” (Cooney, Grouws, & Jones, 1988, p. 259).

In early 1989, NCTM established a commission to produce a set of Professional Standards for Teaching Mathematics. The goal of these standards was to provide guidance to those involved in the reform of school mathematics. These professional standards rests upon two important assumptions (NCTM, 1991):

- Teachers are key figures in changing the ways in which mathematics is taught and learned in school.
- Such changes require that teachers have long-term support and adequate resources. (p.2)

This adapted questionnaire may also serve as a gauge (tool) for measuring a school district’s attempt to change their teachers’ way of thinking about mathematics and its teaching.

This study may help identify high concentrations of teachers who do not care for mathematics, or who have a fear of mathematics who are teaching in our lower grade levels. Thus, not providing a strong mathematical foundation for our students. Passing this fear or dislike on to our students at an early age could cause students not to do well and not like mathematics. In the long run, this could weaken our nation’s welfare and existence. “In a society saturated with quantitative information ranging from global

climate change data to political polls and consumer reports, such skills will help students to understand, make informed decisions about, and affect their world” (NCTM, 1998b, p. 15).

This study may help serve as a means of identifying the philosophy of the majority of teachers in a school district. It can be used to identify if the majority of Early Childhood teachers in a school district are believing and teaching the way the National Council of Education recommends mathematics should be taught and learned by students. If teachers are not teaching as the National Council recommends, then higher learning institutions need to better prepare our teachers by raising the standards of mathematics academic preparation for new teachers. They may find it necessary to create a national board to certify teachers that would replace the many different certifying bodies now operating in the states. This study will also show a need for more mathematical staff developments in school districts for Early Childhood teachers that advocate what the National Council of Mathematics advocates—more problem solving and discovery type activities as the most beneficial ways for students to learn and better understand mathematics.

Last, this study creates an instrument that can be used at all grade levels to determine teachers’ attitudes and beliefs about mathematics and how it should be taught and learned. Results of this study may indicate a need for a change in teacher education programs and district staff developments; or a survey of this type may validate that teacher-training programs are doing a fine job in preparing teachers for the classroom.

# CHAPTER II

## CHAPTER II

### REVIEW OF LITERATURE

According to Thompson (1992), the nature of teachers' beliefs about mathematics subject matter and about its teaching and learning, as well as "the influence of those beliefs on teachers' instructional practice, are relatively new topics of study. As such, these topics constitute largely uncharted areas of research on teaching. Nevertheless, a number of studies in mathematics education, such as Dougherty, 1990; Grant, 1984; Kesler, 1985; Kuhns, 1980; Lerman, 1983; Marks, 1987; McGalliard, 1983; Shroyer, 1978; Steinberg, Haymore, and Marks, 1985; and Thompson, 1984, have indicated that teachers' beliefs about mathematics and its teaching play a significant role in shaping the teachers' characteristic patterns of instructional behavior (as cited in Thompson, 1992).

Thanks to such studies educators now recognize that how teachers interpret and implement curricula are influenced significantly by their knowledge and beliefs. Recent studies (Brown & Borko, 1992; Brown, Cooney, & Jones, 1990) suggest that teachers' beliefs about mathematics and how to teach mathematics are influenced in significant ways by their experiences with mathematics and schooling long before they enter the formal world of mathematics education. Further, these beliefs seldom change dramatically without significant intervention (Lappan, Fitzgerald, Phillips, Winter,

Lanier, Madsen-Nason, Even, Lee, Smith, & Weinberg, 1988). The opportunity for changing their beliefs is essential for teacher development (Lappan & Theule-Lubienski, 1994). Thompson (1992) acclaims, “By recognizing that bringing about changes in what goes on in mathematics classrooms depends on individual teachers changing their approaches to teaching and that these approaches, in turn, are influenced by teachers’ conceptions, mathematics educators have acknowledged the importance of this line of research” (p. 128).

This Review of Literature focuses on urban early childhood teachers and mathematics, which includes a discussion of teachers’ expectations for student achievement, socioeconomic status and achievement, and teacher’s knowledge and qualifications in mathematics. The distinctions between attitude, beliefs, and knowledge are discussed next in this section. Last, specific research dealing with teacher’ conceptions of mathematics that has been done will be presented, including methodology, and findings.

#### The Urban Early Childhood Teacher and Mathematics

As with all teachers, early childhood teachers face the same experiences. In the urban school system, there exist mostly children from poor and middle class families. What are urban teachers’ expectations for urban students’ mathematics achievement? What knowledge and qualifications in mathematics do urban teachers possess?

#### Teacher Expectations for Student Achievement

A baffling issue that continues to plague American schools is the failure of children from economically disadvantaged (poor) families to acquire educational skills at levels comparable to their middle and higher-class counterparts. “Each year, these learners fail in disproportionate numbers, and their difficulties in learning to read and write are apparent from almost the beginning of school” (Smith & Dixon, 1995, p. 243). Since the *Brown vs. the Board of Education in Topeka, Kansas* case in 1954, we have encountered a large body of research documenting that the educational system is “differentially effective for students depending on their social class, race, ethnicity, language background, gender, and other demographic characteristics” (Secada, 1992, p. 623). This differential effectiveness has been found in many academic subjects, including mathematics. Consensus is developing that disparities in the learning of mathematics represent a danger to our society’s functioning (Johnson & Packer, 1987; National Alliance for Business, 1986; National Research Council, 1989; Quality Education for Minorities Project, 1990; Secada, 1992).

The demands of our civilian workforce, military needs, participation in government, and shifts in our world’s economic systems evince the need for *everyone*—not just a few—to possess more and different mathematical and scientific skills than is currently being made available in our schools (Secada, 1992). Johnson and Packer (1987), and Secada (1990) believe if some type mathematical reform or restructure is not undertaken in mathematics education “disparities in opportunities, achievement, course taking, and careers are likely to increase, resulting in the creation of a permanently unemployable underclass who will represent a threat to the United States’ economic and

military well-being and who will strain the country's legal and social systems" (as cited in Secada 1992, p. 624).

As the expectation that all children should learn has increased, and as disparities in school success have become more apparent, attention has turned to the teachers' potential to influence student learning through their expectations and behavior (Gottfredson, Marciniak, Birdseye, & Gottfredson, 1995). The Eisenhower National Clearinghouse (1999) says:

Teachers remain at the core of equity issues; teacher expectations and behaviors are a major influence on equity in U. S. schools. Teacher perceptions of students can be colored by cultural expectations, stereotypes and inaccurate knowledge gleaned from previous experience. These perceptions and the ways in which teachers express and act upon them influence student learning. (part 2)

Studies suggest that students success or failure in the classroom can be strongly influenced by "teachers' beliefs, attitudes, behaviors, and perceptions" (Eisenhower National Clearinghouse, 1999, part 2). Teachers often have a white middle-class student's behaviors and goals as their ideal of a good student (DeMott, 1992, as cited in Eisenhower National Clearinghouse, 1999). Teachers often assume that children who have not yet mastered English cannot be taught mathematics or science (Gibbons, 1992, as cited in Eisenhower National Clearinghouse, 1999). If a student does not speak English, speaks English in a nonstandard way, or comes from a culture with different interaction behavioral patterns—such as those regarding eye contact—a teacher may see that student as less capable or less receptive (Garibaldi, 1992; Irvine, 1992, as cited in

Eisenhower National Clearinghouse, 1999). Studies have found that teachers interact differently with students for whom they have higher expectations. For these students they offer more praise for correct answers and less criticism for incorrect answers (Brophy & Good, 1974). Oakes (1990) reports that teacher expectations also affect the amount of material taught to a class or student.

Many schools offer separate classes or groupings within classes for gifted students. However, access is not proportionately distributed across the student population. Educators and parents tend to construct mental images of gifted students - images reflecting the characteristics of white, middle-class students - that can blind them to the actual abilities of children from minority, poor, and other underrepresented groups. For example, one Texas-based study indicates that Hispanic children who are identified as gifted tend to be more acculturated to mainstream U.S. culture than are other Hispanic children (Education Week, 26 May 1993, as cited in Eisenhower National Clearinghouse, 1999 ).

Disparities also exist in special education. Enrollment in special education is disproportionately high for boys and for African-American and Hispanic students. In 1988, two-thirds of all students in such programs in the United States were male, in spite of the fact that medical reports of learning disabilities and attention-deficit disorders are almost equally divided between boys and girls. Mercer (as cited in Eisenhower National Clearinghouse, 1999) found that students who test the same on objective tests are often treated differentially; she found that "White, female, middle-class students who scored 80

or below were more likely to be retained in regular academic programs than were Black, male, lower-class students who scored the same on the IQ test” (part 2).

Pygmalion in the Classroom (R. Rosenthal & Jacobson, 1968) teachers have borne the brunt of much of the blame for the achievement of minority and of low-SES students” (Secada, 1992, p. 644). Rosenthal and Jacobson (1968) hypothesized that (1) teachers form expectations for student performance, (2) students respond to the behavioral cues of their teachers, and (3) student performance is shaped by these expectations. This hypothesized expectancy effect (sometimes called “self-fulfilling prophecy”) became a central topic of research as investigators attempted to test it by observing behaviors in the classroom (Wittrock, 1986).

Brophy and Good (1970) implied that teachers might differentiate their behavior toward students based on their expectations. They speculated, as a result, students would respond to teachers’ behavioral cues and alter their self-concept and achievement motivation to conform to teachers’ expectations.

Over the years, researchers have explored each component of the expectancy model. They have found that teachers overestimate the achievement of high achievers and underestimate the achievement of low achievers. They predict least accurately the responses of low achievers (Coladarci, 1986; Hoge & Butcher, 1984; Patriarca & Kragt, 1986). Babad (1985) reported that less experienced teachers who prefer the lecture method more often and who believe either that integration will result in great improvement or no improvement had biased expectations. Raudenbush (1984) investigated eighteen studies in order to determine if teacher expectations influenced IQ

test scores. He found that the better the teachers knew the students, the more accurate were their expectations for student academic success. He also found that the effects on test scores were larger for primary grade students (grades 1 and 2) and for seventh grade students than for students in the upper elementary grades. According to Gottfredson, Marciniak, Birdseye, and Gottfredson's (1995) research, socioeconomic status, race, physical attractiveness, retention status, and use of standard English are related to the degree of discrepancy between teacher expectations for academic success and actual achievement. Peterson and Barger (1984), in a study of teachers' attributions for student performance, found that teachers credited the success of perceived high achievers to ability and that of perceived low achievers to luck, making it difficult for perceived low achievers to change their teachers' expectations through their own efforts.

Good (1987) in his attempt to identify teacher behaviors that are dependent upon teacher expectations for student success, listed the following behaviors that are used more often with perceived low achievers: seats are assigned further from the teacher; they reward more incorrect answers or inappropriate behavior; they provide fewer hints or cues to improve responses; make less use of students ideas; monitor and structure activities more closely; they give general, insincere praise; provide less frequent and less informative feedback; require less effort from perceived low achievers; they interrupt student speech more frequently; pay less attention to the student; offer fewer opportunities for these students to respond in class; reduce wait time; give more criticism; make less eye contact; give fewer smiles; and have fewer public and more private interactions (as cited in Gottfredson, Marciniak, Birdseye, & Gottfredson, 1995).

Gottfredson et al. (1995) says that from a student's first year in school, he is able to perceive differences in teacher expectations for his own performance from that of his classmates. Wittrock (1986) summarized the research in this area: "The findings suggest the early and definite effects teachers can have upon students' expectations and self-concepts of school ability" (p. 298). "Young students perceive that low achievers receive more directions, rules, work, and negative feedback and that high achievers enjoy higher teacher expectations for their performance and more freedom of choice" (Weinstein, Marshall, Brattesani, & Middlestadt, 1982, as cited in Gottfredson, et al., 1995). Cooper (1983) found that low-expectation students receive more "non-effort-contingent" feedback designed to control their behavior than high expectation students; consequently the low expectation students are less likely to develop beliefs in the value of effort and thus are less persistent, and less successful.

Also, research over the last decade has shown that "males and females have different classroom experiences because they approach learning differently and because teachers tend to treat them differently. Achievement expectations for females in some subjects are usually lower, as they are for members of certain racial and ethnic groups and "*for poor students*" (Schwartz & Hanson, 1992, p. 1). Fennema and Sherman (1977), as a result of their studies, theorized that lack of development of spatial ability in women caused proportional lacks in other cognitive areas, including mathematical ability. She suggested that socialization might be the problem. Society tends to encourage females to lean toward verbal activities and away from spatial and mechanical ones.

With this in mind, how will a society fare with the majority of its classrooms being manned by females as teachers of mathematics?

Studies as well show that teachers, both female and male, accept cultural assumptions that girls are not interested in science. In all subjects, teachers tend to have lower expectations for girls than they do for boys. They tend to make eye contact with boys more frequently than with girls. In general these teachers show more attention to boys. In their comments about boy's work, teachers tend to focus on the ideas and conceptions contained in the work, while their comments about girl's work often center on its appearance (American Association of University Women, 1993, as cited in Eisenhower National Clearinghouse, 1999).

Common practices and methods of communication in the classroom--known as discourse---is indicative of the treatment of female students that inhibits their ability to successfully learn mathematics. Some negative attitudes about females' mathematics achievement held by teachers and parents may deter girls from continuing their mathematics education ( Blosser, 1990; Blosser & Helgeson 1989; Dunham, 1990; Hartog & Brosnan, 1994; Quimbita, 1991; Schwartz & Hanson, 1992). These type gender misconceptions are a problem, for two reasons. First, they interfere with learning when students use them to interpret new experiences. Secondly, students are emotionally and intellectually attached to their misconceptions, because they have actively constructed them. Hence, students give up their misconceptions, which can have such harmful effect on learning, only with great reluctance (Mestre, 1989).

Secada, 1992). This debate has resurfaced with the growing number of Hispanics in the United States (Dunn, 1987; Fernandez, 1988). A large number of group disparity studies grew out of the “Civil Rights struggles of the 1960s when African Americans, Hispanics, women, and members of other groups pressed their agendas for social change, according to Secada (1992).

Within the last decade, observers have pointed out that the roots of racial and ethnic differences in mathematics achievement can be traced to the overrepresentation of minorities in the lower socioeconomic strata of our society (Jaynes & Williams, 1989). Jaynes and Williams (1989) predict black and white differences in school performance

will persist as long as “differences in the socioeconomic status of the two groups remain” (p. 366). According to the 1980 census data, poverty is more severely concentrated among African Americans and Hispanics than it is among whites (Kennedy, Jung, & Orlando, 1986, as cited in Secada, 1992).

There is evidence to suggest that many poor children enter school at an academic disadvantage to their middle class peers. Kirk, Hunt, and Volkmar (1975) compared two cohort groups of five-year-olds enrolled in Head Start and in a middle class nursery school on a five-part test of number identification. They found no racial differences or gender differences. However, they did find that the Head Start children performed less well than the nursery school children on some tasks involving between two and four objects (Kirk et. al, p. 175). Ginsburg and Russell (1981) administered a series of neo-Piagetian and early number tasks to two cohorts of children. The first group consisted of poor African American preschool children and a mixed group of middle-class African American and White preschool children. The second cohort consisted of preschool and kindergarten children who were pretty much evenly distributed among four groups that resulted by crossing racial and social-class groups--African American and White; and middle class and poor. For the second cohort, Ginsburg and Russell also included analyses based on family structure and child’s age. Family structure consisted of number of parents at home. They found significant statistical differences in social-class and socioeconomic status-by-age interactions on some, but not the majority of their tasks, as well as a number of other findings. All in all, their findings support the claim that there are some very specific--as opposed to general—performance disparities in preschool and

that those disparities are linked to social class. The question becomes: Do teachers add fuel to this already negative situation because of their covert or unknowing beliefs and conceptions about a class of people? Do their less than perfect expectations enter into the picture because of where a child comes from?

### Teachers' Knowledge and Qualifications in Mathematics

Shulman (1985) says, "to be a teacher requires extensive and highly organized bodies of knowledge" (p. 47). Fennema and Franke (1992) discusses the point that:

No one questions the idea that what a teacher knows is one of the most important influences on what is done in classrooms and ultimately on what students learn....There is no consensus on what critical knowledge is necessary to ensure that students learn mathematics....Some scholars suggest that since one cannot teach what one does not know, teachers must have in-depth knowledge not only of the specific mathematics they teach, but also of the mathematics that their students are to learn in the future. Only with this intensive knowledge of mathematics can a teacher know how to structure [ones] own mathematics teaching so that students continue to learn. (p. 147)

Two widely given explanations for why students do not learn mathematics are the inadequacy of their teachers' knowledge of mathematics and a lack of rigorous certification requirements for teachers. Scholars in the field share this belief. Post, Harel, Behr, and Lesh (1988) state, "A firm grasp of the underlying concepts is an important and necessary framework for the elementary teacher to possess...[when] teaching related concepts to children....[and] many teachers simply do not know enough

mathematics” (pp. 210, 213). Ball (1988) states, “Knowledge of mathematics is obviously fundamental to being able to help someone else learn it” (p. 12, as cited in Secada, 1992).

There is also some evidence that the mathematical knowledge of teachers is not very good. This is especially true of elementary and middle school teachers, according to Fennema and Franke (1992). After reviewing studies about elementary preservice teacher’s knowledge Brown, Cooney, and Jones (1990) concluded that “research of this type leaves the distinct impression that preservice elementary teachers do not possess a level of mathematical understanding that is necessary to teach elementary school mathematics as recommended in various proclamations from professional organizations such as NCTM” (p. 643). Post et al. (1988) examined 218 intermediate grade level teachers’ knowledge about the conceptual underpinnings of rational numbers. In their findings they stated, “Regardless of which item category is selected, a significant percentage of teachers were missing one half to two thirds of the items. This percentage varied by category, but in general, 20 to 30 percent of the teachers scored less than 50 percent on the overall instrument” (p. 191).

Many educators, scholars, researchers, and legislatures believe professional preparation and classroom practices have important implications when it comes to achieving excellence in classrooms (M2Press Wire, 1997; National Council of Teachers of Mathematics, 1998). In secondary teaching positions, some states require candidates to take a “national math teaching exam to weed out individuals who are not competent to teach mathematics on a competitive level.” Myers (1998) states that one of the reasons

individuals do not pass this exam is because they most likely had incompetent math instruction during grade school and high school. He states that “children who have an aptitude in mathematics, but receive several years of substandard instruction, find themselves behind the eight ball when finally faced with instruction on the level at which they are capable of performing” (p. 1).

Certification requirements vary among states. Many teacher preparation programs prepare teachers to teach a particular science and when student enrollment falls short in a school, teachers are forced to teach out of their field--that is a teacher teaches a subject not listed on his certificate and of which they are not certified to teach (Blosser & Helgeson, 1990). “A widely-held assumption is that teachers with a lot of subject matter background will do a more effective job than those with less preparation” (Blosser & Helgeson, 1990, p. 2).

The new reform movement for improving student achievement suggests that the key to improving mathematics and science education is “to ensure that every student has a well-prepared teacher--a teacher who has a strong academic background in the subject he or she teaches, and the skills to teach it effectively to diverse groups of students” (M2 Press Wire, 1998, p. 1). Alternative certification is one such program where applicants have to hold at least a bachelors degree in the subject to be taught, achieve a passing score on state-required exams, complete an intensive teacher preparation program, and possibly fulfill a supervised teaching internship before being issued a teaching certificate (ERIC Clearinghouse on Teaching and Teacher Education, 1998).

After recent findings of the Third International Math and Science Study (TIMSS), President Clinton challenged states to better prepare their mathematics and science teachers by requiring them “to pass challenging tests of their subject matter knowledge and teaching proficiency” (M2 Press Wire, 1998, p. 1). He is asking that states “raise the standards for preparing and licensing teachers, so that all math and science teachers have a major in the primary subject they teach, and pass high-level competency tests before being permitted to teach” (M2 Press Wire, 1998, p. 1).

President Clinton also challenged states to reduce the percentage of mathematics and science teachers who are teaching out-of-field. He proposed this be done by requiring new teachers to major in the primary subject they teach, and by providing current teachers with additional course work and training. The M2 Press Wire (1998) reports that “the average K-8th grade mathematics teacher has taken only three undergraduate mathematics courses. Twenty-eight percent of the secondary mathematics teachers lack a major or minor in their subject area, as do 18% of secondary science teachers including 55% of physics teachers” (p. 1).

However, in spite of what people believe—including the President, past research studies, according to Fennema and Franke (1992), have been inconclusive in determining a direct relationship between teachers’ knowledge of mathematics and student learning. This does not necessarily mean that the President and others are wrong in their beliefs. Fennema and Franke reports this discrepancy is probably due to the methodologies that were used in past studies. Past studies, such as the National Longitudinal Study of Mathematics Abilities reported in 1972 and the Eisenberg study in 1977 (a replication of

the 1972 Mathematics Abilities study), have tried to compute correlations between the number of college courses teachers have taken to student learning. Others have attempted to measure the relationship between student learning and teacher results on the National Teachers Examination; others between teachers' acquisition of knowledge and their student learning; and the use of some form of standardized test to identify teachers' knowledge of mathematics. Neither of these type studies indicated much of a relationship between teachers' knowledge and their students' learning (Fennema & Franke, 1992).

