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A comparison of beliefs related to the teaching of mathematics in teacher-trainees and experienced elementary school teachers

Moore, Patrick Joseph, Ph.D.

City University of New York, 1993

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300 N. Zeeb Rd.
Ann Arbor, MI 48106

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A Comparison of Beliefs Related to the Teaching of Mathematics in Teacher-Trainees and Experienced Elementary School Teachers

by

Patrick J. Moore

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July 22, 1993
Date

Carol Kehr Tittle
Chair of Examining Committee

July 22, 1993
Date

Carol Kehr Tittle
Executive Officer

Dr. Zita Cantwell

Dr. Alan Gross

Dr. Marion Fish

Dr. Philip Saigh

Supervisory Committee

The City University of New York

Abstract

A Comparison of Beliefs Related to the Teaching of Mathematics in Teacher-Trainees and Experienced Elementary School Teachers

by

Patrick J. Moore

Advisor: Carol Kehr Tittle

This study investigated the differences between teacher - trainees and experienced teachers in beliefs in teaching mathematics. The beliefs, identified in the educational research literature as related to teachers' instructional activity in the area of mathematics, were personal ability in mathematics, teacher efficacy, personal efficacy for teaching mathematics, malleability of mathematical ability, and the constructivist nature of mathematics learning.

The teacher-trainees sample (group one) consisted of one hundred and eight undergraduate students seeking certification to teach all subjects at the elementary school level, with no teaching experience. The experienced teachers (group two) consisted of one hundred and seven elementary school teachers with no less than three nor no more than twenty five years of teaching experience. Both groups were recruited from four urban colleges and universities. Group one included undergraduates completing a specialization in elementary education; group two included teachers enrolled in Elementary Education masters'programs. Teacher-trainees and experienced teachers with subject area preparation in mathematics or teaching experience were not included in this sample.

A 78-item survey instrument consisting of five Likert-type subscales was used to collect data about the beliefs. Each of the subscales reliably measured one of the beliefs. The subscales were scored separately. Three hypotheses were tested: 1) Higher means scores were predicted on the five subscales for the experienced teachers sample. 2) Higher zero-order coefficients of correlations between the scores on the belief scales were predicted for the experienced teachers. 3) A significantly greater amount of variance would be accounted for among the experienced teachers compared to the teacher-trainees when the criterion variable about how students learn mathematics was predicted on the basis of personal ability in mathematics, teacher efficacy, personal efficacy for teaching mathematics, and the malleability of mathematical ability.

Only the first of the three hypotheses was found to be significant. The result and limitations of the study are discussed in terms of educational implications and future research.

An acknowledgement.

One of the hardest things about completing a project such as this is the realization that it is time to move on. Granted it has been a long time in coming, and anxiously anticipated, but I have always found saying good-byes particularly troublesome, especially when the people I am leaving behind have been so supportive. I am eternally grateful to my many mentors, to my role-models, and to my mother for the opportunities that have been provided to me. I would especially like to thank Carol Tittle and Zita Cantwell for their patience, their concern, and their direction throughout the dissertation process.

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A Comparison of Beliefs Related to the Teaching of Mathematics in Teacher-Trainees and Experienced Elementary School Teachers

I. INTRODUCTION

Holding a professionally developed set of beliefs appears to be instrumental in the provision of sound instruction. Clark and Peterson (1986) describe teachers' cognitive and other behaviors as being guided by and making sense in terms of a personally held set of beliefs, values and principles. Beliefs represent the teachers' subjective knowledge about objects and events.

Beliefs, in general, are formed over time (Rokeach, 1956), and are specific to the domain in which they are developed. Teachers' beliefs vary depending upon the subject matter in which they teach (Nespor, 1987). Within the area of mathematics, teachers are described as possessing "mathematical worldviews" or personal system of beliefs that influence the way teachers approach mathematical instruction. Initially, these beliefs are unconsciously held. However, with repeated experience with the subject matter, these beliefs develop into an overt system (Schoenfeld, 1985).