However until recently, Fennema and Franke (1992) claim no study had attempted to measure the complexity of teacher knowledge or the relationship between the formal mathematics that teachers knew and what they taught. These recent studies have reported somewhat different results because of their methodologies. "Instead of using correlational techniques to measure the relationship between some measure of teacher knowledge and their students' learning, scholars have been looking at teaching itself. What teachers *do* in classrooms has been studied as a mediator between teacher's content knowledge and their students' learning" (Fennema & Franke, 1992, p. 149). Most of these studies have been conducted within the interpretive tradition (Erickson, 1986), and have concentrated on providing rich descriptions of a small number of teachers in action in their classrooms; and inferences are drawn. These studies have made inferences between teachers' subject-matter knowledge and various aspects of the classroom. Experienced veteran teachers are usually compared to less experienced teachers; or a teacher is compared with himself in mathematical domains where he has

more or less knowledge, such as the problem solving domain, the concepts domain, or the computational domain (Erickson, 1986).

Current researchers have concluded that knowledge often develops based on the teacher's pedagogical knowledge and through classroom interactions with the subject matter and the students in the classroom, reports Fennema and Franke (1992). Shulman (1987) states:

The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy, in the capacity of a teacher to *transform* the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by the students.

(p. 15)

The important word here is *transform*. “ Teachers have to take their complex knowledge and somehow change it so that their students are able to interact with the material and learn” (Fennema & Franke, 1992, p. 162).

In recent studies of teaching, researchers are beginning to indicate that knowledge can be transformed through classroom interaction. Ernest (1998), as before stated, believes that “knowledge is important, but it alone is not enough to account for the differences between mathematics teachers” (p. 99) and students' learning. This entails what they think mathematics is about, what they think teaching and learning is about, what mathematics teachers will teach, the use of mathematics textbooks, and how their pupils will learn mathematics. He argues that teaching reforms must also include preservice courses that include teachers' beliefs about mathematics. It is the conflict of

teacher beliefs and social contexts about how mathematics should be taught that are transformed into classroom practices; and when the two does not match, there is interference with a pupil's learning of mathematics (Ernest, 1988).

Fennema and Franke (1992) point out that little research is available that explains the relationship between the components of knowledge as new knowledge develops in teaching. Nor is information available regarding the parameters of knowledge being transformed through teacher implementation. They state this line of research is very important since here is where all aspects of teacher knowledge and beliefs come together; and all must be considered to understand the whole.

#### A Discussion of Attitudes, Beliefs and Knowledge

This section examines the distinctions between attitudes, beliefs and knowledge. For a long time now, social psychologists have been interested in the study of the nature of attitudes and beliefs and their influence on one's actions, as well as in the acquisition of knowledge.

Considerable work investigating the variables influencing attitude formation and change and the effects of attitudes on individual behavior have been performed. Shaw and Wright (1967) claims:

The contributions of this research are great, and their significance for theory and practice cannot be denied. And yet we cannot avoid the impression that much effort has been wasted and that the contributions might have been greater if research had been more cumulative in nature....attitude research has been

hindered by the inaccessibility of existing attitude scales, resulting in less-than-optimum advances in the scientific analysis of attitudes. (pp. ix-x)

Shaw and Wright (1967) define attitude as “a relatively enduring system of affective, evaluative reactions based upon and reflecting the evaluative concepts or beliefs which have been *learned* about the characteristics of a social object or class of social objects” (p. 10). It is a covert or implicit response as an affective reaction. They suggest that it is a drive-producing response that elicits motives and thus gives rise to overt behavior. According to Shaw and Wright, attitude scales measure only one dimension of the affective reactions and that is positivity –negativity. Likert tests are the commonest form of attitude measure (White & Tisher, 1986). These authors report the evaluative reaction is based upon conceptions of the “referent in terms of facilitation or inhibition of attainment of already-existing goals” (p. 11).

McLeod (1992) claims that attitudes toward mathematics appear to develop in two different ways: (1) Attitudes may result from “the automatizing [*sic*] of a repeated emotional reaction to mathematics” (p. 581). For example, if a student has repeated negative experiences with multiplication, the emotional impact will usually lessen in intensity over time. Eventually the emotional reaction to multiplication will become more automatic, “there will be less physiological arousal, and the response will become a stable one that can probably be measured through use of a questionnaire” (p. 581). (2) Attitudes may result from “the assignment of an already existing attitude to a new but unrelated task” (p. 581). A student who has a negative attitude toward problem solving in a mathematics setting may attach that same negative attitude toward problem solving

in a science or language arts setting. In other words, “the attitude from one schema is attached to a second related schema” (p. 581).

The 1986 National Assessment data reported there is a positive correlation between attitude and achievement at grades 3, 7, and 11. However, the percentage of students who say they enjoy mathematics declines from 60% in grade 3 to 50% in grade 11 (Dossey, Mullis, Lindquist, & Chambers, 1988). These same type results appeared in the Second International Mathematics Study (McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, & Cooney, 1987), as well as in studies in other countries (Mclean, 1982). One may say that is not much of a decline from 60% to 50% for eight levels. Research suggests that neither attitude nor achievement is dependent on the other; rather, they interact with each other in complex and unpredictable ways (McKnight et al., 1987). Recent studies disclose a growing appreciation for the complexity of the affective domain (Leder, 1987).

In regard to beliefs, Thompson (1992) claims research in beliefs almost disappeared as a topic in psychological literature in the 1930's, due in part, to the difficulty in accessing these beliefs for study, and in part, to the emergence of "associationism" and behaviorism. However, in the 1960s, 70s, and 80s interest in the study of beliefs was rekindled. Cognitive science in the 1970s created “a place for the study of belief systems in relation to other aspects of human cognition and human affect” (Abelson, 1979, p. 355).

Green (1971) and Rokeach (1960) describe a belief system as a metaphor for examining and describing how ones beliefs are organized. They believe belief systems

undergo change and restructuring as one evaluates his beliefs against his experiences. In the 1980's , interest in beliefs and belief systems was popular among different disciplines, such as psychology, political science, anthropology, and education. However, “despite the current popularity of teacher’s beliefs as a topic of study, the concept of belief has not been dealt with in a substantial way in the educational research literature” (Thompson, 1992).

Thompson (1992) speculates one reason for the scarcity of research in educational literature is due to the difficulty of distinguishing between beliefs and knowledge. Researchers have noted in the case of teachers, that they treat their beliefs as knowledge; an observation that has led many who have initially set out to investigate teachers’ knowledge to also consider teachers’ beliefs (Grossman, Wilson, & Shulman, 1989). Also in mathematics education most researchers seem to assume that the development of beliefs about mathematics is heavily influenced by the cultural setting of the classroom (Schoenfeld, 1989).

Beliefs have been distinguished from knowledge in three distinctive ways in relation to teachers’ beliefs (Thompson, 1992). One characteristic of beliefs is that they can be held with varying degrees of convention. Another characteristic of beliefs is that they are not consensual. “Semantically, ‘belief’ as distinct from knowledge carries the connotation of disputability—the believer is aware that others may think differently” (Abelson, 1979, p. 356). Thompson (1992) says that most philosophers associate disputability with beliefs; and associate truth and certainty with knowledge. The third distinctive characteristic is that knowledge must meet criteria involving gorges of

evidence, when it comes to evaluating and judging its validity. Beliefs on the other hand, “are often held or justified for reasons that do not meet those criteria, and, thus, are characterized by a lack of agreement over how they are to be evaluated or judged” (Thompson, 1992, p. 130).

Ernest (1998) in his theoretical paper based partly on empirical findings of studies of mathematics teachers’ beliefs, noted that among a number of key elements that influence the practice of mathematics teaching, three are most notable:

1. The teacher’s mental contents of schemas, particularly the system of beliefs concerning mathematics and its teaching and learning;
2. The social context of the teaching situation, particularly the constraints and opportunities it provides; and,
3. The teacher’s level of thought processes and reflection. (p. 1)

Ernest (1998) pointed out that these factors determine the autonomy of the mathematics teacher. They determine “the outcome of teaching innovations—like problem solving--which depend on teacher autonomy for their successful implementation” (p. 1). He contended that part of a teacher’s mental content or schema is his knowledge of mathematics, but knowledge of mathematics alone, although important, does not account for differences in practice across mathematics teachers. “According to Ernest, the research literature on mathematics teachers’ beliefs, although scant, indicates that teachers’ approaches to mathematics teaching depend fundamentally on their systems of beliefs, in particular on their conceptions of the nature and meaning of mathematics, and on their mental models of teaching and learning mathematics” (as cited in Thompson, 1992, p. 131).

#### Specific Studies About Teachers’ Conceptions of Mathematics

“A teacher’s conception of the nature of mathematics may be viewed as that teacher’s conscious or subconscious beliefs, concepts, meanings, rules, mental images, and preferences concerning the discipline of mathematics. Those beliefs, concepts, views, and preferences constitute the rudiments of a philosophy of mathematics, although for some teachers they may not be developed and articulated into a coherent philosophy” (Ernest, 1988; Jones, Henderson, & Cooney, 1986; as cited in Thompson, 1992, p. 132).

Ernest (1988) described the following three conceptions of mathematics because of their significance in the philosophy of mathematics and because they have been documented in empirical studies of mathematics teaching:

First,...there is a dynamic, problem-driven view of mathematics as a continually expanding field of human creation and invention, in which patterns are generated and then distilled into knowledge. Thus mathematics is a process of inquiry and coming to know, adding to the sum of knowledge. Mathematics is not a finished product, for its results remain open to revision (**the problem-solving view**).

Secondly, there is the view of mathematics as a static [fixed] but unified body of knowledge, a crystalline realm of interconnecting structures and truths, bound together by filaments of logic and meaning. Thus mathematics is a monolith [a massive, uniform structure that does not permit individual variations], a static immutable [unchangeable] product. Mathematics is discovered, not created (**the Platonist view**).

Thirdly, there is the view that mathematics, like a bag of tools, is made up of an accumulation of facts, rules and skills to be used by the trained artisan skillfully in the pursuance of some external end. Thus mathematics is a set of unrelated but utilitarian rules and facts (**the instrumentalist view**). (p. 10)

Thompson (1992), Seldon and Sheldon (1997) and Cooney (1988) says it is conceivable and quite probable for an individual teacher's conception of mathematics to include more than one of the above mentioned aspects.

Although there has not been a significant number of studies dealing with teachers' attitudes and beliefs regarding mathematics it is becoming a popular subject among educators, mathematicians, and research groups. The studies that have been done have focused on beliefs about mathematics, beliefs about mathematics teaching and learning,

or both. Some studies have examined the relationship between teachers' beliefs and their instructional practices. Researchers have looked at the beliefs of both elementary and secondary teachers. However, they have tended to study more middle school and high school mathematics teachers' beliefs than elementary, according to Thompson (1992). Some belief studies have involved preservice and inservice teachers. Nevertheless, a search of the literature in mathematics education has not revealed a study specific to the topic of beliefs involving both preservice and inservice teachers, or a mix of teachers from the elementary, middle, and high school levels. Most of the studies done have been interpretive in nature and employ qualitative analysis (Thompson, 1992). A review of the literature unveiled the following studies:

Lerman (1983) performed a mathematics conceptions study using an instrument designed to assess views ranging from absolutist to fallibilist. Absolutist and fallibilist views are parallel to Ernest's Platonic and problem-solving views. Tymoczko (1986) in a theoretical discussion of the relationship between philosophy of mathematics and teaching mathematics argued that the fallibilist view (also known as the quasi-empirical view of mathematics) is the only view appropriate for teachers. Lerman in his study offered a theoretical discussion of the connections of the absolutist and fallibilist views with the teaching of mathematics. He explained how each lead to very different models of mathematics teaching. His study involved four preservice secondary teachers. Two teachers were found to be at the absolutist extreme of the dimension and two at the fallibilist. These teachers were asked to react to a video recording of a segment of a mathematics lesson. The teachers' reactions were consistent with their assessed views

about the nature of mathematics. The absolutist teachers were critical of the teacher in the video for not directing the students enough with the content of the lesson. The fallibilist teachers were also critical, but they were critical of the teacher being too directive.

Another study, reported by Vacc and Bright (1999), examined the changes in preservice elementary school teachers' beliefs about teaching and learning mathematics and their abilities to provide mathematics instruction that was based on children's thinking. This study was part of a larger project, the Primary Preservice Teacher Preparation Project (funded by the National Science Foundation). It was designed to begin to investigate the effects of including information about Cognitively Guided Instruction (CGI) in preservice teacher education programs. The project was conducted through the University of Wisconsin and involved preservice teacher education programs at three sites. Thirty-four participants were introduced to CGI as part of a methods course. A 48 item Belief Scale was designed to assess teacher's beliefs, which were categorized on four subscales: Role of the Learner, Relationship Between Skills and Understanding, Sequencing of Topics, and Role of the Teacher. Respondents rated each item using a 5-point Likert scale that ranged from "strongly agree" to "strongly disagree." Each subscale measured interrelated but separate constructs. This Cognitively Guided instructional strategy has been recommended for teaching mathematics to students from diverse cultures (Brophy, 1990; McCollum, 1990).

Cognitively guided instruction (CGI) is a new program that has been found to be effective in first grade students' achievement on basic skills, problem solving, and

confidence. This approach does not prescribe teaching behaviors. It is based on four interlocking principles: (1) teacher knowledge of how mathematical content is learned by their students, (2) problem solving as the focus of instruction, (3) teacher access to how students are thinking about specific problems, and (4) teacher decision-making based on teachers knowing how their students are thinking (Vacc & Bright, 1999). CGI teachers focus their attention on children's thought processes and engage their students in substantive conversations, rather than on *drill and practice activities* that are completed with little attention to student understanding (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Secada, 1992).

The Belief Scale scores indicated that significant changes in the preservice teachers' beliefs and perceptions about mathematics instruction occurred across the two-year sequence of professional course work and student teaching during their undergraduate program; but their use of knowledge of children's mathematical thinking during instructional planning and teaching was limited. The study concluded that preservice teachers may acknowledge the tenets of CGI and yet be unable to use them in their teaching. "The results raised several questions about factors that may influence success in planning instruction on the basis of children's thinking" (Vacc & Bright, 1999, p. 89).

The Leverhulme Primary Project at the University of Exeter, as reported in 1993 by various researchers involved in the project, tracked student teachers experiences in one post-graduate primary teacher-training course. This was a three-year study. It tracked these student teachers as they worked to acquire the appropriate subject and

pedagogical knowledge and as their own attitudes and beliefs about teaching developed through the course. One part of the project was designed to elicit student teachers' beliefs in order to make them aware of the relationship that exist between individual belief systems and its impact upon classroom behavior. Two methods were used. First, a pair of Likert scales were employed in order to provide information on beliefs about current educational aims and issues; secondly, a series of vignettes reflecting classroom practices were used in order to promote discussion about such aims and issues. The rating scales allowed for investigation of two aspects of beliefs—everyday philosophy and pedagogic knowledge. Gender and racial equality were included in this scale as well, “since both have taken on greater significance in the intervening years” (Dunne, 1993, p. 75).

The vignettes tackled two basic pedagogic issues: the kind of classroom environment which is most conducive to learning, and the teacher behaviors which best promote learning. In one example, each vignette provided two scenarios that reflect different attitudes to an educational issue. The student teacher was asked to make a choice between statement A and statement B. The dichotomy characterized specific attitudes with which it was possible to identify as a teacher, or which it was possible to reject as being alien to one's thinking. Additional information was sought by asking “why” one approach was preferred over another, or by requesting an extension of the scenario (Dunne, 1993).

Across the seven vignettes both pre- and post-course, there was not a great deal of change. There was a range from “no change” to maximum of four changes, and the

majority of the sample (52 percent) made one change only. The math groups were the most stable with a maximum of two changes. Change was fairly well balanced across all age groups, though the 25-to 29-year-olds showed most stability. The 40+ age group were as open to change as any other age group. Overall, the following were supported: a kind approach to individual discipline, a positive approach to managing lessons and a qualified need to follow children's interest. In these areas, there was very little change. More change occurred in a second category, different kinds of learning environment, with movement towards favoring a conversational approach to learning, and cooperative learning. The greatest movement was seen in the third category, with support given to the National Curriculum. "During the taught course it became clear that the National Curriculum provided them with a foundation on which to build and a clear outline for curriculum knowledge" (Dunne, 1993, p. 86).

Thompson (1992) described the following past studies that dealt with preservice teachers' beliefs about mathematics and mathematics teaching:

Shirk (1973) examined the conceptual frameworks of four preservice elementary teachers and their relation to the teachers' behavior when teaching mathematics to small groups of junior high school students. He described the teachers' conceptual frameworks in two parts: the teachers' conceptions of mathematics teaching and their conceptions of their roles as teachers. He observed that although the teachers' conceptions had elements in common, the unique combination of elements in each case accounted for their different teaching behaviors. He noted that the teacher' conceptions appeared to be activated in teaching situations, resulting in the teachers behaving in ways that were consistent with

their conceptions. Grant (1984) also reported congruence of professed beliefs and instructional practice in the case of three senior high mathematics teachers.

There have been other studies, however, that have reported that they found discrepancies between teachers' professed beliefs about teaching mathematics and their practice (Brown, 1985; Cooney, 1985). Within one study, some teachers reportedly professed beliefs about mathematics teaching that were largely consistent with their instructional practices, whereas other teachers in the same study showed a great disparity (Thompson, 1984). The inconsistencies reported in these studies indicate that teachers' conceptions of teaching and learning mathematics are not related in a simple cause-and-effect way to their instructional practices. Instead, they suggest a complex relationship, with many sources of influence at work, such as the social context in which mathematics teaching takes place. It imposes constraints and it offers opportunities. It has embedded values, beliefs, and expectations for students, parents, administrators, other teachers, the curriculum adopted, assessment practices, and the educational system at large (Thompson, 1992). Brown (1985) documented this in her study of the socialization to teaching.

Brown (1985) used a subject called Fred, a beginning secondary mathematics teacher, in his study. Fred experienced tensions and conflicts between his strong views of mathematics teaching—favoring a strong emphasis on problem solving-- and his perceptions of the realities of his teaching situation. He described his teaching situation as imposing obstacles to him actualizing his views. As a result, when faced with the

pressure to cover subject matter and maintain class control, Fred freely compromised his beliefs in problem solving. Ernest (1988) noted when addressing this social context that,

These sources lead the teacher to internalise [sic] a powerful set of constraints affecting the enactment of the models of teaching and learning mathematics. The socialization effect of the context is so powerful that despite having differing beliefs about mathematics and its teaching, teachers in the same school are often observed to adopt similar classroom practices. (p. 4)

In a study looking at changing teachers' conceptions, Collier (1972) used Likert scales to measure preservice elementary teachers' beliefs about mathematics and mathematics teaching along a formal-informal dimension. The formal end consisted of items that characterized mathematics as being rigid and exact, free of ambiguity and contradiction, and consisting of rules and formulas for problem solving. This formal end of the dimension viewed mathematics instruction in terms of items that emphasized teacher demonstration, memorization of facts and procedures, and single approaches to the solution of problems. The informal end, in contrast, was characterized by items depicting mathematics as aesthetic, creative, and investigative in nature and as allowing for a multiplicity of approaches to the solution of problems. The informal view of mathematics instruction was characterized by an emphasis on student discovery, experimentation, and creativity. Trail-and-error techniques and the encouragement of original thinking were used.

Collier (1972) defined a quotient of ambivalence and used it, along with the formal-informal dimension, to describe the beliefs of prospective teachers at different

stages of the preparation program. These prospective teachers nearing the end of the program had more informal and less ambivalent views about mathematics and mathematics teaching than teachers beginning the program. He also found that prospective teachers who had been identified as high-achievers viewed mathematics as less formal and had less ambivalent views of mathematics instruction than the low-achievers. He noted however, that most scores reflected a neutral position along the formal-informal dimension. Collier concluded that, allowing for the cross-sectional nature of the samples, the results indicated a slight progression in the beliefs of the teachers toward an informal view of mathematics and mathematics instruction as they went through the program.

Meyerson (1978) looking at changing teachers' beliefs over a longer period of time, conducted a study with preservice secondary mathematics teachers that were enrolled in his methods course. The course was designed to affect change in the subjects' conception of knowledge with respect to mathematics and mathematics teaching. The conceptions were diagnosed according to their position on Perry's scheme of intellectual and ethical development. They applied this scheme to knowledge of mathematics and mathematics teaching. During the course, the teachers engaged in exercises focusing on seven themes: mathematical mistakes, surprise, doubt, reexamination of pedagogical truisms, feelings, individual differences, and problem solving. Meyerson reported some success in moving teachers along the scheme, noting that the key element affecting change was doubt. "Doubting one's relationship with authority and reexamining one's beliefs" (p. 137) were essential in moving from one stage to the next. Doubt was

generally incited in problem-posing situations that caused confusion and created disagreement.

In another study Thompson (1992) described, examined the effect of courses on preservice elementary teachers' mathematical conceptions that was carried out by Schram, Wilcox, Lanier, and Lappan (1988). Their goal was to examine changes in undergraduate education majors' knowledge about mathematics, mathematics learning, and mathematics teaching as they progressed through a sequence of three innovative mathematics courses. In these courses the teachers emphasized conceptual development, cooperative learning, and problem-solving activities. The study concluded, that changes in students' thinking about mathematics were attributed to their participation in one of the courses in the sequence. At the end of the 10-week course, changes were reported in the participants' conceptions of the nature of mathematics, of the structure of mathematics classes, and of the process of learning mathematics.