Although teachers' beliefs have been found to have a significant but subtle influence on instructional practices (Thompson, 1985; Ulerick & Tobin, 1989), relatively few research studies have been conducted to examine and define teachers' beliefs. Studies reported in the research literature typically have been limited to small sample, ethnographic and single case studies (Clark & Peterson, 1986; Underhill, 1988).

The purpose of this study was to investigate beliefs identified in the research literature as relating to teachers' instructional activity in the area of mathematics, and to examine the relationship of these beliefs in two groups: The first group consists of one hundred and eight undergraduate students enrolled in a teacher education program leading to certification to teach at the elementary school level, teacher-trainees; the second group consists of one hundred and seven experienced elementary school teachers. The beliefs to be examined were situated within the content area of mathematics as taught in the context of the elementary school curriculum.

In a broad sense, a system of beliefs is defined as including all sets, hypotheses or expectations that a person holds to be true at a given time (Rokeach, 1960). However, this study was limited to five beliefs selected for their relevance to the teaching of mathematics at the elementary school level:

1) a teacher's beliefs in his/her personal ability in mathematics;

2) a teacher's beliefs in the efficacy of teaching, in general;
3) a teacher's beliefs in his/her efficacy as a teacher of mathematics, in particular
4) a teacher's beliefs in students' mathematics ability as malleable; and
5) a teacher's beliefs in how students learn mathematics.

The first belief to be examined concerns teachers' perceptions of their personal ability in mathematics. This belief, which is grounded in the individual's experience as a learner of mathematics, influences expectations for success in future mathematics courses (Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983). Teachers who differ in beliefs about their personal mathematical ability may approach mathematical instruction in very different ways.

The second belief, that of teacher efficacy, is defined as teachers' perceptions of "their ability to have a positive effect on student learning" (Ashton, 1985, p. 142). This belief in teacher efficacy has two dimensions (Ashton & Webb, 1986; Gibson & Dembo, 1984; Woolfolk & Hoy, 1990). The first dimension measures the efficacy of teaching, or the belief that teaching, in general, can have a positive influence on student learning. The second dimension, the third belief, measures a teacher's personal sense of efficacy, or the belief that, as an individual, the teacher has the capacity to perform the skills necessary to promote student learning. Teachers who vary on these two beliefs have been found to engage in very different instructional activity (Ashton & Webb, 1986).

The fourth belief concerns teachers' perceptions that students' mathematical ability is malleable. Teachers who believe that students' mathematical ability is changeable may approach mathematical instruction differently than teachers who believe ability to be a fixed and unchangeable entity (Dweck & Bempechat, 1983).

The fifth belief is based on the work of Peterson, Carpenter, Fennema, & Loef (1989), and it concerns teachers' perceptions about how students learn mathematics. This belief falls on a continuum from the belief that students actively construct mathematical knowledge to the opposite pole, the belief that students passively absorb mathematical knowledge (Cobb, 1988; von Glasersfeld, 1987). Teachers who strongly endorse the belief that students actively construct mathematical knowledge pursue very different instructional activities compared to teachers who believe otherwise (Peterson, et al, 1989).

Each of these beliefs have been investigated independently in prior research, and several of the beliefs have been found to differ depending on the experience level of the teachers sampled. The intent of this study was to examine the interrelationship of these beliefs in two groups of teachers who are at different points in time with respect to their professional experience.

Three hypotheses were tested in order to examine the relationship among these beliefs, and to examine the differences in beliefs in the two groups.

First, it was hypothesized that the experienced teachers will endorse each of the four beliefs more strongly than will the teacher-trainees.

Second, it was hypothesized that the strength of association (zero order correlations) exhibited between the belief scales will be stronger for the experienced teachers than for the teacher-trainees.

Third, it was hypothesized that a larger percentage of the variance will be accounted for in the experienced teachers when using the four beliefs, (the belief in personal ability, the efficacy measures and the belief in the malleability of mathematical ability) to predict the teacher's belief about how students learn mathematics, than would be accounted for when using the same variables to predict the teacher-trainees' belief about how students learn mathematics.