According to Thompson (1992), Schram and Wilcox (1988) also conducted case studies of two prospective elementary teachers enrolled in the first of the three innovative mathematics courses. These case studies focused specifically on the students' views about how mathematics is learned and what it means to know mathematics. The students' views were examined against a setting developed by the researchers, consisting of three levels that reflected different orientations to mathematics teaching and learning. One of the students changed his original views of what it means to know mathematics. The other student appeared to take in the new experiences and conceptual ideas by modifying them to fit into her original conceptions. Thompson points out that this

phenomenon of teachers modifying new ideas to fit their existing schemas is not well known. He states it is central to effecting change in understanding why teachers do this instead of restructuring their current schemas. Skemp (1978) offered the following as one factor that contributes to the difficulty of teachers changing their instructional practices:

The great psychological difficulty for teachers of accommodating (restructuring) their existing and longstanding schemas, even for the minority who know they need to, want to do so, and have time for study. (p. 13)

In one last past study described by Thompson (1992), Carpenter, Fennema, and Peterson at the University of Wisconsin conducted a set of studies reporting a high degree of success in changing teachers' beliefs and practices. The studies were designed to investigate the effect that information regarding children's thinking in solving simple addition and subtraction word problems would have on primary school teachers' instructional practice. The researchers observed important changes in the instructional decisions of the teachers. It was reported the teachers also spent more time during class listening to their students' explanations of problem solving strategies (classroom discourse) and less time engaging students in rote activities (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989).

More recent studies examining mathematical conceptions and mathematics teaching follow:

Peterson, Fennema, Carpenter, and Loef (1989) examined relationships among first-grade teachers' pedagogical content beliefs, teachers' pedagogical content

knowledge, and students' achievement in mathematics. Thirty-nine teachers completed structured questionnaires and interviews on their beliefs and knowledge about instruction, children's learning, and the mathematics content in addition and subtraction. Results indicated significant positive relationships among teachers' beliefs, teachers' knowledge, and students' problem-solving achievement. Compared to teachers with a less cognitively based perspective, teachers with a more cognitively based perspective made extensive use of word problems in introducing and teaching addition and subtraction. They also spent time developing children's counting strategies before teaching number facts. Cognitively based perspective teachers had greater knowledge of word-problem types and greater knowledge of their children's problem-solving strategies than did less cognitively based perspective teachers. Furthermore, cognitively based perspective teachers obtained this latter knowledge by observing their children in problem situations rather than by relying on tests or formal assessments. Children with cognitively based perspective teachers scored higher on word problem-solving achievement than did children with less cognitively based perspective teachers, but children from both types of classes did equally well on addition/subtraction number facts.

McDiarmid (1990), Associate Director at the National Center for Research of Teacher Education, used field experiences to challenge prospective teachers' underlying beliefs about teaching and learning. In the experiences described, teacher education students are deliberately brought face-to-face with their assumptions through encounters with negative numbers, third-graders, and an unconventional teacher. The unconventional teacher through the creation of a learning community in her classroom,

enables all pupils regardless of language, cultural background, or gender to participate on an equal footing in a continuing conversation about mathematics and to voice their understandings relatively free of worry about ridicule from their classmates.

The teacher education students before observing the unconventional teacher's classroom, wrote about and discussed operations with positive and negative numbers, the same topic that the third-graders were discussing. The education students, before and after each class they observed, interviewed the unconventional teacher about her purposes, goals, plans, her reactions to events and particular pupils, and the rationale for her actions. They observed the third-graders discussing positive and negative numbers and working in small groups. The students subsequently responded in writing to questions about what they had observed. A clinical interview was developed where the researcher, teacher, and students explored the third-graders' understandings of operations with positive and negative numbers. The prospective teachers then attempted to teach someone they knew about operations with positive and negative numbers. Finally, they wrote a "case study" of the teaching and learning of operations with negative numbers.

The entire sequence occurred over a 4-week period and involved 4 hours of observation in the unconventional teacher's classroom, another 4 hours of discussion with her, and about 10 hours in the university classroom. It was concluded that although the teacher education students appeared to reconsider their beliefs, such changes may be superficial and short-lived. McDiarmid (1990) explained that prospective teachers who are willing to reexamine their understandings and beliefs may be prepared to transfer the lessons they learned about the teaching and learning of mathematics to other subjects.

Many of the students in this study came to realize the inadequacy of their knowledge of most subjects and consoled themselves with the belief that future college courses will teach them what they need to know. McDiarmid questioned if one focused, in-depth experience with one topic in mathematics taught by an atypical teacher in a single third-grade classroom could change the way that prospective teachers think about mathematics and its teaching. The researcher suggested more is needed.

Wood, Cobb, and Yackel (1991) used a case study to examine a teacher's learning in the setting of the classroom. In an ongoing mathematics research project based on constructivist views of learning and set in a second-grade classroom, the teacher changed in her beliefs about learning and teaching. These alterations occurred as she resolved conflicts and dilemmas that arose between her previously established form of practice and the emphasis of the project on children's construction of mathematical meaning. The changes that occurred as the teacher reorganized her practice were analyzed and interpreted by using selected daily video recordings of mathematics lessons along with field notes, open-ended interviews, and notes from project meetings. The analyses indicated that changes occurred in her beliefs about the nature of (a) mathematics from rules and procedures to meaningful activity, (b) learning from passivity to interacting and communicating, and (c) teaching from transmitting information to initiating and guiding students' development of knowledge.

Wood, Codd, and Yackel (1991) resolved if teachers are to effect the changes that have been recommended, they need to develop a form of practice that is a radical change from the way that they are currently teaching mathematics. "The project teacher, in

creating a setting that focused on the mathematical activity of her students, encountered major contradictions with her prior traditional practice. It was during these periods of conflict, followed by *reflection* and resolution, that opportunities for her to learn occurred” (p. 610). The researchers, as a result of their experiences with the project teacher, also “recognized the crucial importance of the classroom as an environment in which both teachers and students have opportunities to learn” (p. 611).

This last study was designed to determine the perceptions of five concerned groups about the outcomes for the elementary school mathematics curriculum in Japan (Fujioka & Suwannaprasert, 1995). This study was supported by a grant from the Japan Society for the Promotion of Science in October 1993, under the scientific cooperation between the National Research Council of Thailand. The outcomes and a Likert-type scale were submitted to the following groups: (a) elementary school mathematics teachers; (b) elementary school principals; (c) mathematics educators; (d) professors of education; and (e) scientists, mathematicians, and engineers. The list of outcomes contained 71 statements of outcomes expected to result from the study of mathematics. These were based on the four major headings of (a) general skills; (b) attitude, interests, and appreciation; (c) knowledge; and (d) intellectual abilities and skills. Ordinal ranks and correlations were used to determine outcomes for each group. The highest correlation was between mathematics educators and professors of education.

The results of this study imply that a mathematics curriculum based on expected outcomes that an individual or a small group of like-minded individuals considers important will possibly lack balance; that is, those outcomes may not include

outcomes that are perceived to be important by large groups of individuals.

(Fujioka & Suwannaprasert, 1995, p. 375).

The researchers believed that “programs based on outcomes perceived to be relatively important by large, diverse groups of individuals are likely to be similar to each other as far as outcomes are concerned” (Fujioka & Suwannaprasert, 1995, p. 375).

Other findings: the group of professors of education viewed the expected outcomes in the category of *attitudes, interests, and appreciation* as more important than any other group did. The group of scientists, mathematicians, and engineers considered the expected outcomes in the category of general skills to be less important than outcomes in the other categories. The group of mathematics educators placed more importance on the expected outcomes in the category of general skills than all the other groups did. The group of elementary school mathematics teachers viewed the outcomes in the category of knowledge as more important than the outcomes in other categories.

In general, their existing elementary mathematics curriculum emphasized knowledge and intellectual abilities and skills to be more important than general skills, attitudes, interests, and appreciation for mathematics. However, their research findings indicate that various groups believed

that the development of proper attitudes toward, interest in, and appreciation of mathematics in the elementary school curriculum is important. Therefore, the existing gap in the elementary school mathematics curriculum in the categories of attitudes, interests, and appreciation and the category of general skills needs to be bridged. (Fujioka & Suwannaprasert, 1995, p. 377).

It should be obvious that the study of mathematics teachers' attitudes, beliefs, teacher mathematical knowledge, teacher education, and mathematics teaching and learning has established a place for itself within mathematics education research. This line of research has produced information that can be used as a driving force for preservice education programs, school districts' staff developers, and others to *reexamine* aspects of their work. Thompson (1992) states,

...some teacher educators have already begun to raise thoughtful and important questions such as: What conceptions of mathematics and of mathematics teaching and learning do teachers (pre- and in-service) bring to teacher education and staff development programs? What can those programs offer to support or challenge those conceptions? (p. 141)

She states although these questions may not be answered by research on teachers' beliefs and conceptions, they nevertheless are important questions that might not have been asked in the absence of this line of research.

This study continues this line of research by looking at urban early childhood teachers' attitudes and beliefs about mathematics and how they view it should be taught and learned.



# CHAPTER III

## CHAPTER III

### METHOD

#### Participants

This research study was conducted in two urban school districts. Due to agreements of confidentiality, they are referred to as District A and District B. The study was conducted with teachers who taught kindergarten, first, second, or third grade students in both districts. Six types of teachers were targeted. The six included:

1. Self-contained kindergarten, first, second, and third grade teachers
2. English Speakers of Other Languages (ESOL) or English as a Second Language (ESL) teachers
3. Bilingual teachers
4. Special Education including Resource teachers
5. Talented and Gifted (TAG) teachers, and
6. Mixed-Age teachers that have kindergarten, first, second and/or third grade students. (District B does not have ESL/ESOL, Resource, or Mixed-age teachers.)

District A: District A is an urban school district and is one of the largest public school districts in the nation. It serves close to 160, 000 students in the Early Childhood through twelfth grades, representing 58 different native languages. The district encompasses an area of 351 square miles and includes all portions of eleven municipalities. It has a total

of 220 schools, of which 144 houses K-3rd grade students. Student ethnicity in the district is approximately 47% Hispanic, 41% African American, 10% White, 1.6% Asian, and 0.4% other (percentages are rounded). Teacher ethnicity is approximately 11% Hispanic, 39% African American, 49% White, and 2% other (percentages are rounded). Approximately 36% of the participants have 5 or fewer years of experience and 64% of the participants have more than 5 years of experience. The average years of experience would be approximately 13.1 years (percentages are rounded).

Twenty -four schools out of 144 schools housing kindergarten, first, second, and third grade students were randomly selected to participate in this research study. Out of approximately 3,392 teachers who teach kindergarten, first, second, and third grade students, a sample size of 347 teachers participated in this study. The participants were new and veteran age teachers, male and female, and from a diversity of ethnicities. The teachers who received the questionnaires were: kindergarten, first, second, and third grade teachers and special category teachers who teach kindergarten first, second and third grade students (ESOL and/or ESL, Bilingual, Special Education and/or Resource, TAG, or Mixed-Age).

District B: District B is located in the same county as District A. It serves two cities as well as parts of two other cities, including part of the city of District A. It encompasses sixty-four square miles and is a blend of urban, suburban and rural settings. It serves approximately 3,600 students in pre-kindergarten through twelfth grade. It has a total of 7 schools, of which 4 house K-3rd grade students. Student ethnicity in the district is approximately 16% Hispanic, 78% African American, 5% White, 1% Asian/Pacific

Islander, and 0.1% other (percentages are rounded). Teacher ethnicity is approximately 0.8% Hispanic, 71% African American, and 28% White. Approximately 45% of the participants have 5 or fewer years of experience, 19% have 6-10 years experience, 21% of the participants have 11-20 years of experience, and 15% of the participants have over 20 years experience (percentages are rounded). The average years of experience are approximately 9.6 years.

All four schools that house kindergarten, first, second, and third grade students were chosen to participate in this study. Out of approximately 60 teachers who teach kindergarten, first, second, and third grade students, a sample size of 50 teachers participated in the study. The participants were new and veteran age teachers, female, and from a diversity of ethnicities. The teachers who received the questionnaires were: kindergarten, first, second, and third grade teachers and special category teachers who teaches kindergarten first, second and third grade students (Bilingual, Special Education, and TAG). This school district does not have ESOL, Resource, or Mixed-Age teachers.

#### Instrumentation

A mathematics opinion survey was used to solicit the responses of the teachers in this investigative research study.

*Questionnaire Title:* “Mathematics: What’s Your Opinion?”

*Time Allotment:* The questionnaire was designed to take approximately 15-minutes to complete.

*Questionnaire Description:* This 57 item, five point Likert-type scale questionnaire is an adaptation of the 152 item scale entitled “Questionnaire on the Teaching of Maths [sic],”

developed by Paul Ernest, Ph.D., University of Exeter, School of Education, Exeter, United Kingdom. His scale was used to measure primary preservice teachers' attitudes, beliefs, conceptions, and views regarding mathematics teaching and learning. The researcher communicated with Ernest through e-mail over several months during the development of this survey. This scale (Appendix B), the same as Ernest's, was designed to exam the following questions:

- What are urban early childhood teachers' general attitudes toward mathematics?
- 2. What are urban early childhood teachers' views of mathematics? Do urban teachers' views of mathematics lean more toward the: **a. Platonist view**—mathematics is exact and certain truth; **b. Instrumental view**—mathematics is facts and rules, not creative; or **c. Problem Solving view**— many answers, exploring patterns versus routine tasks (Ernest, 1988; Ernest 1996). The NCTM endorses the problem solving approach.
- 3. What are urban early childhood teachers' attitudes toward teaching mathematics?
- 4. What are urban early childhood teachers' views of teaching mathematics?
  - a. Basic Skills Practice**—basic skills vs. calculator, other emphasis
  - b. Problem Solving View**—problem solving aim vs. routine tasks
  - c. Discovery (Active) View**— need to be told vs. can/should discover
  - d. Teacher Designed Curriculum**—children's needs, differences and preferences are accommodated; one text is not followed for all abilities, the mathematics curriculum is differentiated for individual needs and differences
  - e. Text Driven Curriculum**-- mathematics is taught by following the text or syllabus exactly

- f. Many Methods Encouraged**—teacher’s unique method vs. many methods; or,
  - g. Cooperative Learning View**—isolated vs. cooperative learning. (Ernest 1996)
5. What are urban early childhood teachers’ views of children learning mathematics?
- a. Rote Learning**—mathematics is remembering facts, rules, learning by rote
  - b. Constructivist View (Previous Knowledge Respected)** —transmission (transference) vs. building on existing knowledge
  - c. Role of Errors**—careless errors vs. answers over emphasized.

In other words, the problem-solving process is more important than getting the correct answer. The learner will receive partial credit for his “process” efforts when he does not get the correct answer. The learner focuses on the essence of the problem while he attempts to come up with the solution. When answers are over emphasized the learner receives no credit for his incorrect answer, or process efforts. Or,

- d. Choice and Autonomy**—imposed order and tasks vs. child choice (centered) and direction. (Ernest, 1996)

*Response Mode:* Participants respond to each item by choosing one of five Likert alternatives—Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree.

*Scoring:* Response alternatives for positive items are weighted from 4 (strongly agree) to 0 (strongly disagree). These weights were reversed for alternatives to negative items.

The person’s score in the attitude toward mathematics section and the attitude toward teaching mathematics section was the sum of the weighted alternatives endorsed by the person. High scores reflect positive attitudes for the construct being measured. The

highest score any participant can score in the attitude toward mathematics section is 36—there are nine questions, each worth 4 positive points. The highest score for a sub-construct in any section is 12. The highest score any participant can score in the attitude toward teaching mathematics section is 24—there are six questions, each worth 4 positive points. The highest score for a sub-construct in any section is 12. (The questionnaire was designed where there are only three questions in each sub-construct category—each worth four positive points.) Descriptive analyses were used to describe the participants' views regarding the constructs and sub-constructs, such as view of mathematics and problem solving aim verses not (routine tasks).

*Coding:* The response mode for part A of the questionnaire was coded as follow: 4-Strongly Agree, 3-Agree, 2-Undecided, 1-Disagree, and 0-Strongly Disagree. The demographics were coded: item 58-Grade Level, 1-Kindergarten, 2-First, 3-Second, 4-Third, 5-All of the above, 6-All grade levels; item 59-Type Classroom, 1-Regular Classroom, 2-ESOL or ESL, 3-Bilingual, 4-Special Education or Resource, 5-Talented and Gifted, 6-Mixed-Age Program; item 60-Years of Experience, 1-One to Three years, 2-Four to Seven years, 3-Eight to Fifteen years, 4-Sixteen to Twenty-nine years, 5-Thirty or More years; item 61-Gender, 1-Female, 2-Male; item 62-Ethnicity, 1-Hispanic, 2-African American, 3-Caucasian, 4-Asian, 5-Other; and item 63-Was mathematics a college minor or major of yours? 1-Yes, 2-No.

*Validity:* Content validity addresses whether or not the appropriate content is in the instrument. It looks at whether the instrument measures what it is intended to measure and whether the instrument elicited accurate information (Cox, 1996; Huck & Cormier,

1996). Content validation was established by cross-referencing the content of the instrument (questionnaire) to those elements reported in the literature and supported by experience to determine if there was in deed a match. A panel of experts (Appendix C) examined the instrument and offered suggestions regarding additions or deletions to enhance the content validity of the instrument. Seven experts in the fields of ECE and mathematics addressed this. Three are directors in the participating large public school system in which the study was conducted one was of their Head Start program, one of the ECE department, and one of the mathematics department. One expert is a professor of early childhood education, one a professor of mathematics (Ernest himself from the University of Exeter), and one a director of research and evaluation—all from leading universities. All are former teachers in their fields. Each was given an evaluation checklist (Appendix C) recommended by Cox (1996) to help guide them through the instrument. Also a panel of educators and researchers in both districts in which the study was conducted reviewed the entire project and instrument; and participants in the Pilot Study were allowed to give feedback at the bottom of their questionnaires (Appendix C).

*Reliability:* “The basic idea of reliability is summed up by the word *consistency*” (Huck & Cormier, 1996, p. 76). Test-retest reliability asks, “Does the instrument measure consistently over time?” (Cox, 1996, p. 37). Cox (1996) says for questionnaires, consistency is generally the most important issue. A pilot study was implemented to assess the reliability of the instrument (questionnaire). The pilot study was conducted at a school in District A not included in the study. Fifteen individuals that teach kindergarten, first, second and third grade students volunteered to participate. There was

a mixture of ESL, ESOL, Bilingual, Special Education, Talented and Gifted, male and female, with varied teaching years of experience, and from various ethnic groups as reflected in this study. The same questionnaire was administered twice to the same group of 15 individuals with an interval of 15 days between the first and second administrations. The individuals were cautioned against trying to remember what they answered on the first administration of the questionnaire. Each time they were asked to answer as they truly feel about the subject of mathematics. They were compensated with a small gift at the completion of the second administration of the questionnaire.

Each person's first and second responses were matched for each questionnaire item to see if the ratings were the same on the five point Likert-type scale. Every item was evaluated on its own merits. An objective method was used to assess the reliability of each item. The responses from the first administration were correlated with the responses from the second administration. A Pearson Correlation Coefficient was calculated. "With a test-retest approach to reliability, the resulting coefficient addresses the issue of consistency, or stability, over time. For this reason, the test-retest reliability coefficient is frequently referred to as the coefficient of stability" (Huck & Cormier, 1996, p. 77). The test-retest reliability coefficients for the subsections on the pilot test are as follow: (a) .894 for "Attitude Toward Mathematics", (b) .808 for "Attitude to Teaching Mathematics", (c) .603 for "View of Mathematics", (d) .766 for "View of Teaching Mathematics", and (e) .711 for "View of Children Learning Mathematics". Correlations are significant at the 0.01 level (2-tailed).

## Data Collection Procedures

Data collection procedures were somewhat different for District A, the larger school district, than for District B, the smaller school district. The larger school district suggested that the survey packet containing the questionnaire be mailed directly to the kindergarten through third grade teachers at each of the randomly selected campuses. They also required that approval be obtained from each of the school principals at the randomly chosen campuses before sending any packets to their teachers. The district's intra-district mailboxes were utilized for this purpose.

After obtaining permission from District A's Office of Institutional Research to perform the research study, an introductory letter/packet was sent to all principals of the selected 24 schools. The letter reiterated the District's approval for the research study and briefly explained the study. It also informed principals of their rights to withdraw from the study at any time without prejudice or penalty. The introductory letter/packet consisted of a pre-notification letter regarding the survey study and the extent of the principal's involvement--which was only to sign the consent form. This packet also contained a copy of the approval letter from the district's Office of Institutional Research, a letter of support from the District's Director of Early Childhood Education, and a letter of consent form. This mailing was sent through the United States Postal Service for faster delivery. After four days of this mailing, a followed-up was made by telephone to the campuses that had not returned their consent forms. This call was made in order to confirm receipt of the pre-notification letter/packet, to answer any questions the principals might have regarding the study, and to persuade them to allow the researcher

to send the questionnaires to their teachers. Other campuses were randomly chosen for the campuses that denied access to their teachers.

Each principal was asked to fax the consent form back to the researcher indicating whether consent was granted or not. After obtaining permission from each participating principal, another telephone call was made requesting that they fax their faculty rosters with teachers' names, subject(s) taught, and grade level(s) taught for the current year. Each teacher was assigned a serial number.

Labels were made for each faculty roster received and a serial numbered packet was sent to each teacher. Inside each packet was a letter explaining the study and the teacher's participation, a serial numbered cover letter that was attached to the questionnaire, a corresponding serial numbered questionnaire, a slip of paper asking them to return the completed questionnaire "ASAP", and a large self-addressed stamped return envelope. The letters also contained a clause that informed the teachers of their rights to not participate in the study. U. S. postage was placed on these "return" envelopes for faster delivery and so that the questionnaires could be mailed from their homes or from other locations other than the schools, if they so desired. Each return envelope's label was numbered with the corresponding serial number on the questionnaire as well, so each questionnaire could be logged in upon its return. This serial numbering also served as a way to track teachers who did and who did not return their completed questionnaires, so a "Thank You" letter could be sent, or so another questionnaire could be sent.

Packets were mailed immediately to the teachers as consent forms and rosters were received from the participating campuses. The study was conducted from April 30

to May 24, 1999--the last day of the school year for the teachers. Due to duplicating costs of the questionnaires and letters, large envelopes' cost, and the cost of postage for the return envelopes, a reminder letter was first sent to teachers who had not returned their questionnaires within four days. After twelve days following the reminder notices, another round of serial numbered questionnaire packets with a reminder letter enclosed were sent to the teachers who had not responded. Again, the school mail was utilized. On the fifteenth day, the researcher started sending thank you letters through the district-mail system to all participating principals and to all teacher respondents. On the 19<sup>th</sup> day another reminder letter was sent to all teachers who had not responded up to this point, along with a plea to complete the questionnaire and a "thank you" in advance.

The smaller school district was simpler in its distribution and collection of completed questionnaires. The central office staff assisted. Once granted permission to perform study in District B, central office sent an inquiry form that the researcher designed to each campus. This form was to assist in finding out the exact number of teachers per campus and the subject areas and grade levels they taught, so that the researcher would know how many questionnaires to take to each campus. Upon obtaining this information, one packet per campus was made. The questionnaires were not numbered.

After obtaining permission from District B's central office to perform the research study, an introductory letter/packet was sent to all principals of the K-3 schools. This letter reiterated the District's approval for the research study and briefly explained the study. It also informed principals of their rights and the teachers' rights to withdraw from

the study at any time without prejudice or penalty. The introductory letter/packet consisted of a pre-notification letter regarding the survey study and the extent of the principal's involvement—which was more involved than District A. This packet also contained a copy of the approval letter from the district's central office and a letter of consent form. This mailing was sent through the United States Postal Service for faster delivery as well. Within a few days of receipt of letter/packet, a telephone call was made to the principals in order to check on the letter/packet's arrival and to set up an appointment to discuss survey, answer any questions, and to discuss distribution and collection of questionnaires. A packet containing the teacher pre-notification letters, cover letters, the questionnaires, and large envelopes was taken along with the researcher to these campus visits. (The teachers' letters also contained a clause that informed teachers of their rights to not participate in the study.) After explaining the study and the distribution and collection procedures, the consent forms were signed in my presence by the principal. The packets were left with the principals along with a plan to pick up the completed questionnaires. This collection of data ran from May 3 to May 24, 1999, the last day of school for the teachers. When the completed questionnaires were picked up, copies of a generic "thank you" letter was left behind with each principal in order to pass out to the teachers who responded to the study. A thank you letter was mailed to each participating principal after the researcher received their teachers' completed questionnaires and to the central office staff.

The following procedures were explained and given in print to each of the four participating principals in District B:

1. See attached “Materials List”. (The materials list contained the following items: pre-notification letters, survey cover letters and questionnaires stapled together inside envelopes, one larger envelope [used for collection of the individual teachers’ sealed envelopes with completed questionnaires], a reminder letter form [2-part], and no. 2 pencils –they were reminded that black ink could also be used.)
2. During the **weeks of May 3-17**, choose a day to distribute pre-notification letters to the following groups of teachers. The groups include: self-contained kindergarten, first, second, and third grade teachers, English as a Second Language (ESL), Bilingual, Special Education, and Talented and Gifted (TAG) teachers who have kindergarten, first, second, or third grade students. (All these groups may not apply to your campus.) They will need to specify what category they are in on their questionnaires.
3. Once all teachers of kindergarten, first, second, and third grade students have received their pre-notification letters early in the week, distribute the questionnaires with accompanying survey letter. You may have the teachers to complete the questionnaires individually during their planning periods, during their grade level meetings, or you may want to call the teachers together as one group—whatever is convenient for you. The researcher’s only concern is that they complete the questionnaires **independently**—no communicating with one another. Give them a number two pencil if they do not have one, or they may use

black ink. **Teachers are to fill out questionnaires independently of each other in order for the study to be valid.**

4. Have teachers return questionnaires in their sealed envelopes on the same day of issuance immediately after completing it. You want to **check teachers' names off of a list** as they submit them, in case you need to give a questionnaire another day to a person who was absent, or for some unforeseen reason. Make sure teachers circle their grade levels or category on the outside of their envelopes. This is a precaution in case they forget to mark it on the questionnaire itself. **It is important that teachers only fill out one questionnaire.**

5. Place sealed envelopes with questionnaires inside the one large envelope provided.

6. Once all questionnaires have been collected, call the researcher for pick up.

7. Please do not fold or bend questionnaires. They possibly will be machine-scored by new technology at the University of North Texas.

*Last, they were thanked for their time.*

In both school districts, district administrators and teachers were offered a copy of the research results for their participation.

# CHAPTER IV

## CHAPTER IV

### RESULTS

#### Analysis of Data

The Statistical Analysis System (SAS 7.0) was used in this study to analyze the data collected. It is both a statistical language and a system that performs sophisticated data management and statistical analysis.

Teacher information obtained from the survey study was analyzed with descriptive statistics. Characteristics of teachers were analyzed (disaggregated) by teaching level, type classroom, years of experience, gender, ethnicity, and mathematics major /minor.

Summary scores were calculated for attitude toward mathematics and attitude to teaching sections of the questionnaire. Sums indicated a specific type of response preference for each teacher in these sections of the survey. The teacher's score is the sum of the weighted sections. High scores reflect positive attitudes toward mathematics and/or to teaching. Low scores reflect negative attitudes. Descriptive statistics, frequency distributions, and t-tests (for paired samples) were calculated for the remaining three sections of the instrument: view of mathematics, view of teaching mathematics, and view of children learning mathematics.

Comparative analyses were also used to compare and delineate the responses of teachers. Analyses of Variance (ANOVA) with Tukey post hoc tests in the case of significant between group differences, and Pearson Correlations were conducted in order to investigate the relationships between the dependent variables and independent variables. The dependent variables were attitude toward mathematics, view of mathematics, attitude to teaching mathematics, view of teaching mathematics, and view of children learning mathematics; the independent variables were grade level, type class, years of experience, gender, ethnicity, and major/minor in mathematics.

#### District A Results

The findings of this study will be presented in two parts. The analysis will be given separately by school districts. Results of District A, the larger school district, will be presented first, followed by the results of District B, the smaller district.

The number of teachers who returned their questionnaires by demographic categories is indicated in Table 1 for District A. Three hundred forty-seven teachers responded to the survey.

Table 1

#### Survey Participants by Demographics Categories - District A

Grade	Surveys Returned	Percent
K	84	25.7%
1	77	23.5%
2	67	20.5%
3	70	21.4%

(Table Continues)

Grade	Surveys Returned	Percent
All of the Above	12	3.7%
All Grade Levels	17	5.2%

Note. Total observations = 347. Frequency Missing = 20 . K = Kindergarten.

Survey Participants by Demographics Categories - District A

Type Class	Surveys Returned	Percent
Regular Classroom	158	46.2%
ESOL/ESL	80	23.4%
Bilingual	47	13.7%
Special Education/Resource	28	8.2%
Talented & Gifted	16	4.7%
Mixed-Aged	13	3.8%

Note. Total observations = 347. Frequency Missing = 5. ESOL = English Speakers of Other Languages. ESL = English as a Second Language.

Years of Experience	Surveys Returned	Percent
1-3	73	21.7%
4-7	60	17.8%

8-15 57 16.9%

*(Table Continues)*

Years of Experience	Surveys Returned	Percent
16-29	122	36.2%
30 or more	25	7.4%

Note. Total observations = 347. Frequency Missing = 10.

Survey Participants by Demographics Categories - District A

Gender	Surveys Returned	Percent
Female	326	94.2%
Male	20	5.8%

Note. Total observations = 347. Frequency Missing = 1.

Ethnicity	Surveys Returned	Percent
Hispanic	46	13.9%
African American	92	27.8%
Caucasian	179	54.1%
Asian	7	2.1%
Other	7	2.1%

Note. Total observations = 347. Frequency Missing = 16.

*(Table Continues)*

Math Major/Minor	Surveys Returned	Percent
Yes	24	7.1%
No	315	92.6%

Note. Total observations = 347. Frequency Missing = 8.

Descriptive statistics and ANOVAs were used to examine early childhood teachers' general attitudes toward mathematics and their attitudes to teaching mathematics. The participant's score in the attitude toward mathematics and attitude to teaching mathematics sections is the sum of the weighted alternatives for that particular participant.

The attitudes toward mathematics section of the questionnaire contained nine items, each worth 4 positive points. (See "scoring" in the Method section.) The highest possible score on this section is a 36. If the middle response, "Undecided", were chosen on every item, the middle score would be an 18. The mean "summed" score of teachers in District A was a 24.8 (SD = 7.5), indicating that overall they had a positive attitude toward mathematics.

The sample was then divided on the basis of their score on their attitude toward mathematics. Participants scoring above the median were characterized as having positive attitudes; those scoring below the median were characterized as having negative attitudes. By this criterion, sixty-three percent of the sample population had a positive attitude toward mathematics. The teacher responses are shown in Table 2.

Table 2

Teacher Responses for Attitudes toward Mathematics – District A

Type Response	No. of Teachers	Percent
Negative	129	37.2%
Positive	218	62.8%
N	347	

The ANOVA indicated that attitudes toward mathematics were not significant ( $\alpha=0.05$ ) for grade level, type of classroom, or gender. Years of experience was significant ( $F(4, 323) = 2.60, p = 0.036$ ). Tukey post hoc test revealed that teachers with 30 or more years of experience had more positive attitudes toward mathematics than teachers with 1-3 years of experience. Ethnicity was also significant ( $F(4, 318) = 3.75, p = 0.005$ ). Tukey post hoc test revealed that African American teachers had a more positive attitude toward mathematics than Caucasian teachers. Having majored or minored in mathematics was significant as well ( $F(2, 328) = 7.01, p = 0.001$ ). Those with mathematics majors/minors had a better attitude toward mathematics. These comparison findings are reflected in Tables 3 through 8.

Table 3

Attitude toward Mathematics and Years of Experience

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	571.46	142.86	2.60	0.0359
Error	323	17721.37	54.86		
Corrected Total	327	18292.83			

Table 4

Years of Experience, Attitude toward Mathematics, and Least Squares Means

Years of Experience	Attitude toward Mathematics LS Mean
1-3	22.75
4-7	25.40
8-15	25.16
16-29	25.15
30 or more	27.80

Table 5

Attitude toward Mathematics and Ethnicity

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	816.31	204.08	3.75	0.0054
Error	318	17324.20	54.48		
Corrected Total	322	18140.51			

Table 6

Ethnicity, Attitude toward Mathematics, and Least Squares Means

Ethnicity	Attitude toward Mathematics LS Mean
Hispanic	24.09
African American	26.58
Caucasian	23.54
Asian <sup>a</sup>	27.14
Other <sup>a</sup>	30.14

Note. <sup>a</sup> Although the mean for the Asian teachers and teachers with other ethnicities were greater than the mean for African Americans, the Tukey tests for these groups were nonsignificant due to having larger standard errors.

Table 7

Attitude toward Mathematics and Major/Minor

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	758.78	379.39	7.01	0.0010
Error	328	17755.22	54.13		
Corrected Total	330	18514.01			

Table 8

Major/Minor, Attitude toward Mathematics, and Least Squares Means

Major/Minor	Attitude toward Mathematics LS Mean
Yes	30.04
No	24.38

The attitudes to teaching mathematics section of the questionnaire contained six items, each worth 4 positive points. (See “scoring” in the Method section.) The highest possible score on this section is a 24. If the middle response, “Undecided”, were chosen on every item, the middle score would be 12. The mean “summed” score of teachers in District A was a 16.6 (SD = 4.0), indicating that overall they had a positive attitude to teaching mathematics.

As with teachers’ attitudes toward mathematics, the sample was divided on the basis of their score on their attitude toward teaching mathematics. Participants scoring above the median were characterized as having positive attitudes; those scoring below the median were characterized as having negative attitudes. With this criterion, eighty-seven percent of the sample population had a positive attitude toward teaching mathematics. The teacher responses are shown in Table 9.

Table 9

Teacher Responses for Attitudes to Teaching Mathematics - District A

Type Response	No. of Teachers	Percent
Negative	45	13.0%
Positive	302	87.0%
N	347	

An ANOVA showed that attitudes to teaching mathematics were not significant ( $\alpha = 0.05$ ) for grade level, years of experience, or gender. The type of classroom the teacher taught was significant ( $F(5, 326) = 2.66, p = 0.023$ ). However, none of the pairwise comparisons were significant due to the compensation the Tukey test makes to control the alpha level at .05. Ethnicity was significant ( $F(4, 317) = 2.84, p = 0.025$ ). Tukey post hoc test showed that African American teachers had a more positive attitude to teaching mathematics than Caucasian teachers. The Tukey post hoc test showed no significance with regards to other ethnicities. Having a mathematics major or minor was significant ( $F(2, 328) = 4.30, p = 0.014$ ). Those with mathematics majors/minors had a better attitude to teaching mathematics than those who did not. These comparison findings are reflected in Tables 10 through 15.

Table 10

Attitude to Teaching Mathematics and Type Class

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	207.80	41.56	2.66	0.0226
Error	326	5098.85	15.64		
Corrected Total	331	5306.65			

Table 11

Type Class, Attitude to Teaching Mathematics, and Least Squares Means

Type Class	Attitude to Teaching Mathematics LS Mean
Regular Classroom	17.16
ESOL or ESL	15.89
Bilingual	17.09
Special Ed. or Resource	15.29
TAG	14.93
Mixed-Aged	17.83

Note. ESOL = English Speakers of Other Languages. ESL = English as a Second Language. TAG = Talented and Gifted.

Table 12

Attitude to Teaching Mathematics and Ethnicity

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	179.04	44.76	2.84	0.0246
Error	317	5002.85	15.78		
Corrected Total	321	5181.89			

Table 13

Ethnicity, Attitude to Teaching Mathematics, and Least Squares Means

Ethnicity	Attitude to Teaching Mathematics LS Mean
Hispanic	17.04
African American	17.57
Caucasian	15.92
Asian	17.29
Other	17.14

Table 14

Attitude to Teaching Mathematics and Major/Minor

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	135.99	67.99	4.30	0.0144
Error	328	5191.57	15.83		
Corrected Total	330	5327.56			

Table 15

Major/Minor, Attitude to Teaching Mathematics, and Least Squares Means

Major/Minor	Attitude toward Mathematics LS Mean
Yes	18.63
No	16.46

Teachers demonstrated that the problem solving view was the most favored view of mathematics. Teachers demonstrated significantly more favorable attitudes toward problem solving than for instrumentalist ( $t(330) = -13.497, p < 0.001$ ) and Platonist views ( $t(332) = -19.342, p < 0.001$ ). Teachers also demonstrated more favorable attitudes towards the instrumentalist view over the Platonist view ( $t(330) = -4.239, p < 0.001$ ). However, the difference in means between the instrumentalist and Platonist views was so small, that it renders little practical significance. See Tables 16 and 17. Furthermore, the teachers were classified in terms of the view of mathematics they endorsed most strongly. The endorsement of teachers for the three views of mathematics are reflected in Table 18.

Table 16

Paired Samples Test – District AView of Mathematics

Paired Differences						
Paired	Mean	Std.	Std.	T	df	Sig.
View		Deviation	Error Mean			(2-tailed)
Platonist & Instrumentalist	-.5347	2.2471	.1235	-4.329	330	.000
Platonist & Problem Sol.	-2.9520	2.7851	.1526	-19.342	332	.000
Instrumentalist & Problem Sol.	-2.4048	3.2417	.1782	-13.497	330	.000

Table 17

Descriptive Statistics – District AView of Mathematics

View	N	Mean	Std. Deviation
Platonist	338	5.3343	1.9083
Instrumentalist	336	5.8810	2.4159
Problem Solving	341	8.3050	1.5721
Valid N (listwise)	326		

Table 18

District A - Frequencies

Views of Mathematics

View	Frequency	Percent	Valid Percent
Platonist	4	1.2%	1.4%
Problem Solving	217	62.5%	77.5%
Instrumentalist	59	17.0%	21.1%
Total	280	80.7%	100.0%
Frequency Missing	67	19.3%	
Total	347	100.0%	

In regard to the view of teaching mathematics, each comparison differed significantly. See Table 19. Participants had the most favorable view toward problem solving, but also had favorable views toward many methods. Teacher designed curriculum, cooperative learning, and basic skills fell in the middle. Teachers had less favorable views toward discovery and text driven views. See Table 20. In addition, the teachers were classified in terms of the view of teaching mathematics they endorsed most strongly. Table 21 reflects the endorsement of teachers for the seven views of teaching mathematics.

Table 19

Paired Samples Test – District A

View of Teaching Mathematics

Paired Differences						
Paired	Mean	Std.	Std.	T	df	Sig.
View		Deviation	Error Mean			(2-tailed)
Basicski & Probsol	-2.8537	2.5382	.1387	-20.578	334	.000
Basicski & Discove	.2337	2.0078	.1092	2.140	337	.033
Basicski & Teadesig	-1.5105	2.4441	.1339	-11.278	332	.000
Basicski & Textdriv	1.1502	2.3171	.1270	9.058	332	.000
Basicski & Manymeth	-2.2789	2.1601	.1177	-19.367	336	.000
Basicski & Manymeth	-2.2789	2.1601	.1177	-19.367	336	.000
Basicski & Cooplear	-1.1869	2.2921	.1249	-9.506	336	.000

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Probsol & Discove	3.0445	2.0121	.1096	27.777	336	.000
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*(Table Continues)*

Paired View	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Probsol & Teadesig	1.3183	2.2268	.1220	10.803	332	.000
Probsol & Textdriv	3.9850	2.5406	.1392	28.623	332	.000
Probsol & Manymeth	.5917	1.6680	9.073E-02	6.522	337	.000
Probsol & Cooplear	1.6805	1.6714	9.091E-02	18.484	337	.000
Probsol & Cooplear	1.6805	1.6714	9.091E-02	18.484	337	.000
Discove & Teadesig	-1.7463	2.0411	.1115	-15.659	334	.000
Discove & Teadesig	-1.7463	2.0411	.1115	-15.659	334	.000
Discove & Textdriv	.9194	1.9780	.1081	8.507	334	.000

Discove & Manymeth	-2.4631	1.6411	8.913E-02	-27.635	338	.000
Discove & Cooplear	-1.3717	1.6401	8.908E-02	-15.399	338	.000

*(Table Continues)*

Paired View	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Teadesig & Textdriv	2.6737	2.4356	.1333	20.062	333	.000
Teadesig & Manymeth	-.7194	2.0819	.1137	-6.325	334	.000
Teadesig & Cooplear	.3612	2.0277	.1108	3.260	334	.001
Textdriv & Manymeth	-3.3910	2.2238	.1215	-27.910	334	.000
Textdriv & Cooplear	-2.3104	2.3096	.1262	-18.309	334	.000
Manymeth & Cooplear	1.0941	1.5352	8.326E-02	13.141	339	.000

Note. Basicski = Basic Skills. Probsol = Problem Solving. Discove = Discovery.

Teadesig = Teacher Designed. Textdriv = Text Driven. Manymeth = Many Methods.

Cooplear = Cooperative Learning.

Table 20

Descriptive Statistics – District A

View of Teaching Mathematics

View	N	Mean	Std. Deviation
Basic Skills	339	5.1209	1.9200
Problem Solving	339	7.9676	1.5582
Discovery	341	4.9091	1.2511
Teacher Designed	337	6.6528	1.7444
Text Driven	337	3.9792	1.8842
Many Methods	343	7.3703	1.1945
Cooperative Learning	343	6.2682	1.2035
Valid N (listwise)	323		

Table 21

District A - Frequencies

Views of Teaching Mathematics

View	Frequency	Percent	Valid Percent
Basic Skills	12	3.5%	5.2%
Problem Solving	136	39.2%	59.4%
Discovery	2	0.6%	0.9%
Teacher Designed	32	9.2%	14.0%

*(Table Continues)*

View	Frequency	Percent	Valid Percent
Text Driven	2	0.6%	0.9%
Many Methods	36	10.4%	15.7%
Cooperative Learning	9	2.6%	3.9%
Total	229	66.0%	100.0%
Frequency Missing	118	34.0%	
Total	347	100.0%	

In the view of learning mathematics, each comparison differed significantly. See Table 22. Teachers demonstrated that role of errors plays an integral part in the learning of mathematics. Participants had the most favorable view toward role of errors, but also had favorable views toward constructivism. Rote learning and choice and autonomy came in last, but rote learning was clearly favored over choice and autonomy. See Table 23. As with view of mathematics and view of teaching mathematics, the teachers were classified in terms of the view of learning mathematics they endorsed most strongly. The four views of learning mathematics endorsed by the teachers are shown in Table 24.