II. REVIEW OF THE LITERATURE

From one cognitive perspective, a teacher can be viewed as a clinical information processor who must attend to, sort and make sense of a vast array of information from a complex instructional task environment (National institute of Education, 1975; Shulman & Elstein, 1975). Teaching, as a profession, however, has often been criticized for its lack of a shared technical knowledge base to guide pedagogical practices (Jackson, 1968; Lortie, 1975). In part, this dearth of shared knowledge is due to the isolated, cellular classroom environments in which teachers provide instruction (Sarason, 1982). In lieu of a shared knowledge base, Clark and Peterson (1986) describe a teacher's cognitive and other behaviors as being guided by a personally held set of beliefs. Beliefs are a subjective form of knowledge grounded in personal experience, and are therefore idiosyncratic. The purpose of this study was to investigate four beliefs that teachers with similar experiences may hold in common, and to examine the extent to which these beliefs are shared among the teachers.

Beliefs - Theoretical Overview

In general, beliefs represent all sets, expectancies, or hypotheses that a teacher holds to be true at any given time (Rokeach, 1956). Beliefs refer to the rich store of knowledge about people, objects and events that a teacher accumulates through years of classroom experience (Nespor, 1987; Thompson, 1984, 1985; Ulerick & Tobin, 1989).

Although beliefs are grounded in personal experience, common beliefs can be shared by groups of teachers with similar professional experiences (Nespor, 1987). In this sense, beliefs are similar to practical knowledge, which Elbaz (1981) describes as knowledge about practice and knowledge mediated by practice.

Beliefs begin as relatively isolated units of descriptive information that over time develop into a complex system of interconnected and interrelated concepts and ideas. Once developed, this system of beliefs functions as a cognitive framework through which new information is evaluated.

Working in the area of mathematics, Thompson (1985) used an expanded version of Rokeach's (1960) model to describe a teacher's conceptual system. Included within this conceptual framework are the teacher's systems of beliefs, disbeliefs and concepts related to a specific domain. Using the metaphor of a filter to explain the functional aspect of the conceptual system, Thompson (1985) describes the conceptual system as creating a fairly consistent set of expectations for the teacher.

Schoenfeld (1985) uses the term "mathematical worldview" to describe an uncodified and unconsciously held set of beliefs that a teacher holds about mathematics. Schoenfeld sees the worldview as a precursor to the belief system. Through interactions and experience a teacher is able to test implicitly held beliefs and to develop them into a codified system of explicitly held beliefs.

A teacher's belief system serves to define the task environment (Nespor, 1987). Beliefs affect the way a teacher frames problems, and subsequently, the setting of problems affects the teaching resources and strategies applied to solving these problems (Schoenfeld, 1985). In this sense, beliefs are a conceptual framework that maps across a task environment and guides the teacher's thoughts and actions.

Theoretically, a teacher's belief system can include a limitless number of concepts. However, research in the social and psychological literature indicates that beliefs form clusters specific to a particular domain (Sigel, 1985). One set of beliefs may not be generalizable to other domains. Therefore, this examination will be limited to five beliefs identified in the research literature as relating to the teaching of mathematics in the context of the elementary school curriculum. Each of the five beliefs to be examined is discussed below.

Beliefs in Personal Ability in Mathematics

Self-concept of ability is defined as "the assessment of one's competency to perform a specific task" (Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley, 1983, p 82). Through a process of observation and interpretation of personal behavior, as well as the behaviors of others, one develops beliefs about his/her personal ability to perform in mathematics. These are long standing beliefs that are grounded in one's experience as a learner. These beliefs are important because competency in mathematics is a critical skill that is directly related to academic and occupational decisions (Meece, Parsons, Kaczala, Goff, Futterman, 1982).

A student's self-concept of mathematical ability has been identified as an important variable that influences the student's decision to enroll in advanced mathematics courses (Eccles, Adler, Futterman, Goff, Kaczala, Meece & Midgley, 1983). Measured by a three-item scale (coefficient alpha reliability .79), self-concept of ability in mathematics was found to be significantly related to expectations for academic achievement and to the value a student placed on mathematics as a subject. These two beliefs, expectancy for success and value of the subject, were found to positively relate to students' plans to enroll in mathematics class (Meece, Parsons, Kaczala, Goff, Futterman, 1982). Self-concept of ability, although indirectly related to the decision to enroll in mathematics courses, was found to be directly related to course grades once the student enrolled.