Table 22

Paired Samples Test – District A

View of Learning Mathematics

Paired Differences						
Paired	Mean	Std.	Std.	T	df	Sig.
View		Deviation	Error Mean			(2-tailed)
Rotelear &	-.7424	2.1389	.1177	-6.306	329	.000

Construc						
Rotelear &	-1.9880	2.1792	.1196	-16.621	331	.000
Roleerro						
Rotelear &	1.3565	1.8373	.1010	13.433	330	.000
Choauton						
Construc &	-1.2335	2.1194	.1160	-10.637	333	.000
Roleerro						
Construc &	2.0663	2.1962	.1205	17.143	331	.000
Choauton						
Roleerro &	3.3373	2.1367	.1167	28.587	334	.000
Choauton						

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Note. Rotelear = Rote Learning. Construc = Constructivist. Roleerro = Role of Errors.  
Choauton = Choice and Autonomy.

Table 23

Descriptive Statistics – District A

View of Learning Mathematics

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View	N	Mean	Std. Deviation
Rote Learning	336	5.4137	1.6853
Constructivist	338	6.1775	1.8834
Role of Errors	340	7.3971	1.6088
Choice and Autonomy	340	4.0706	1.4393

Rote Learning	336	5.4137	1.6853
Valid N (listwise)	322		

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Table 24

District A - Frequencies

Views of Learning Mathematics

View	Frequency	Percent	Valid Percent
Rote Learning	22	6.3%	9.1%
Constructivist	43	12.4%	17.8%
Role of Errors	171	49.3%	71.0%
Choice and Autonomy	5	1.4%	2.1%
Total	241	69.5%	100.0%
Frequency Missing	106	30.5%	
Total	347	100.0%	

---

An area of interest was how the teachers responded to each of the fifty-seven individual items on the questionnaire. These responses can be found in Appendix D.

District B Results

Below are the results from District B, the smaller school district. The number of teachers who returned their questionnaires by demographic categories is indicated in Table 25. Fifty kindergarten through third grade teachers responded to the survey.

Table 25

Survey Participants by Demographics Categories - District B

Grade	Surveys Returned	Percent
K	13	27.1%
1	10	20.8%
2	11	22.9%
3	12	25.0%
All of the Above	--	--
All Grade Levels	2	4.2%

Note. Total observations = 50. Frequency Missing = 2. K = Kindergarten.

Type Class	Surveys Returned	Percent
Regular Classroom	44	89.9%
ESOL/ESL	--	--
Bilingual	1	2.0%

*(Table Continues)*

Type Class	Surveys Returned	Percent
Special Education/Resource	4	8.2%
Talented & Gifted	--	--
Mixed-Aged	--	--

Note. Total observations = 50. Frequency Missing = 1. ESOL = English Speakers of Other Languages. ESL = English as a Second Language.

Years of Experience	Surveys Returned	Percent
1-3	4	8.3%
4-7	8	16.7%
8-15	16	33.3%
16-29	16	33.3%
30 or more	4	8.3%

Note. Total observations = 50. Frequency Missing = 2.

Gender	Surveys Returned	Percent
Female	45	91.8%
Male	4	8.2%

Note. Total observations = 50. Frequency Missing = 1.

*(Table Continues)*

Ethnicity	Surveys Returned	Percent
Hispanic	--	--
African American	35	81.4%
Caucasian	6	14.0%
Asian	--	--
Other	2	4.7%

Note. Total observations = 50. Frequency Missing = 7.

Survey Participants by Demographics Categories

Math Major/Minor	Surveys Returned	Percent
Yes	1	2.2%
No	45	97.8%

Note. Total observations = 50. Frequency Missing = 4.

Same as District A, descriptive statistics and ANOVAs were used to examine early childhood teachers' general attitudes toward mathematics and their attitudes to teaching mathematics. The teacher's score in the attitude toward mathematics and attitude to teaching mathematics sections is the sum of the weighted alternatives for that particular individual.

As stated in the Method section, the attitudes toward mathematics section of the questionnaire contained nine items, each worth 4 positive points. The highest possible score on this section is a 36. If the middle response, "Undecided", were chosen on every item, the middle score would be an 18. Overall the teachers in District B had a positive attitude toward mathematics with a mean "summed" score of 26.3 (SD = 7.2).

Like District A, the sample population was divided on the basis of their score on their attitude toward mathematics. Participants scoring above the median were characterized as having positive attitudes; those scoring below the median were characterized as having negative attitudes. By this standard, sixty-eight percent of the sample population had a positive attitude toward mathematics and thirty-two had a negative attitude. The teacher responses are shown in Table 26. The ANOVA disclosed that attitudes toward mathematics were not significantly different ( $\alpha=0.05$ ) for any of the independent variables--grade level, type of classroom, years of experience, ethnicity, gender, or major/minor.

Table 26

Teacher Responses for Attitudes toward Mathematics - District B

Type Response	No. of Teachers	Percent
Negative	16	32.0%
Positive	34	68.0%
N	50	

The attitudes to teaching mathematics section of the questionnaire contained six items, each worth 4 positive points. (See “scoring” in the Method section.) The highest possible score on this section is a 24. If the middle response, “Undecided”, were chosen on every item, the middle score would be 12. The mean “summed” score of teachers in District B was a 17.1 (SD = 3.2), indicating that overall they had a positive attitude to teaching mathematics.

Unlike teacher's attitudes toward mathematics, it was clearly evident that the teachers in District B had a positive attitude toward teaching mathematics. Participants scoring above the median were characterized as having positive attitudes; those scoring below the median were characterized as having negative attitudes. With this parameter, forty-six of the fifty participants had a positive attitude toward teaching mathematics. Only four had a negative attitude. The teacher responses are shown in Table 27. As with attitude to mathematics, an ANOVA showed that attitudes to teaching mathematics were not significantly different ( $\alpha= 0.05$ ) for grade level, type of classroom, years of experience, gender, ethnicity, or major/minor.

Table 27

Teacher Responses for Attitudes to Teaching Mathematics - District B

Type Response	No. of Teachers	Percent
Negative	4	8.0%
Positive	46	92.0%
N	50	

Teachers in District B made evident that the problem solving view was the most favored view of mathematics. Teachers demonstrated significantly more favorable attitudes toward problem solving than for instrumentalist ( $t(45) = -2.149, p = .037$ ) and Platonist views ( $t(42) = -4.640, p < 0.001$ ). Teachers also demonstrated more favorable attitudes toward instrumentalist view over the Platonist view ( $t(42) = -4.434, p < .001$ ). However, the difference between the means of each was fairly small as compared to

District A results. See Tables 28 and 29. Furthermore, the teachers were classified in terms of the view of mathematics they endorsed most strongly. The endorsement of teachers for the three views of mathematics is reflected in Table 31.

Table 28

Paired Samples Test – District B

View of Mathematics

Paired Differences						
Paired	Mean	Std.	Std.	T	df	Sig.
View		Deviation	Error Mean			(2-tailed)
Platonist & Instrumentalist	-1.3256	1.9606	.2990	-4.434	42	.000
Platonist & Problem Sol.	-2.3721	3.3525	.5113	-4.640	42	.000
Instrumentalist & Problem Sol.	-1.0870	3.4308	.5058	-2.149	45	.037

Table 29

Descriptive Statistics – District B

View of Mathematics

View	N	Mean	Std. Deviation
Platonist	43	5.4651	1.9922
Instrumentalist	48	6.7917	2.2214
Problem Solving	47	7.8298	1.8687
Valid N (listwise)	43		

Table 30

District B - Frequencies

Views of Mathematics

View	Frequency	Percent	Valid Percent
Platonist	1	2.0%	3.0%
Problem Solving	20	40.0%	60.6%
Instrumentalist	12	24.0%	36.4%
Total	33	66.0%	100.0%
Frequency Missing	17	34.0%	
Total	50	100.0%	

With three exceptions, each comparison was significantly different than the other with regard to the view of teaching mathematics. The exceptions to this were that the cooperative learning view was not significantly preferred to basic skills, that teacher designed curriculum was not preferred to cooperative learning, and problem solving was not preferred to many methods. See Table 31. Teachers had the most favorable view toward problem solving, but also were favorable to many methods. Teacher designed curriculum, cooperative learning, and basic skills view fell in the middle. Teachers in District B had less favorable views toward discovery and text driven approaches as did District A. See Table 32. Furthermore, the teachers were classified in terms of the view of teaching mathematics they endorsed most strongly. Table 33 reflects the endorsement of teachers for the seven views of teaching mathematics.

Table 31

Paired Samples Test – District B

View of Teaching Mathematics

Paired Differences						
Paired	Mean	Std.	Std.	T	df	Sig.
View		Deviation	Error Mean			(2-tailed)
Basicski &	-1.9318	3.3229	.5009	-3.856	43	.000
Probsol						

*(Table Continues)*

Paired View	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Basicski & Discove	.7174	2.4373	.3594	1.996	45	.052
Basicski & Teadesig	-1.2553	2.9152	.4252	-2.952	46	.005
Basicski & Textdriv	1.7447	2.0480	.2987	5.840	46	.000
Basicski & Manymeth	-1.8936	2.6063	.3802	-4.981	46	.000
Basicski & Cooplear	-.5227	3.0077	.4534	-1.153	43	.255
Probsol & Discove	2.6591	2.6584	.4008	6.635	43	.000
Probsol & Discove	2.6591	2.6584	.4008	6.635	43	.000
Probsol & Teadesig	.8000	2.6423	.3939	2.031	44	.048
Probsol & Teadesig	.8000	2.6423	.3939	2.031	44	.048
Probsol	3.6667	3.1116	.4638	7.905	44	.000

&Textdriv						
Probsol &	2.222E-02	2.2309	.3326	.067	44	.947
Manymeth						

(Table Continues)

Paired View	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Probsol & Cooplear	1.4186	2.1847	.3332	4.258	42	.000
Discove & Teadesig	-1.8511	2.6456	.3859	-4.797	46	.000
Discove & Textdriv	.8723	2.2128	.3228	2.703	46	.010
Discove & Manymeth	-2.7234	1.9416	.2832	-9.616	46	.000
Discove & Cooplear	-1.1364	2.1630	.3261	-3.485	43	.001
Discove & Cooplear	-1.1364	2.1630	.3261	-3.485	43	.001
Teadesig & Textdriv	2.8333	2.9270	.4225	6.706	47	.000

706

Teadesig & Manymeth	-.7917	2.4664	.3560	-2.224	47	.031
Teadesig & Cooplear	.6000	2.1574	.3216	1.866	44	.069

(Table Continues)

Paired View	Mean	Std. Deviation	Std. Error Mean	T	Df	Sig. (2-tailed)
Textdriv & Manymeth	-3.6250	2.3213	.3350	-10.819	47	.000
Textdriv & Cooplear	-2.1333	2.6251	.3913	-5.452	44	.000
Manymeth & Cooplear	1.4889	2.1173	.3156	4.717	44	.000

Note. Basicski = Basic Skills. Probsol = Problem Solving. Discove = Discovery.

Teadesig = Teacher Designed. Textdriv = Text Driven. Manymeth = Many Methods.

Cooplear = Cooperative Learning.

Table 32

Descriptive Statistics – District B

View of Teaching Mathematics

View	N	Mean	Std. Deviation
Basic Skills	47	5.7234	2.2526
Problem Solving	45	7.6889	2.1513
Discovery	47	4.9787	1.6351
Teacher Designed	48	6.8750	2.0172

*(Table Continues)*

View	N	Mean	Std. Deviation
Text Driven	48	4.0417	2.0312
Many Methods	48	7.6667	1.2604
Cooperative Learning	45	6.2222	1.4124
Valid N (listwise)	41		

Table 33

District B - Frequencies

Views of Teaching Mathematics

View	Frequency	Percent	Valid Percent
Basic Skills	5	10.0%	16.7%
Problem Solving	13	26.0%	43.3%
Discovery	1	2.0%	3.3%
Teacher Designed	7	14.0%	23.3%

Text Driven	0	--	--
Many Methods	4	8.0%	13.3%
Cooperative Learning	0	--	--
Total	30	60.0%	100.0%
Frequency Missing	20	40.0%	
Total	50	100.0%	

In regard to the view of learning mathematics for District B, with one exception each comparison was significantly different than the other. The exception was that constructivism was not preferred to rote learning. See Table 34. Teachers had the most favorable view toward the role of errors. Constructivism and rote learning fell in the middle. Teachers had less favorable views toward choice and autonomy. See Table 35. As with the view of mathematics and view of teaching mathematics, the teachers were classified in terms of the view of learning mathematics they endorsed most strongly. The four views of learning mathematics endorsed by the teachers are shown in Table 36.

Table 34

Paired Samples Test – District B

View of Learning Mathematics

Paired Differences						
Paired	Mean	Std.	Std.	T	df	Sig.
View		Deviation	Error Mean			(2-tailed)

Rotelear - Construc	-.3864	2.7127	.4090	-.945	43	.350
Rotelear - Roleerro	-1.9348	1.8904	.2787	-6.942	45	.000

*(Table Continues)*

Paired View	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Rotelear - Choauton	1.2979	2.0633	.3010	4.312	46	.000
Construc - Roleerro	-1.6591	2.8688	.4325	-3.836	43	.000
Construc - Roleerro	-1.6591	2.8688	.4325	-3.836	43	.000
Construc - Choauton	1.5333	2.7019	.4028	3.807	44	.000
Construc - Choauton	1.5333	2.7019	.4028	3.807	44	.000
Roleerro - Choauton	3.1064	2.1892	.3193	9.728	46	.000

Note. Rotelear = Rote Learning. Construc = Constructivist. Roleerro = Role of Errors.

Choauton = Choice and Autonomy.

Table 35

Descriptive Statistics – District B

View of Learning Mathematics

View	N	Mean	Std. Deviation
Rote Learning	47	5.7234	1.6772
Constructivist	45	6.0222	2.5090
Role of Errors	47	7.6383	1.6074
Choice and Autonomy	48	4.4792	1.3836
Valid N (listwise)	43		

Table 36

District B - Frequencies

Views of Learning Mathematics

View	Frequency	Percent	Valid Percent
Rote Learning	2	4.0%	5.9%
Constructivist	7	14.0%	20.6%
Role of Errors	25	50.0%	73.5%
Choice and Autonomy	0	--	--
Total	34	68.0%	100.0%
Frequency Missing	16	32.0%	

Total	50	100.0%
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Table 37

Summary of Significant Effects

Variables	Significance
District A	
Attitude toward Mathematics & Years of Experience	F (4, 323) = 2.60, p = 0.036
Attitude toward Mathematics & Ethnicity	F (4, 318) = 3.75, p = 0.005
Attitude toward Mathematics & Major/Minor	F (2, 328) = 7.01, p = 0.001
Attitude to Teaching Mathematics & Type of Classroom	F (5, 326) = 2.66, p = 0.023
Attitude to Teaching Mathematics & Ethnicity	F (4, 317) = 2.84, p = 0.025

*(Table Continues)*

Summary of Significance Effects

Variables	Significance
Attitude to Teaching Mathematics & Major/Minor	F (2, 328) = 4.30, p = 0.014
Problem Solving View over Instrumentalist View	t (330) = -13.497, p < 0.001
Problem Solving View over Platonist View	t (332) = -19.342, p < 0.001
Instrumentalist over Platonist View	t (330) = -4.239, p < 0.001
District B	
Problem Solving View over Instrumentalist View	t (45) = -2.149, p < 0.037
Problem Solving View over Platonist View	t (42) = -4.60, p < 0.001
Instrumentalist over Platonist View	t (42) = -4.434, p < 0.001

The teacher responses for each of the fifty-seven individual items on the questionnaire for Districts A and B can be found in Appendix D.

### Summary of Findings

Following is a brief summary of the findings of this research study. The summary findings will be presented separately by school districts—District A first, followed by District B.

#### District A

1. Over half of the teachers in District A had a positive attitude toward mathematics.

Attitudes toward mathematics were significant in relation to years of experience. Teachers with 30 or more years of experience had more positive attitudes toward mathematics than teachers with 1-3 years of experience.

Ethnicity was also significant with regard to attitude toward mathematics. The study showed that the African Americans had a more positive attitude toward mathematics than did the Caucasian teachers.

Teachers with a major or minor in mathematics also had a better attitude toward mathematics than those who did not.

Teachers in District A also had a positive attitude to teaching mathematics.

Attitudes to teaching mathematics were significant as far as type of classroom.

However, the Tukey test did not reveal which type classroom was significant in its attempt to compensate and control the alpha level at 0.05.

Ethnicity was also significant with regard to attitudes to teaching mathematics.

The study showed that the African American teachers had a more positive attitude to teaching mathematics than did the Caucasian teachers.

Teachers with a major or minor in mathematics also had a positive attitude to teaching mathematics than those who did not.

The problem solving view was the most favored view of mathematics by teachers in District A. Teachers also demonstrated more favorable attitudes towards the instrumentalist view over the Platonist view.

Most teachers favored the many methods view as well as the problem solving view when it came to their views of teaching mathematics. Teacher designed curriculum, cooperative learning, and basic skills views fell in the middle. They had least favorable views towards discovery and text driven approaches to teaching mathematics.

In regard to the teachers' views of children learning mathematics, they had a most favorable view toward the role that errors play in children learning mathematics; emphasizing "process efforts" over obtaining the correct answer. They also had favorable views toward constructivism. Rote learning and choice and autonomy came in last as a favorable view of learning mathematics, but rote clearly out favored choice and autonomy.

Some additional interesting findings:

Over 75% of the teachers in District A have never liked mathematics, even though they perceive it to be fascinating and fun. At the same time, 70% were ambivalent and said they really do like mathematics.

Regarding anxiety and mathematics, over 70% feel a sense of insecurity and nervousness when attempting mathematics.

Teachers in District A are confident in their own mathematical ability when it comes to the grade levels in which they teach. However, they feel much more confident in teaching other subject areas than in teaching mathematics.

Liking and enthusiasm for teaching was scarce. About 74% of the teachers regard mathematics teaching as a necessary but unenjoyable chore and do not enjoy teaching it.

For a specific breakdown of the responses to all the 57 statements in the questionnaire by all teachers, grade level, type of class, and years of experience, refer to Appendix D.

### District B

2. Sixty –eight percent of the teachers in District B had a positive attitude toward mathematics. They were not significantly different for grade level, type of classroom, years of experience, ethnicity, gender, or major/minor.
3. Teachers in District B also had a positive attitude toward teaching mathematics. Again, their attitudes to teaching mathematics did not differ

significantly for grade level, type classroom, years of experience, gender, ethnicity, or major/minor.

4. As with District A, the problem solving view was the most favored view of mathematics. Teachers as well favored the instrumentalist view over the Platonist view of mathematics.
5. Teachers in District B most favored view of teaching mathematics was the problem solving view. They also had high regard for the many methods view. Teacher designed curriculum, cooperative learning, and basic skills view fell in the middle. They had less favorable views for the discovery and text driven approaches to teaching mathematics.
6. Regarding District B's teacher's views to children learning mathematics, they favored rote learning over constructivism. Their most favored view of learning mathematics was role of errors, which emphasizes "process efforts" over obtaining the correct answer. Constructivism and rote learning fell in the middle as far as their views toward learning mathematics. As with District A, teachers had less favorable views toward choice and autonomy.

Some additional interesting findings:

7. Over 80% of the teachers in District B have never liked mathematics, even though they perceive it to be fascinating and fun. At the same time, about 78% were ambivalent and said that they really do like mathematics.
8. With regards to anxiety and mathematics, over 85% feel a sense of insecurity and nervousness when attempting mathematics.

9. Overall, teachers in District B are confident in their mathematical ability when it comes to the grade levels in which they teach. However, they feel much more confident in teaching other subjects areas than in teaching mathematics. This was also true of District A's teachers.
10. As far as liking and enthusiasm for teaching mathematics, over 72% of the teachers believe mathematics teaching to be a necessary but unenjoyable chore and do not enjoy teaching it.
11. For a specific breakdown of the responses to all the 57 statements in the questionnaire by all teachers, grade level, type of class, and years of experience, refer to Appendix D.

Results of this study were analyzed through quantitative measures. In the discussion section that follows, the findings will be evaluated and interpreted further.

# CHAPTER V

## CHAPTER V

### DISCUSSION

Results of this study suggest that both school districts are making progress in the reform of mathematics. However, it is evident more work is needed in changing the way mathematics is taught in the classroom. One method is through altering--if not changing--the mathematical attitudes and beliefs (philosophies) of their teachers. Lerman (1983) says the influence of the philosophy of mathematics on teaching style is of major significance in any attempt to alter present mathematics acquisition. He states that “the logical connection between philosophy of mathematics and teaching are stronger, more significant in influencing student’s attitudes to mathematics, and also less clearly represented in the work of teachers” (Lerman, 1983, p. 59). Lerman asserts that “the choice of syllabus content, teaching style and students’ attitudes to mathematics are all determined by the philosophical choice a teacher makes ‘even if scarcely coherent’” (p. 62).

This study was conducted out of concern of children not performing well in mathematics and the anxiety and dislike of it by so many—children, parents, teachers, administrators and others alike. The researcher questioned the origination of this anxiety and dislike for mathematics and reasoned it had to start in the classroom with the attitudes and beliefs of teachers. Martinez and Martinez (1996) validated this thought.

They stated that mathematics anxiety is learned at a very young age—often in elementary school and even sometimes in kindergarten. Other studies have also shown that parents who have mathematics anxiety can pass it on to their children, and that teachers who have mathematics anxiety can also pass it on to their students (Lazarus, 1974). Williams (1988) contends that most mathematics anxiety starts with teachers and with the teaching of mathematics. A bad experience with a mathematics teacher can cause this anxiety (Tobias, 1978). Greenwood (1984) suggests that mathematics anxiety results more from the way the subject matter is presented than from the subject matter itself.

The reformation of mathematics education also added fuel to the researcher's thinking. Mathematics reform studies confirmed that the way mathematics is presented is the key to changing beliefs about mathematics, thus improving student achievement. This study commenced to examine if strides have been made in urban school districts since the NCTM and others set out in the 1980's to change the way mathematics is presented in the classroom. The mathematics reform movement was a start in changing the way future students, parents, teachers, administrators, and others view mathematics.

The researcher's concerns led to a survey study that examined attitudes, beliefs, and views of teachers in two urban school districts. Questionnaires were mailed directly to the teachers in the larger school district, District A, through its intra-district mail system. Principals of the smaller school district, District B, distributed the questionnaires to their teachers in envelopes. The teachers sealed their envelopes containing their completed questionnaires before returning them to their principals. The study was conducted with teachers who taught kindergarten, first, second, or third grade students.

This study set out to explore these attitudes, beliefs, views of mathematics, and teachers' teaching and learning views by looking at five questions. The data collected were analyzed through descriptive analyses, frequencies, t-tests (for paired samples), and comparative analyses. Results are discussed with regard to the five questions and current research.

***Question 1:*** What are early childhood teachers' general attitudes toward mathematics?

Over half of the teachers in both school districts had a positive attitude toward mathematics. In District A, teachers with 30 or more years of experience had more positive attitudes toward mathematics than teachers with 1-3 years of experience. Ethnicity and mathematics major/minor was also significantly different. An interesting finding was that African American teachers had more positive attitudes toward mathematics than Caucasian teachers. This may be due to the number of years of experience, the number who responded to study, the general differences in child rearing practices of the two races. Many, many factors may exist, thus warranting further research in this area. Teachers also with a major or minor in mathematics had more positive attitudes toward mathematics.

Pajares (1992) claims all teachers hold beliefs, however scarcely defined and labeled. They hold beliefs about their work, their students, their subject matter, and their roles and responsibilities. Tabachnick and Zeichner (1984) perceive attitudes and beliefs as little more than opinions with a disposition to act. These perspectives include both the teachers' beliefs about their work, which include goals, purposes, conceptions of

children, curriculum, and “the ways in which they [give] meaning to these beliefs by their behavior in the classroom” (p. 28).

Pajares (1992) contends that students start developing beliefs and practices related to being a teacher early in grade school by mimicking teachers they have been exposed to. They will hone these practices and strengthen these beliefs over the years. By the time they enter preservice education programs these beliefs and attitudes they hold are well developed. They are developing what Lortie (1975) called the apprenticeship of observation that takes place during the years students spend at school. Pajares (1992) says these ideas include “what it takes to be an effective teacher and how students ought to behave, and, though usually unarticulated and simplified, they are brought into teacher preparation programs” (p. 322). Florio-Ruane and Lensmire (1990) cautioned that some of these beliefs are consistent with educational teacher preservice programs and some or not. They stated that,

Most preservice teachers have an unrealistic optimism and a self-serving bias that account for their believing that the attributes most important for successful teaching are the ones they perceive as their own. They believe that problems faced by classroom teachers will not be faced by them, and the vast majority predict they will be better teachers than their peers. (Pajares, 1992, p. 323)

Pajares and other researchers proclaim that “entering teacher candidates view teaching as a process of transmitting knowledge and of dispensing information” (p. 323). Pajares also said they tend to value the affective domain and undervalue cognitive (academic) variables. It is up to educational preservice programs and school districts to

alter or change these beliefs and attitudes of their teachers to the thinking that they advocate, especially of their neophyte teachers.

Also one must take into account that attitudes towards mathematics and to teaching mathematics are not one-dimensional. There are many different kinds of mathematics, as well as a variety of feelings about the various type of mathematics. Teachers may like geometry, have a dislike for story problems, they may be inquisitive with regard to topology, and they just may be bored with algebra. These attitudes may be a result of a repeated emotional reaction to mathematics or, the assignment of an already existing attitude to a new but unrelated task (McLeod, 1992).

***Question 2:*** What are early childhood teachers' views of mathematics? Does the view lean more toward the **Platonist view**—mathematics is exact and certain truth; the **Instrumental view**—mathematics is facts and rules, not creative; or the **Problem Solving view**—mathematics is a problem solving approach, providing many answers and exploring patterns versus employment of routine tasks (Ernest, 1988; Ernest 1996). According to the NCTM, the view in this day and time should be more of a problem solving one.

The study revealed that the problem solving view of mathematics was the most favored view of teachers in both school districts. The teachers also demonstrated more favorable attitudes towards the instrumental view over the Platonist view. This observation says that these two school districts are making strides in convincing teachers that problem solving is a more favorable view of mathematics.

The NCTM (1989) states that problem solving should be the central focus of the mathematics curriculum. “It is a primary goal of all mathematics instruction and an integral part of all mathematical activity. Problem solving is not a distinct topic but a process that should permeate the entire program and provide the context in which concepts and skills can be learned” (p. 23). The classroom climate should encourage and support problem solving efforts. For example (Lerman, 1983):

[A teacher asks] a class for a fraction between  $1/2$  and  $3/4$ . A student replied ‘ $2/3$ ’ and when asked to justify his answer, the student explained that 2 is between 1 and 3 (the numerators) and the 3 is between 2 and 4 (the denominators). The teacher can reply that one does not work out the answer that way, and turn to another student for the ‘correct’ method, thus encouraging the impression by the student that mathematics is a closed body of knowledge. An alternative reaction from the teacher reflects the problem solving-solving nature of mathematics. The student can be encouraged to test the novel idea, with other examples. Fellow students can be asked to think of possible counter-examples. The student should be asked to try to extend the method to cover other cases, such as finding fractions between  $1/3$  and  $1/2$ , and so on. (p. 64)

The problem solving approach reflects both the conceptual growth view of mathematical knowledge as well as the nature of the learning process (Lerman, 1983).

In a classroom that promotes problem solving, students and teachers share their problem solving approaches. Students should learn several ways of representing problems and several strategies for solving them. “Students should have many

experiences in creating problems from real-world activities, from organized data, and from equations” (NCTM, 1989, p. 23). The NCTM (1989) proclaims that when mathematics emerges naturally from problem situations that have meaning for children and are related to their environment, it becomes relevant to them and helps them to link their knowledge to many kinds of situations. Thus, when problem solving becomes the focus of classroom instruction and children experience success in problem solving, they gain confidence in doing mathematics, they grow in their ability to communicate mathematically and use higher order thinking skills. They also develop perseverance and inquisitive minds.

In the early grades, most problem solving situations involve situations from school and other everyday experiences. The teacher who practices a problem solving approach to instruction employs thought provoking questions, speculations, explorations and investigations. “The teacher’s primary goal is to promote a problem-solving approach to learning of all mathematics content” (NCTM, 1989, p. 23).

***Question 3:*** What are early childhood teachers’ attitudes to teaching mathematics?

The majority of the teachers in both school districts had a positive attitude toward teaching mathematics. Another interesting finding was that African American had more positive attitudes toward the teaching of mathematics than Caucasian teachers. Many causes may exist, thus warranting more research in this area. The study also found those teachers with a major or minor in mathematics had more positive attitudes than teachers without a major or minor.

Pajares (1992) claims all teachers hold beliefs, however scarcely defined and labeled. They hold beliefs about their work, their students, their subject matter, and their roles and responsibilities. Tabachnick and Zeichner (1984) perceive attitudes and beliefs as little more than opinions with a disposition to act. These perspectives include both the teachers' beliefs about their work, which include goals, purposes, conceptions of children, curriculum, and "the ways in which they [give] meaning to these beliefs by their behavior in the classroom" (p. 28).

Pajares (1992) contends that students start developing beliefs and practices related to being a teacher early in grade school by mimicking teachers they have been exposed to. They will hone these practices and strengthen these beliefs over the years. By the time they enter preservice education programs these beliefs and attitudes they hold are well developed. They are developing what Lortie (1975) called the apprenticeship of observation that takes place during the years students spend at school. Pajares (1992) says these ideas include "what it takes to be an effective teacher and how students ought to behave, and, though usually unarticulated and simplified, they are brought into teacher preparation programs" (p. 322). Florio-Ruane and Lensmire (1990) cautioned that some of these beliefs are consistent with educational teacher preservice programs and some or not. They stated that,

Most preservice teachers have an unrealistic optimism and a self-serving bias that account for their believing that the attributes most important for successful teaching are the ones they perceive as their own. They believe that problems

faced by classroom teachers will not be faced by them, and the vast majority predict they will be better teachers than their peers. (Pajares, 1992, p. 323)

Pajares and other researchers proclaim that “entering teacher candidates view teaching as a process of transmitting knowledge and of dispensing information” (p. 323). Pajares also said they tend to value the affective domain and undervalue cognitive (academic) variables. It is up to educational preservice programs and school districts to alter or change these beliefs and attitudes of their teachers to the thinking that they advocate, especially of their neophyte teachers.

Also one must take into account that attitudes towards mathematics and to teaching mathematics are not one-dimensional. There are many different kinds of mathematics, as well as a variety of feelings about the various type of mathematics. Teachers may like geometry, have a dislike for story problems, they may be inquisitive with regard to topology, and they just may be bored with algebra. These attitudes may be a result of a repeated emotional reaction to mathematics or, the assignment of an already existing attitude to a new but unrelated task (McLeod, 1992).

**Question 4:** What are early childhood teachers’ views of teaching mathematics?

- a. Basic Skills Practice**—basic skills vs. calculator, other emphasis
- b. Problem Solving View**—problem solving aim vs. routine tasks
- c. Discovery (Active) View**— need to be told vs. can/should discover
- d. Teacher Designed Curriculum**—children's needs, differences and preferences are accommodated; one text is not followed for all abilities, the mathematics curriculum is differentiated for individual needs and differences

**e. Text Driven Curriculum**-- mathematics is taught by following the text or syllabus exactly

**f. Many Methods Encouraged**—teacher's unique method vs. many methods; or,

**g. Cooperative Learning View**—isolated vs. cooperative learning. (Ernest 1996)

Most teachers from both school districts favored the problem solving view as well as the many methods view when it came to their dominate views of teaching mathematics. Teacher designed curriculum, cooperative learning, and basic skills views fell in the middle. They had least favorable views towards discovery and text driven approaches to teaching mathematics. These results are an indication that the problem solving approach to teaching mathematics has been communicated effectively to most teachers. However, continued work in convincing, persuading, and training all teachers is yet needed.

The many methods view, cooperative learning, use of calculators, teacher designed curriculum, and the discovery view go hand-in-hand with the problem solving approach. Teachers with a problem solving type classroom will at one time or another employ all of these views. For example, most teachers agree that after students master computational skills, calculators aid in checking computation and facilitates problem solving (Dessart, DeRidder, & Ellington, 1999). They free the child so he can concentrate on the essence of the problem (Curcio, 1999). Burns (1998) says that calculators can help children think and reason numerically. Cooperative learning type activities have been credited with promoting higher achievement over competitive classes. Cooperative learning may increase the group identity of children and help them to feel a part of the class

(Eisenhower National Clearinghouse: For Mathematics and Science Education., 1999). The discovery approach is used to discover concepts that already exist (Lerman, 1983). In North America, we develop problem solving strategies and skills, perhaps through the discovery approach, and then apply them (Sawada, 1999). In problem solving, students are encouraged to try different methods/strategies to help them understand a situational problem. Because evidence suggests that children construct some ideas slowly, “it is crucial that teachers use physical materials, diagrams, and real world situations in conjunction with ongoing efforts to relate their learning experiences to oral language and symbols” (NCTM, 1989, p. 57). Teacher designed curricula affords the teacher to meet the individual needs of the students, consequently the mathematics curriculum is modified for individual needs and differences (Ernest, 1996).

**Question 5:** What are early childhood teachers’ views of children learning mathematics?

- a. **Rote Learning**—mathematics is remembering facts, rules, learning by rote
- b. **Constructivist View (Previous Knowledge Respected)** —transmission (transference) vs. building on existing knowledge
- c. **Role of Errors**—careless errors vs. answers over emphasized.

In order words, the problem solving process is more important than getting the correct answer. The learner will receive partial credit for his “process” efforts when he does not get the correct answer. The learner focuses on the essence of the problem while he attempts to come up with the solution. When answers are over emphasized the learner receives no credit for his incorrect answer, or process efforts. Or,

**d. Choice and Autonomy**—imposed order and tasks vs. child choice (centered) and direction. (Ernest, 1996)

In regard to the teachers' views of children learning mathematics, District A had a most favorable view toward the role that errors play in children learning mathematics; emphasizing “process efforts” over obtaining the correct answer. They also had favorable views toward constructivism. Rote learning and choice and autonomy came in last as a favorable view of learning mathematics, but rote clearly out favored choice and autonomy.

District B's teachers favored rote learning over constructivism. Their most favored view of learning mathematics was also role of errors. Constructivism and rote learning fell in the middle as far as their views toward learning mathematics. As with District A, teachers had less favorable views toward choice and autonomy.

The NCTM Standards (1989) de-emphasizes rote learning and memorizing. It advocates constructing knowledge. The back-to-basics approach—rote learning and memorizing--to learning has dominated U.S. mathematics classes throughout this century (O'Brien, 1999).

As early as the 1930s the math education researcher William Brownell saw parrot math as dominant and criticized it heartily, pleading for children to be allowed to find meaning in math. But the view of math as isolated bits of information to be transmitted to passive receptors continues to be dominant in America's schools

O'Brien (1999) argues "we cannot go back to basics as the critics demand. We've been there all along.... The fact is that the back-to-basics approach, not the activity-based approach, has failed us" (p. 436).

Isaacs (1999) says, "the rote approach encourages students to believe that mathematics is more memorizing than thinking" (p. 509). He states that the essence of current reforms in primary –grade mathematics is to recognize and build on the abundance of informal mathematical knowledge that children bring with them to the classroom, which in the past has been ignored or suppressed. Lerman (1983) points out that there is a strong analogy between the growth of new knowledge and conceptual development in a person, and the work of Piaget—his theories of development. Piaget's idea is that the child is responsible for the construction of his own knowledge. "This knowledge is neither exclusively preexistent, not solely environmentally determined but rather results from the interaction between these factors" (Lerman, p. 65). In a constructivist classroom, by careful choice of problems, the teacher stimulates the student to examine his own knowledge. "If it is found inadequate to solve the problem, the students are guided to extend their knowledge by hypothesis, or by taking a solution from another problem and then testing this hypothesis" (Lerman, 1983, p. 65). Constructivism is based on the premise that we all construct our own viewpoint of the world, based on our individual experiences and schema. It focuses on preparing the learner for solving problem in ambiguous situations (CSCL, 1998). Litman, Anderson, Andrican, Buria, Christy, Koski, and Renton (1999) had this to say about constructivism:

Children begin life learning about themselves and the world immediately around them, learning through experiences that are sensory and concrete. Gradually each child's world expands as his experiences and activities reach out beyond himself. We are responsible for grounding the child's play in experiences that flow from his own family, neighborhood, community, and local culture. (p. 5)

Rugen (1998) points out that there are five guiding principles of constructivism:

1. Posing problems of emerging relevance to students
2. Structuring learning around primary concepts: The quest for essence
3. Seeking and valuing students' points of view
4. Adapting curriculum to address students' suppositions
5. Assessing student learning in the context of teaching (p. 1)

Constructivism impacts learning by calling for "the elimination of a standardized curriculum. Instead, it promotes using curricula customized to the student's prior knowledge. Also, it emphasizes hands-on problem solving" (On Purpose Associates, 1998, p. 1). Teachers focus on making connections between facts and promoting new understanding in students. Teachers tailor their teaching strategies to student responses and encourage students to analyze, interpret, and predict outcomes. They also "rely heavily on open-ended questions and promote extensive dialogue among students" (On Purpose Associates, 1998, p. 1). Pure constructivism eliminates grades and standardized testing. Instead, assessment becomes a part of the learning process and students play a greater part in judging their own progress (On Purpose Associates, 1998). Also, in this type classroom, the problem solving process is more important than getting the correct

answer. The learner will receive partial credit for his “process” efforts when he does not get the correct answer. The learner focuses on the essence of the problem while he attempts to come up with the solution. This is the concept of “role of errors” (Ernest, 1996).

One of the difficulties with breaking the cycle of traditional teaching is that it has perpetuated itself for generations of teachers and learners--which may explain District B’s preference for rote learning over constructivist learning. Fosnot (1996) states most teachers teach as they were taught.

Also constructivism is still quite new to teachers (Mikusa & Lewellen, 1999). Stork and Engel (1999) claims that in order for the traditional methods of teaching to be broken,

Teachers must model themselves to their students as learners who themselves still grapple in the pursuit of meaning.... However, it seems that teachers have an incomplete understanding of constructivist learning until they have experienced it themselves. As in traditional settings, teachers with personal experience in learning via constructivist methods are more likely to pass on such methodologies in their own teaching. (p. 22)

### Conclusion

The 1980’s called for widespread school reform in teacher education, school structure, graduation requirements, and accountability measures. The early childhood profession entered this educational debate, represented by the National Association for the Education of Young Children (NAEYC), by issuing position statements defining

developmentally appropriate practices for young children (Bredekamp, 1987). The National Council of Teachers of Mathematics (NCTM) entered this debate by calling for, put simply, problem solving in mathematics education. NCTM denounced the traditional scope and sequence approach to curriculum which emphasized drill and practice of isolated mathematical concepts, which fail to produce students who possess the kinds of higher-order thinking and problem-solving abilities that will be needed in the 21<sup>st</sup> century. Together both national organizations called for schooling that placed greater emphasis on:

Active, hands-on learning

- Conceptual learning that leads to understanding along with acquisition of basic skills
- Meaningful, relevant learning experiences
- Interactive teaching and cooperative learning
- A broad range of relevant content, integrated across traditional subject matter divisions (Bredekamp, Knuth, Kunesh, & Shulman, 1992, p. 2).

At the same time, they both criticized rote memorization, drill and practice on isolated academic skills, teacher lecture, and repetitive seatwork. These national organizations along with others are “calling for more performance-based assessments that align with current views of curriculum [that] more accurately reflect children’s learning”

(Bredekamp, et al, 1992, p. 2).

Mathematical knowledge is the capacity of children, as well as others, to use thinking skills necessary to solve problems. Problem solving involves understanding the

problem, which is defining the unknown and deciding what information is relevant, then devising a plan of appropriate strategies, carrying out the plan, and then checking the solution.

Teachers exercise immense power over their students' academic success, especially in the primary grades. This power affects one's beliefs and attitudes toward particular subject areas in school. Getting children to be positive about mathematics boils down to attitude. The teacher must convey that mathematics is exciting and fun. "If a teacher is excited, so are the kids" (Bernstein, 1999, p. 23). Teachers need to reflect on their beliefs about teaching and learning and then ask themselves what can they do to help their students develop and keep positive attitudes towards mathematics. They need to plan challenging instructional activities as well. "The teacher's mental contents or schemas, particularly the system of beliefs concerning mathematics and its teaching and learning; the social context of the teaching situation, particularly the constraints and opportunities it provides; and the teacher's level of thought processes and reflection" (Ernest, 1988, p. 1) are factors which determine the autonomy of the mathematics teacher. Teaching innovations, such as problem solving, depend on teacher autonomy for their successful implementation (Ernest, 1988). Therefore, a school district must ensure teachers hold the same beliefs and attitudes it advocates.

In mathematics reform, teaching and learning can seem overwhelming to a school district because it requires a complete redesign of the content of school mathematics and the way it is taught (Mathematical Sciences Education Board, 1990). It must also have public acceptance of this "realistic philosophy of mathematics that reflects

practice and pedagogical experience” (Cook, 1995, p. 1). The following questions must be addressed by all:

1. What is mathematics?
2. Which mathematics should be taught?
3. How do people learn mathematics? [And,]
4. How can mathematics be taught effectively? (Cook, 1995, p. 1)

If instruction is to be transformed, teachers’ philosophies need to be understood also. That is how their beliefs are structured and held. Lappan and Theule-Lubienski (1994) say these beliefs, which are essential for teachers’ development, seldom change without significant intervention. When a teacher is in a classroom behind closed doors it is his/her beliefs and attitudes that take the forefront in what gets taught and passed on to students. Research such as the present study represents a start at getting at the root of teachers’ attitudes, beliefs and views of mathematics and how they perceive it should be taught and learned.

Knowledgeable educators and other mathematics educators should assume responsibility for leading the reform efforts in mathematics. The NCTM Standards represent a vehicle that can serve as a basis for improving the teaching and learning of mathematics in America (NCTM, 1989). “The best way to bring about reform is to challenge directly the perceptions held by many about the content of mathematics, what is important for students to learn.... It is all too easy to agree with the rhetoric of reform but still maintain long-held beliefs or practices inconsistent with intended reform practices” (NCTM, 1989). Teachers must reflect and recognize their beliefs and

practices and analyze them against the NCTM Standards. The NCTM (1989) vision is for:

- mathematical power for all in a technological society;
- mathematics as something one does—solve problems, communicate, reason;
- a curriculum for all that includes a broad range of content, a variety of contexts, and deliberate connections;
- the learning of mathematics as an active, constructive process;
- instruction based on real problems; [and]
- evaluation as a means of improving instruction, learning, and programs. (p. 255)

The most important barriers to the implementation of these standards are “the strongly held beliefs, expectations, and attitudes of all people in education about specific aspects of the reform” (NCTM, 1989, p. 254). This is inclusive of teachers, administrators, board members, superintendents, parents, and society alike.

Cooney (1987) argued that substantive changes in the teaching of mathematics as advocated by the NCTM Standards “will be slow in coming and difficult to achieve because of the basic beliefs teachers hold about the nature of mathematics” (as cited in Dossey, 1992). Cooney cautions us to beware of teachers who use the word “present” to describe their teaching. “This conception of teaching embodies the notion of authority in that there is a presenter with a fixed message to send. Such a position assumes the external existence of a body of knowledge to be transmitted to learners and is thus more Platonic” (as cited in Dossey, 1992). To change the situation Dossey (1992) states “one

must construct alternate ways of conceptualizing the nature of mathematics and the implications of such conceptions for mathematics education” (p. 42).

### Implications

This study suggests some teachers may yet be teaching mathematics by outdated traditional methods. All teachers, so to speak, need to be on the same page, as far as mathematical teaching, if we are to advance technologically in the 21<sup>st</sup> Century. Colleges and universities must teach preservice teachers with methods as recommended by the NCTM. School districts must make sure teachers are getting the mathematical training needed that advocates a problem solving approach and help them sort through the problem solving approach as needed in mathematics teaching.

School districts must become informed about the changes necessary for reform in mathematics teaching and learning. They need to come to grips with what they perceive mathematics to be and what should be taught and learned. Will they follow the advice of the NCTM Standards, or, will they follow some other reasoning behind what they perceive mathematics to be? Hersh (1979) says, “controversies about teaching... cannot be resolved without confronting problems about the true nature of mathematics” (p. 33). If a district is advocating the problem solving approach as the NCTM recommends, the teacher must then reflect the problem solving nature of mathematics in ones’ classroom.

Urban school districts must work with all nationalities/ethnicities of teachers to make sure they understand its philosophy of mathematics. They must seek to build mathematics confidence in all its teachers. Making each feel successful in their teaching of mathematics by providing teachers with the best of training and classroom materials.

Teachers must deepen their understanding of subject matter; learn to think about academic content from the students' viewpoint; present mathematics in appropriate and engaging ways; and learn to organize students for teaching and learning. If instruction is to be transformed, teachers must move from their positions at the front or center of the classroom and allow students to investigate with their own tools. In doing so, students and teachers will use communication and reason to critique their ideas and methods for finding solutions to problems. For teachers to perform well at teaching, teachers will need high quality materials, ongoing professional development in that which the school district advocates and in order to remain current in the field of mathematics teaching, and they will need the support of their administrators, parents, and the public.

Teacher education programs as well as school districts need to recruit high quality applicants and teachers in the field of mathematics. School districts also need to work hard toward retaining these teachers by competing salary-wise with other professions. Top teachers in each district need to be utilized to help train other teachers as well as students. School districts should also proceed cautiously in placing primary level teachers in intermediate grade levels, especially where these teachers will have to teach mathematics. It is recommended that school districts locate colleges and universities that teach mathematics teaching courses the same as they advocate and see that all interested teachers enroll in such courses. It is also recommended that school districts compensate interested teachers who want to return to college to study mathematics, especially primary level teachers.

Teacher preservice programs and district staff developments should “weave three forms of knowledge together: teachers’ background theories, beliefs and understandings of teaching” and learning of mathematics; “theoretical frameworks and empirical premises as derived from current research; and alternative practices that instantiate both teachers’ beliefs and research knowledge” (Richardson, Anders, Tidwell, & Lloyd, 1991, p. 579).

We as a nation must do a better job in helping teachers, children, parents, and people in general to like mathematics more. Positive public service announcements are one way to accomplish this. Further, school districts can concentrate on providing mathematics workshops specially designed to show teachers how to present mathematics in interesting and fun ways, mediums, and contexts.

Parents and communities should hold high mathematics expectations for all their children and expect schools to do the same. They should also make conscious efforts to support schools in their mathematics endeavors. Parents and the community should provide learning opportunities and activities in the home and in the community where children can be stimulated to reason and problem solve. Partnerships can be created between schools and businesses and community facilities to enhance teaching and student learning. Last, educators need to always continue to look at ways in which to improve education, particularly mathematics education.

## Recommendations for Future Research

The investigation of teachers' beliefs and attitudes is an essential and valuable course of educational inquiry. Some interesting questions and areas of research may include the following:

1. What is early childhood teachers' knowledge of mathematics? This can be accomplished by including a mathematics test in the study that progresses from simple elementary mathematics to college level mathematics. Several teachers have admitted that they are capable of teaching elementary mathematics and that they know enough mathematics to teach elementary or primary level students, however they lack the skills and knowledge to teach upper level students. Even though their elementary certifications certify them to teach up to eighth grade, they yet are not confident to teach at that level. Will these teacher be able to adequately teach these students should they be placed there, or will they need additional training to prepare them to teach this level of student (seventh and eighth graders)?
2. How do teachers' beliefs, attitudes, views, and knowledge of mathematics in middle and high socioeconomic schools compare to or differ from low socioeconomic schools? This type of study may indicate (show) that teacher's expectations are not the same for all students. That students in low socioeconomic areas cannot learn and should not be taught the same mathematics as students in a middle, or higher socioeconomic area. These teachers may believe that the curricula for economically disadvantaged students should be simplified, presenting more skill and rote oriented type curricula in comparison to presenting higher –order thinking skills to students from higher socioeconomic families.

Such a study may identify those teachers that believe they, as teachers should not waste their time teaching higher order thinking skills and higher mathematical concepts to children of lower socioeconomic status—the type children usually found in urban school districts. Maybe these type of teachers believe these type of students just cannot learn like those students coming from affluent homes. Thus, a poor urban school district should teach students differently from more affluent ones. Its curricula should be taught differently and perhaps watered down in comparison. **This type of study may also indicate just the opposite**, that teachers have the same expectations for all classes of students. The study may indicate that teachers believe regardless of a student's family status, all students should be given a chance to learn the same curricula with the same vigor.

3. One may want to look at teacher's attitudes and beliefs in relation to female students and to cultural expectations. Studies have shown teachers have different expectation for male and female students. Studies of this type may reveal that there is a direct relationship, or not, between teachers' attitudes and beliefs and females' acquisition of knowledge.

The notions that males excel in mathematics, science, and technology and that females excel in the arts are two of many beliefs and cultural influences that are passed down through generations. The dynamic is all the more powerful in that adults may not realize they are holding these beliefs and acting on them. Subtle and unintended messages can create the idea among girls and boys that there are

fields they cannot be successful in because of their sex. Children reflect and reinforce this attitude through their peer interactions. (Sanders, 1997, p. 1)

4. Having a positive attitude toward mathematics and its teaching is a plus for student achievement. An interesting finding that came out of the present research was that one ethnicity had a more positive attitude than another. It would be advantageous to study the causal relations between such differences in attitudes with relations to mathematics.
5. It is recommended that further studies be done using the same survey instrument as used in this study with higher grade level teachers, the 4-6 configuration, middle school level teachers, high school teachers as well as with preservice education teachers.
6. Studies have revealed that there is a strong relationship between teachers' beliefs and their planning and instructional delivery , it would be interesting to study how these beliefs affect student achievement in mathematics and in other subject areas, as well as how their beliefs affect students' acquisition and interpretations of these subject areas. Also studies looking at students' achievement in relation to teacher knowledge would equally be contributory. This type of information would be instrumental in determining staff developments and other directions. Such studies may reveal that collectively teachers tend to favor more the affective domain for students and undervalue the cognitive domain. This would warrant school districts to select methods and strategies to remedy this and help teachers develop a more balanced view.
7. Self-efficacy beliefs are an individual's discernment of his/her competence to do a particular task. Bandura (1986) argued that self-efficacy beliefs are the strongest predictors of human motivation and behavior. If this is so, studies of this type might help

schools, school districts, and preservice programs determine their teachers academic and professional preferences, wishes and strengths.

8. Survey results can help detect inconsistencies and areas that merit attention in mathematics education, but the development of additional measures, methods, and designs are needed in this line of research that studies attitudes and beliefs. Research on beliefs and attitudes of teachers and teacher candidates are yet scarce. By creating other measures, this type research would flourish and offer more insight into the teacher, the teacher candidate and their teaching methodologies.

Children who start to school usually have relatively neutral or positive attitudes toward mathematics. However, as they progress from grade level to grade level negativity toward the subject becomes apparent. It is clear that whatever else may occur in the school, the teacher has the most effect on the child's development of his affective responses. Khan and Weiss (1973) says this "stems from the teacher's interaction with instructional strategies and curriculum materials, his attitudes toward the group and each child, and his educational values and beliefs" (p. 786).

Fenstermacher (1979) predicted that beliefs are the single most important construct in educational research. "Teachers' beliefs about teaching and learning mathematics significantly affect the form and type of instruction they deliver" (Vacc & Bright, 1999, p. 91). If a teacher's belief is compatible with the underlying philosophy of his school district and its curricula, there is a greater likelihood that the district's philosophy and curricula will be fully implemented (Vacc & Bright, 1999). Hence,

attention to the beliefs and attitudes of teachers can inform educational practice in ways that other type research studies have and possibly cannot do. It appears that attitudes and beliefs lie at the very core of teaching.

## REFERENCES

- Abelson, R. (1979). Differences between belief systems and knowledge systems. Cognitive Science, 3, 355-366.
- American Speech-Language-Hearing Association. (1999). Elementary and Secondary Education Act reauthorization [On-line]. Available: [http://convention.asha.org/professionals/governmental\\_affairs/esea.htm](http://convention.asha.org/professionals/governmental_affairs/esea.htm)
- Arends, R. I. (1994) Learning to teach (3rd ed.). New York, NY: McGraw Hill, Inc.
- Babad, E. A. (1985). Some correlates of teacher expectancy bias. American Educational Research Journal, 22, 175-183.
- Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.
- Battista, M. T. (1999). The mathematical miseducation of America's youth: Ignoring research and scientific study in education. Phi Delta Kappan, 80 (6), 424-433.
- Bernstein, R. (1999, April). How sweet it is!: Getting kids excited about math—philosophies and strategies from teaching pros. Intermediate Instructor, 23-26.
- Blosser, P. (1990). Procedures to increase the entry of women in science-related careers. ERIC/SMEAC Science Education [On-line], 1. Available: <http://ericae.net/edo/ED321977.HTM>

Blosser, P., & Helgeson, S. (1990). Selected procedures for improving the science curriculum. ERIC/SMEAC Science Education Digest [On-line], 2. Available: <http://ericae.net/edo/ED325303.HTM>

Bouck, M. K., & Wilcox, S. K. (1996). A case study of success. Xchange, 2-4.

Bredekamp, S. (Ed.). (1987). Developmentally appropriate practice in early childhood education programs serving children from birth through age 8. Washington, DC: NAEYC.

Bredekamp, S., Knuth, R. A., Kunesch, L. G., & Shulman, D. D. (1992). What does research say about early childhood education? [On-line]. Available: [http://www.ncrel.org/sdrs/areas/stw\\_esys/5erly\\_ch.htm](http://www.ncrel.org/sdrs/areas/stw_esys/5erly_ch.htm)

Bredekamp, S., & Rosegrant, T. (Eds.). (1992). Reaching potentials: Appropriate curriculum and assessment for young children (Vol. 1). Washington, DC: National Association for the Education of Young Children (NAEYC).

Bredekamp, S., & Rosegrant, T. (Eds.). (1995). Reaching potentials: Transforming early childhood curriculum and assessment (Vol. 2). Washington, DC: National Association for the Education of Young Children.

Brickman, W. W. (1993-96). Teacher training [CD-ROM]. Microsoft® Encarta® 97 Encyclopedia.

Brophy, J. (1990). Effective Schooling for disadvantaged students. In M. S. Knapp & P. M. Shields (Eds.), Better schooling for the children of poverty: Alternatives to conventional wisdom (Vol. 2): Commissioned papers and literature review. Chapter

IX. Study of Academic Instruction for Disadvantaged Students, U. S. Department of Education Contract No. LC88054001). Washington, DC: Government Printing Office.

Brophy, J., & Good, T. (1970). Teachers' communication of differential expectations for children's classroom performance: Some behavior data. Journal of Educational Psychology, 61, 365-374.

Brophy, J., & Good, T. (1974). Teacher-student relationships: Causes and consequences. New York: Holt, Rinehart and Winston.

Brown, C. A. (1985). A study of the socialization to teaching of a beginning mathematics teacher. Unpublished doctoral dissertation, University of Georgia, Athens.

Brown, C. A., & Borko, H. (1992). Becoming a mathematics teacher. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 209-239). New York: Macmillan.

Brown, S., Cooney, T., & Jones, D. (1990). Mathematics teacher education. In W. R. Houston (Ed.), Handbook of research on teacher education (pp. 639-656). New York: Macmillan.

Bruer, J. T. (1993). Schools for thought: A science of learning in the classroom. Cambridge, MA: The MIT Press.

Bruner, J., Goodnow, J., & Austin, A. (1956). A study of thinking. New York: Wiley Publishers.

Burns, M. (1998, April). Can I balance arithmetic instruction with real-life math? Instructor, 107 (7) 55-58.

- Caine, R. N., & Caine, G. (1991). Making connections: Teaching and the human brain. Alexandria, VA: Association for Supervision and Curriculum Development.
- Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C. P., & Loef, M. (1989). Using knowledge of children's mathematical thinking in classroom teaching: An experimental study. American Educational Research Journal, 26, 499-532.
- Cartwright, S. (1999). What makes good early childhood teachers? Young Children, 54 (4), 4-7).
- Coladarci, T. (1986). Accuracy of teacher judgements of student response to standardized test items. Journal of Educational Psychology, 78 (2), 141-146.
- Collier, C. P. (1972). Prospective elementary teachers' intensity and ambivalence of beliefs about mathematics and mathematics instruction. Journal for Research in Mathematics Education, 3, 155-163.
- Cook, C. (1995). What is mathematics? Pathways Critical Issues [On-line]. Available: <http://www.ncrel.org/sdrs/areas/issues/content/cntareas/math/ma300.htm>
- Cooney, T. J. (1985). A beginning teacher's view of problem solving. Journal for Research in Mathematics Education, 16, 324-336.
- Cooney, T. J. (1988). The issue of reform: What have we learned from yesterday? Mathematics Teacher, 81 (5), 352-363.
- Cooney, T. J., Grouws, D. A., & Jones, D. (1988). An agenda for research on teaching mathematics. In T. J. Cooney, D. A. Grouws, & D. Jones (Eds.), Perspectives on research on effective mathematics teaching (pp. 253-263). Reston, VA.: The National Council of Teachers of Mathematics.

Cooper, H. M. (1979). Pygmalion grows up: A model for teacher expectation, communication, and performance influence. Review of Educational Research, 49, 389-410.

Cooper, H. (1983). Communication of teacher expectations to students. In J. Levin & M. C. Wang (Eds.), Teacher and student perceptions: Implications for learning. Hillsdale, NJ: Erlbaum.

Cox, J. (1996). Your opinion , please! How to build the best questionnaires in the field of education. Thousand Oaks, CA: Corwin Press, Inc.

CSCL. (1998). A brief overview & interesting links for further study [On-line]. Available: [http://www.uib.no/People/sinial/CSCL/web\\_\\_struktur-838.htm](http://www.uib.no/People/sinial/CSCL/web__struktur-838.htm)

Curcio, F. R. (1999). On my mind: Dispelling myths about reform in school mathematics. NCTM Mathematics Teaching in the Middle School, 4 (5), 282-284.

Dessart, D. J., DeRidder, C. M., & Ellington, A. J. (1999). The research backs calculators. Mathematics Education Dialogues, 2 (3), 6.

Dossey, J. (1992). The nature of mathematics: Its role and its influence. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 39-48). New York: Macmillan.

Dossey, J., Mullis, I., Lindquist, M., & Chambers, D. (1988). The mathematics report card: Trends and achievement based on the 1986 National assessment. Princeton: Educational Testing Service.

Dunham, P. (1990). Procedures to increase the entry of women in mathematics-related careers. ERIC/SMEAC Mathematics Education Digest [Online], 3. Available: <http://ericae.net/edo/ED324195.HTM>

Dunn, L. M. (1987). Bilingual Hispanic children on the U. S. mainland: A review of research on their cognitive, linguistic, and scholastic achievement. Circle Pines, MN: American Guidance Service.

Dunne, E. (1993). General beliefs about teaching and learning. In N. Bennett & C. Carré (Eds.), Learning to Teach (pp. 73-87). London: Routledge.

Edwards, T. G. (1994). Current reform efforts in mathematics education. In ERIC/CSMEE digest [On-line]. Available: [http://www.ed.gov/databases/ERIC\\_Digests/ed372969.html](http://www.ed.gov/databases/ERIC_Digests/ed372969.html)

Eisenhower National Clearinghouse: For Mathematics and Science Education. (1999, March 12). Part 2: Issues involved in equity [On-line]. Available: [http://www.enc.org/reform/journals/ENC2430/nf\\_2430cnts.htm](http://www.enc.org/reform/journals/ENC2430/nf_2430cnts.htm)

ERIC Clearinghouse on Rural Education and Small Schools. (1989). Why don't our children like math? [On-line]. Available: <http://ericps.crc.uiuc.edu/npin/respar/texts/parschoo/likemath.html>

ERIC Clearinghouse on Teaching and Teacher Education. (1998). Infocard #2: Alternative routes to teacher certification [On-line]. Available: <http://www.ericsp.org/altcert.html>

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), Handbook of research on teaching, (3<sup>rd</sup> ed.). (pp. 119-161). New York: Macmillan.

Ernest, P. (1988, July). The impact of beliefs on the teaching of mathematics. Paper prepared for the 6<sup>th</sup> International Congress on Mathematics Education, Budapest, Hungary.

Ernest, P. (1996). Question bank: Questionnaire on the teaching of maths. [Online]. E-mail: P.Ernest@exeter.ac.uk.

Fennema, E., & Franke, M. (1992). Teacher's knowledge and its impact. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 147-164). New York: Macmillan.

Fennema, E., & Sherman, J. A. (1977). Sex-related differences in mathematics achievement, spatial visualization, and sociocultural factors. American Educational Research Journal, 14, 51-71.

Fenstermacher, G. D. (1980). On learning to teach effectively from research on teacher effectiveness. In C. Denham & A. Lieberman (Eds.), Time to learn (pp. 127-138). Washington, DC: National Institute of Education.

Fenstermacher, G. D. (1979). A philosophical consideration of recent research on teacher effectiveness. In L. S. Shulman (Ed.), Review of research in education (Vol. 6, pp. 157-185). Itasca, IL: Peacock.

Fernandez, R. R. (ED.). (1988). Achievement testing: Science versus ideology. Hispanic Journal of Behavior Sciences [Special issue], 10 (3).

Florio-Ruane, S., & Lensmire, T. J. (1990). Transforming future teachers' ideas about writing instruction. Journal of Curriculum Studies, *22*, 277-289.

Fosnot, C. T. (1996). Teachers construct constructivism: The center for constructivist teaching/teacher preparation project. In C. T. Fosnot (Ed.), Constructivism: Theory, perspective, and practice (pp. 205-216). New York: Teachers College Press.

Fruehling, J. A. (1993-96). Educational Guidance [CD-ROM]. Microsoft®Encarta® 97 Encyclopedia.

Fujioka, N., & Suwannaprasert, B. (1995). Japanese mathematics curriculum outcomes. The Journal of Educational Research, *88* (6), 372-377.

Garwood, A. N., & Hornor, L.L. (Eds.). (1991). Dictionary of U. S. Government Statistical Terms. Palo Alto, CA: Information Publications.

Ginsburg, H. P., & Russell, R. L. (1981). Social class and racial influence on early mathematical thinking. Monographs of the Society for Research in Child Development, *46*, Serial No. 6.

Grabe, M., & Grabe, C. (1998). Integrating technology for meaningful learning (2<sup>nd</sup> ed.). Boston, MA: Houghton Mifflin.

Grant, C. E. (1984). A study of the relationship between secondary mathematics teachers' beliefs about the teaching-learning process and their observed classroom behaviors (Doctoral dissertation, University of North Dakota, 1984). Dissertation Abstracts International, *46*, DA8507627.

Green, T. F. (1971). The activities of teaching. New York: McGraw-Hill.

Greene, M. (1978). The matter of mystification: Teacher education in unquiet times. In M. Greene (Ed.), Landscapes of learning (pp. 53-73). New York: Teachers College Press.

Greenwood, J. (1984). Soundoff: My anxieties about math anxiety. Mathematics Teacher, 77, 662-63.

Griffin, S. A., Case, R., & Siegler, R. S. (1994). Right-start: Providing the central conceptual prerequisites for first formal learning of arithmetic to students at risk for school failure. In K. McGilly (Ed.), Classroom lessons: Integrating cognitive theory and classroom practice. Hillsdale, NJ: Erlbaum.

Gottfredson, D., Marciniak, E., Birdseye, A., & Gottfredson, G. (1995). Increasing teacher expectations for achievement. The Journal of Educational Research, 88 (3), 155-163.

Grossman, P., Wilson, S., & Shulman, L. (1989). Teachers of substance: Subject matter knowledge for teaching. In M. C. Reynolds (Ed.), Knowledge base for the beginning teacher (pp. 23-24). Oxford: Pergamon Press.

Guralnik, D. B. (Ed.). (1969). Webster's new world dictionary of the American language. Nashville, TN: The Southwestern Company.

Hartog, M. D., & Brosnan, P. A. (1994). Doing mathematics with your child. ERIC/CSMEE Digest [On-line]. Available: <http://ericae.net/edo/ED372967.HTM>

Haury, D. L. (1993). Teaching science through inquiry. ERIC/CSMEE Digest [On-line]. Available: [http://www.ed.gov/databases/ERIC\\_Digests/ed359048.html](http://www.ed.gov/databases/ERIC_Digests/ed359048.html)

Hendrick, J. (Ed.). (1997). First steps toward teaching the Reggio way. Upper Saddle River, NJ: Prentice-Hall, Inc.

Hersh, R. (1979). Some proposals for revising the philosophy of mathematics. Advances in Mathematics, 31 (1), 31-50.

Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 65-97). New York: Macmillan.

Hiebert, J., & Wearne, D. (1993). Instructional tasks, classroom discourse, and students' learning in second-grade arithmetic. American Educational Research Journal, 30, 393-435.

Hildebrand, V. (1992). Profiles of early childhood teachers and child care providers. In L. R. Williams & D. P. Fromberg (Eds.), Encyclopedia of early childhood education (pp. 424-425). New York: Garland Publishing, Inc.

Hoge, R. D., & Butcher, R. (1984). Analysis of teacher judgements of pupil achievement level. Journal of Educational Psychology, 76 (5), 777-781.

Huck, S. W., & Cormier, W. H. (1996). Reading statistics and research (2<sup>nd</sup> ed.). New York, NY: Harper Collins College Publishers.

Isaacs, A. C., & Carroll, W. M. (1999). Strategies for basic-facts instruction. Teaching Children Mathematics, 5 (9), 508-515.

Jaynes, G., & Williams, R., Jr. (Eds.). (1989). A common destiny: Blacks and American society. Washington, DC: National Academy Press.

Johnson, W. B., & Packer, A. E. (1987, June). Workforce 2000: Work and workers for the twenty-first century. Indianapolis: Hudson Institute.

Khan, S. B., & Weiss, J. (1973). The teaching of affective responses. In R. Travers (Ed.), Second handbook of research on teaching (pp. 759-804). Chicago, IL: Rand McNally College Publishing Co.

Kirk, M., Hunt, J., & Volkmar, F. (1975). Social class and preschool language skill: Cognitive and semantic mastery of number. Genetic Psychology Monographs, 92, 131-153.

Knapp, M. S., Adelman, N. E., Marder, C., McCollum, H., Needels, M. C., Shields, P. A., Turnball, B. J., & Zucker, A. A. (1993). Academic challenge for the children of poverty. Volume 1: Finding and conclusions. Washington, D. C.: U. S. Department of Education, Office of Policy and Planning.

Lappan, G. (1999, February). President's message: Mathematics and the workplace. NCTM News Bulletin, 35 (7), 3.

Lappan, G., Fitzgerald, W., Phillips, E., Winter, M., Lanier, P., Madsen-Nason, A., Even, R., Lee, B., Smith, J., & Weinberg, D. (1988). The middle grades mathematics project. The challenge: Good mathematics—taught well (Final report to the National Science Foundation for Grant #MDR8318218). East Lansing: Michigan State University.

Lappan, G., & Theule-Lubienski, S. (1994). Training teachers or educating professionals? What are the issues and how are they being resolved? In D. F. Robitaille, D. H. Wheeler, & C. Kieran (Eds.), Selected lectures from the 7<sup>th</sup> international congress

on mathematics education (pp. 249-261). Sainte-Foy, Canada: Les Presses de L'Université Laval.

Lazarus, M. (1974). Mathophobia: Some personal speculations. National Elementary Principal, 53, 16-22.

Leder, G. C. (1987). Attitudes toward mathematics. In T. A. Romberg & D. Steward (Eds.), The monitoring of school mathematics (Vol. 2), (pp. 261-277). Madison, WI: Wisconsin Center for Education Research.

Le Moyne College. (1999). Study skill guides: Math anxiety [On-line]. Available:

[http://www.lemoyne.edu/academic\\_affairs/academic\\_support\\_center/index.htm](http://www.lemoyne.edu/academic_affairs/academic_support_center/index.htm)

Lerman, S. (1983). Problem solving or knowledge centered: The influence of philosophy on mathematics teaching. International Journal of Mathematical Education in Science and Technology, 14 (1), 59-66.

Litman, M., Anderson, C., Andrican, L., Christy, C., Koski, B., & Renton, P. (1999). Curriculum comes from the child! A Head Start family child care program. Young Children, 54 (3), 4-9.

Loeffler, M.H. (Ed.). (1992). Montessori in contemporary American culture. Portsmouth, NH: Heinemann.

Lortie, D. (1975). Schoolteacher: A sociological study. Chicago: University of Chicago Press.

Lycos, Inc. (1999). Infoplease.com [On-line]. Available: <http://infoplease.lycos.com/ipd/A0513302.html>

M2Press Wire. (1997). NSF: Presidential awards recognize the world's best teaching [On-line]. Available:  
[http://www1.elibrary.com/s/edumark/getdoc...rydocid=770543@library\\_e&dtype=0~0&dinst=](http://www1.elibrary.com/s/edumark/getdoc...rydocid=770543@library_e&dtype=0~0&dinst=)

M2 Press Wire. (1998). The white house: President convenes top leaders, challenges nation to improve math & science education [On-line]. Available:  
<http://www.ed.gov/free>

Martinez, G. R., & Martinez, N. C. (1996). Math without fear: A guide for preventing math anxiety in children. Needham Heights, MA: Allyn and Bacon.

Mathematical Sciences Education Board. (1989). Everybody counts: A report to the nation on the future of mathematics education. Washington, DC: National Academy Press.

Mathematical Sciences Education Board. (1990). Reshaping school mathematics: A philosophy and framework for curriculum. Washington, DC: National Academy Press.

The Math Forum. (1998). Constructivism in math education. In Mathematics Education: Constructivism in the Classroom [On-line]. Available:  
<http://www.forum.swarthmore.edu/orlando/construct.selden.html>

Merriam-Webster, Inc. (1999). WWWebster Dictionary [On-line]. Available:  
<http://www.merriam-webster.com/dictionary/construct>

McCollum, H. (1990). A review of research on effective instructional strategies and classroom management approaches. In M. S. Knapp & P. M. Shields (Eds.), Better schooling for the children of poverty: Alternatives to conventional wisdom (Vol. 2: Commissioned papers and literature review. Chapter 12. Study of Academic Instruction for Disadvantaged Students, U. S. Department of Education Contract No. LC88054001). Washington, DC: Government Printing Office.

McDiarmid, G. W. (1990). Challenging prospective teachers' beliefs during early field experience: A quixotic undertaking? Journal of Teacher Education, 41 (3), 12-20.

McKnight, C., Crosswhite, F., Dossey, J., Kifer, E., Swafford, J., Travers, K., & Cooney, T. (1987). The underachieving curriculum: Assessing U.S. school mathematics from an international perspective. Champiagn, IL: Stipes Publishing Company.

Mclean, L. D. (1982). Willing but not enthusiastic. Toronto: Ontario Institute for Studies in Education.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 575-596). New York: Macmillan.

Mestre, J. (1989). Hispanic and Anglo students' misconception in mathematics. ERIC Digest [On-line]. Available: <http://ericae.net/edo/ED313192.HTM>

Meyerson, L. N. (1978). Conception of knowledge in mathematics: Interaction with and applications to a teaching methods course (Doctoral dissertation, State University of New York, Buffalo, 1977). Dissertation Abstracts International, 38, 733A.

Microsoft. (1998). Microsoft® word thesaurus [Computer Program]. Microsoft® Office 98

Mikusa, M. G., & Lewellen, H. (1999). Now here is that authority on mathematics reform, Dr. Constructivist! NCTM The Mathematics Teacher, 92 (2), 158-163.

Morrison, G. S. (1997). Teaching in America. Needham Heights, MA: Allyn & Bacon.

Myers, G. (1998). Readers' Forum [On-line]. Available: <http://proquest.umi.com/pqdweb?Did=00000...82&Fmt=3&Deli=1&Mtd=1&Idx=2&Sid=1&RQT=309>

National Alliance for Business. (1986). Employment policies: Looking to the year 2000. Washington, DC: Author.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. Washington, DC: U.S. Government Printing Office.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA.: The Council.

National Council of Teachers of Mathematics. (1998a, December). NCTM PSA campaign urges kids to “do math”. NCTM News Bulletin, 35 (5), 1-12.

National Council of Teachers of Mathematics. (1998b). Principals and standards for school mathematics: Discussion draft. Reston, VA.: The Council.

National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA.: The Council.

National Council of Teachers of Mathematics. (1999). Shaping the standards: Share your thoughts about principles. Teaching Children Mathematics, 5 (5), 262-263.

National Research Council. (1989). Everybody counts: A report on the future of mathematics education. Washington, D.C.: National Academy Press.

National Science Foundation. (1996). Third international mathematics and science study (TIMSS) [On-line]. Available: <http://ustimss.msu.edu/>

National Science Foundation. (1999a). About the NSF [On-line]. Available: <http://www.nsf.gov/home/about/start.htm>

National Science Foundation. (1999b). Grants & Awards [On-line]. Available: <http://www.nsf.gov/home/grants.htm>

National Urban League. (1999). Math opens doors...and it's fun too! Who needs math? [On-line]. Available: <http://ericps.crc.uiuc.edu/npin/respar/texts/parschoo/mathdoor.html>

Nickson, M. (1992). The culture of the mathematics classroom: An unknown quantity? In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp.101-114). New York: Macmillan.

Oakes, J. (1990). Opportunities, achievement, and choice: Women and minority students in science and mathematics. In C. B. Cazden (Ed.), Review of Research in Education, 16, 153-222.

O'Brien, T. C. (1999). Parrot math. Phi Delta Kappan, 80 (6),434-437.

On Purpose Associates. (1998). How do people learn? In About Learning/theories [On-line]. Available:

[http://www.Funderstanding.com/learning\\_\\_theory\\_\\_how1.html](http://www.Funderstanding.com/learning__theory__how1.html)

Ormrod, J. (1995). Educational psychology: Principles and applications. Englewood Cliffs, NJ: Prentice-Hall.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. Review of Educational Research, *62* (3), 307–332.

Pathways. (1998). Constructivist teaching and learning models [On-line]. Available: <http://www.ncrel.org/sdrs/areas/issues/envrnmnt/drugfree/sa3const.htm>

Patriarca, L. A., & Kragt, D. M. (1986). Teacher expectations and student achievement: The ghost of Christmas future. American Review, May/June, 48-50.

Perry, N. S. (1992). Educational reform and the school counselor. In ERIC/CSMEE digest [On-line]. Available:

[http://www.ed.gov/databases/ERIC\\_Digests/ed347491.html](http://www.ed.gov/databases/ERIC_Digests/ed347491.html)

Peterson, P. L., & Barger, S. A. (1984). Attribution theory and teacher expectancy. In J. B. Dusek (Ed.), Teacher expectancies (pp. 159-184). Hillsdale, NJ: Erlbaum.

Peterson, P. L., Fennema, E., Carpenter, T. P., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. Cognition and Instruction, *6* (1), 1-40.

Post, T., Harel, G., Behr, M., & Lesh, R. (1988). Intermediate teachers' knowledge of rational number concepts. In E. Fennema, T. P. Carpenter, & S. J. Lamon

(Eds.), Integrating research on teaching and learning mathematics (pp. 177-198). Albany, NY: SUNY Press.

Powell, A. G. (1993-96). Education in the United States [CD-ROM].

Microsoft® Encarta® 97 Encyclopedia.

Quality Education for Minorities Project. (1990). Education that works: An action plan for the education of minorities. Cambridge, MA: The MIT Press.

Quimbita, G. (1991). Preparing women and minorities for careers in math and science: The role of community colleges. ERIC Digest [On-line]. Available: <http://ericae.net/edo/ED333943.HTM>

Raudenbush, S. W. (1984). Magnitude of teacher expectancy effects on pupil IQ as a function of the credibility of expectancy induction: A synthesis of findings from eighteen experiments. Journal of Educational Psychology, *76* (1), 85-97.

Reys, B., Robinson, E., Sconiers, S., & Mark, J. (1999). Mathematics curriculum based on rigorous national standards: What, why, and how? Phi Delta Kappan, *80* (6), 454-456.

Richardson, V., Anders, P., Tidwell, D., & Lloyd, C. (1991). The relationship between teacher' beliefs and practices in reading comprehension instruction. American Educational Research Journal, *28* (3), 559-586.

Roblyer, E., Havriluk, M.D., Edwards, J., & Havriluk, M. A. (1997). Integrating educational technology into teaching. Upper Saddle River, NJ: Merrill.

Rokeach, M. (1960). The open and closed mind. New York, NY: Basic Books.

Rosenthal, R., & Jacobson, L. (1968). Pygmalion in the classroom. New York: Holt, Rinehart and Winston.

Rugen, L. (1998). In search of understanding: The case for constructivist classrooms [On-line]. Available:

<http://www.ilt.Columbia.edu/K12/SPCweb/docs/teacher/constcase.html>

Ryder, M. (1999). Constructivism. In University of Colorado at Denver: School of Education [On-line]. Available:

[http://www.cudenver.edu/~mryder/itc\\_data/constructivism.html](http://www.cudenver.edu/~mryder/itc_data/constructivism.html)

Sanders, J. (1997). Teacher education and Gender equity. ERIC Digest [On-line]. Available: <http://ericae.net/edo/ED408277.htm>

Sawada, D. (1999). Mathematics as problem solving: A Japanese way. Teaching Children Mathematics, 6 (1), 54-58.

Schlechty, P. C. (1990). Schools for the 21<sup>st</sup> century: Leadership imperatives for educational reform. San Francisco, CA: Jossey-Bass Inc., Publishers.

Schoen, H. L., Fey, J. T., Hirsch, C. R., & Coxford, A. F. (1999). Issues and options in the math wars. Phi Delta Kappan, 80 (6), 444-453.

Schoenfeld, A. H. (1989). When good teaching leads to bad results: The disasters of “well-taught” mathematics courses. Educational Psychologist, 23, 145-166.

Schram, P., & Wilcox, S. K. (1988, November). Changing preservice teachers' conceptions of mathematics learning. In M. J. Behr, C. B. Lacampagne, & M. M. Wheeler (Eds.), PME-NA: Proceedings of the tenth annual meeting (pp. 349-355). DeKalb, IL: Northern University.

Schram, P., Wilcox, S., Lanier, P., & Lappan, G. (1988). Changing mathematical conceptions of preservice teachers: A content and pedagogical intervention (Research Report No. 1988-4). East Lansing, MI: National Center for Research on Teacher Education.

Schwartz, W., & Hanson, K. (1992). Equal mathematics education for females. ERIC/CUE Digest [On-line], 78. Available: <http://ericae.net/edo/ED344977.HTM>

Secada, W. (1990). The challenges of a changing world for mathematics education. In T. J. Cooney (Ed.), Teaching and learning mathematics in the 1990s (pp. 135-143). Reston, VA: National Council of Teachers of Mathematics.

Secada, W. (1992). Race, ethnicity, social class, language, and achievement in mathematics. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 623-660). New York: Macmillan.

Shaw, M., & Wright, J. (1967). Scales for the measurement of attitudes. New York, NY: McGraw-Hill Book Company.

Seldon, A., & Sheldon, J. (1997). Preservice teachers' conceptions of mathematics and how to teach it [On-line]. Available: [http://www.maa.org/t\\_and\\_l/sampler/rs\\_3.html](http://www.maa.org/t_and_l/sampler/rs_3.html)

Shirk, G. B. (1973). An examination of conceptual frameworks of beginning mathematics teachers. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Shulman, L. S. (1985). On teaching problem solving and solving the problems of teaching. In E. A. Silver (Ed.), Teaching and learning mathematical problem: Multiple research perspectives (pp. 439-450). Hillsdale, NJ: Laurence Erlbaum.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. Harvard Educational Review, *57* (1), 1-22.

Sigurdson, S. E., & Olson, A. T. (1992). Teaching mathematics with meaning. Journal of Mathematics Behavior *11*, 361-388.

Silver, E. A., & Lane, S. (1995). Can instructional reform in urban middle schools help students narrow the mathematics performance gap? Some evidence from the QUASAR project. Research in Middle Level Education *18*, 49-70.

Silver, E. A., & Stein, M. K. (1996). The QUASAR project: The 'revolution of the possible' in mathematics instructional reform in urban middle schools. Urban Education *30*, 476-521.

Skemp, R. R. (1978). Relational understanding and instrumental understanding. Arithmetic Teacher, *26* (3), 9-15.

Smith, S. S., & Dixon, R. G. (1995). Literacy concepts of low-and-middle-class four-year-olds entering preschool. The Journal of Educational Research, *88* (4), 243-253.

Smith, B. S., & Smith, W. H. (1998). Coping with math anxiety. Math Academy Online/Platonic Realms [On-line]. Available:

[http://www.mathacademy.com/platonic\\_realms/minitext/anxiety.html](http://www.mathacademy.com/platonic_realms/minitext/anxiety.html)

Soukhanov, A., et al. (Ed.). (1996). The American heritage dictionary of the English language (3<sup>rd</sup> ed.). Boston, MA: Houghton Mifflin Company.

Stein, M. K., & Lane, S. (1996). Instructional tasks and the development of student capacity to think and reason: An analysis of the relationship between teaching and learning in a reform mathematics project. Educational Research and Evaluation 2, 50-80.

Stork, S. & Engel, S. (1999). So, what is constructivist teaching? A rubric for teacher evaluation. Southern Early Childhood Association Dimensions of Early Childhood, 27 (1), 20-27.

Tabachnick, B. R. & Zeicher, K. M. (1984). The impact of the student teaching experience on the development of teacher perspectives. Journal of Teacher Education, 35 (6), 28-36.

Tatarewicz, J. N. (1993-96). Sputnik [CD-ROM]. Microsoft®Encarta® 97 Encyclopedia.

Thom, R. (1972). Modern mathematics: Does it really exist? In A. G. Howson (Ed.), Developments in mathematical education (pp. 194-209). Cambridge, U.K.: Cambridge University Press.

Thompson, A. G. (1984). The relationship of teachers' conceptions of mathematics teaching to instructional practice. Educational Studies in Mathematics, 15, 105-127.

Thompson, A. G. (1992). Teacher's beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp.127-146). New York: Macmillan.

Tobias, S. (1978). Overcoming math anxiety. Boston: Houghton Mifflin Co.

Tymoczko, T. (Ed.). (1986). Making room for mathematics in the philosophy of mathematics. The Mathematical Intelligencer, 8, 44-50.

U. S. Census Bureau. (1999). U. S. census bureau glossary: Census geographic terms [On-line]. Available: <http://www.census.gov/main/www/glossary.html>

U. S. Department of Education. (1998). Expanding federal educational research in the 1950's. In Changing federal strategies for supporting educational research, development, and statistics [On-line]. Available: <http://www.ed.gov/pubs/FedStrat/expand.html>

U. S. Department of Education. (1999a). An expanding role for government [On-line]. Available: <http://www.ta.doc.gov/Reports/TechNI/chp2c.htm>

U. S. Department of Education. (1999b). The federal role in education [On-line]. Available: <http://www.ed.gov/offices/OUS/fedrole.html>

U. S. Department of Education. (1999c). National Educational Goals [On-line]. Available: <http://www.ousd.k12.ca.us/netday/links/refs/Goals.html>

Vacc, N., & Bright, G. (1999). Elementary preservice teachers' changing beliefs and instructional use of children's mathematical thinking. Journal for Research in Mathematics Education, 30 (1), 89-110.

Valverde, G. A., & Schmidt, W. H. (1997-98). Refocusing U.S. Math and Science Education [On-line]. Available: <http://ustimss.msu.edu/>

Waite-Stupiansky, S., & Stupiansky, N. (1998, November/December). Mathematics...a web of connections. Instructor, 108 (4), 76-77.

Weiss, I. (1989). Science and mathematics education briefing book. Chapel Hill, N.C.: Horizon Research.

Weisstein, E. W. (1999). CRC concise encyclopedia of mathematics. Boca Raton, FL: CRC Press LLC.

Welch, W. (1978). Science education in Urbanville: A case study. In R. Stake & J. Easley (Eds.), Case studies in science education (p.6). Urbana, Ill.: University of Illinois.

White, R., & Tisher, R. (1986). Research on natural sciences. In M. C. Wittrock (Ed.), Handbook of research on teaching, (3<sup>rd</sup> ed.) (pp. 874-905). New York: Macmillan.

Wilhelmsen, S. (1998). CSCL – A brief overview & interesting links for further study: Constructivism [On-line]. Available: [www.uib.no/People/sinia/CSCL/](http://www.uib.no/People/sinia/CSCL/)

Williams, W. V. (1988). Answers to questions about math anxiety. School Science and Mathematics, 88, 95-104.

Wittrock, M. (Ed.). (1986). Students' thought processes. In M. C. Wittrock (Ed.), Handbook of research on teaching, (3<sup>rd</sup> Ed.) (pp. 297-314). New York: Macmillan.

Wood, T., Cobb, P., & Yackel, E. (1991). Change in teaching mathematics: A case study. American Educational Research Journal, 28 (3), 587-616.