Although the focus of Eccles, et al's (1983) work has been to identify gender differences in the personal beliefs and academic behaviors of students, their results support the saliency of beliefs as influencing academic and personal actions. Teachers, as prior learners of a subject matter, develop self-concepts of their personal ability that they bring with them to the classroom environment. This self-concept of mathematics ability may be significantly related to their self-concept as a teacher, and particularly to their self-concepts of themselves as teachers of mathematics.

Beliefs in the Efficacy of Teaching

One belief identified in the literature as influencing the activities and expectations of teachers is that of self-efficacy. Bandura (1977, 1982) defines self-efficacy as the personal conviction that accompanies the mastering of the skills necessary to accomplish a desired outcome. For Bandura, self-efficacy is a cognitive mechanism that regulates human behavior. Efficacy is not a fixed personality trait, it is a situationally-specific determinant of behavior.

A teacher's sense of efficacy was found to be a salient factor in relation to reading achievement gains made by low-achieving and minority students among a sample of 83 sixth grade teachers in 20 elementary schools (Armour, Conry-Oseguera, Cox, King, Mc Donnell, Pascal, Pauly, & Zellman, 1976). A teacher's sense of efficacy was also found to be among the factors that significantly influenced the implementation and continuation of a federally-funded project in reading in a sample of 1072 elementary and secondary school teachers (Berman, McLaughlin, Bass, Pauly, & Zellman, 1977).

In these early studies, a teacher's sense of efficacy was defined as the belief that a teacher can have a positive influence on student achievement (Berman, et al, 1977). Efficacy was measured by two items:

1. When it comes right down to it, a teacher can't really do much because most of a student's motivation and performance depends on his or her home environment.

2. If I really try hard, I can get through to even the most difficult or unmotivated students.

Teachers responded on a five point Likert scale ranging from Strongly Agree (1) to Strongly Disagree (5).

Typically, the individual scores of these items were summed and the total score was used to represent a teacher's sense of efficacy. Later studies of efficacy, however, divided the construct into two separate dimensions when the items were found to be uncorrelated or correlated with different criteria in four of five samples of teachers investigated (Ashton, Webb, & Doda, 1983). Nonsignificant correlations were found between the two items for a group of 45 elementary school teachers (r=.15, p=.32), and a group of 61 undergraduate education majors (r=.20, p=.13). However, a significant correlation between the items was found among a group of high school basic skills teachers (r=.36, p=.05).

The first dimension of efficacy, measured by item one, is the belief that teaching, in general, can have a positive effect on the achievement of all students. This dimension of efficacy was found to be significantly related (r=.78, p=.003, N=45) to student achievement on the mathematics subtest of the Metropolitan Achievement Test for a group of basic skills high school teachers from four high schools (Ashton, Webb & Doda, 1983).

The second dimension of efficacy, measured by item two, is personal teaching efficacy, or the belief that as a teacher you can perform the actions necessary to promote achievement in your students. This dimension of efficacy was found to be significantly related (r=.83, p=.02, N=45) to achievement scores on the language and reading subtest of the Metropolitan Achievement Test in the same group of teachers (Ashton, et al, 1983).

The finding that the two items correlate differently with subject matter areas supports the notion that self-efficacy is a situationally-specific concept.

Further support for the two dimension hypothesis of teaching efficacy was provided by the work of Gibson & Dembo (1984), who gave a thirty item efficacy scale to 208 elementary school teachers (K thru 6) who ranged from one to 39 years of experience. Results of a factor analysis of the efficacy scale revealed two major factors coinciding with the personal and general dimensions of efficacy reported by Ashton, Webb & Doda (1983). In the final analysis, only 16 of the 30 items were retained. Factor one, which measured personal efficacy, had nine items with loadings above .45, and accounted for 18.2% of the variance. Factor two, the general teaching efficacy scale contained seven items loading above .45 and accounted for 10.6% of the variance. An oblique rotation revealed the two factors to be relatively uncorrelated (r= -.19), supporting the two dimensional hypothesis. Coefficient alpha reliabilities of .78 and .75, respectively, were reported for the two scales (Gibson & Dembo, 1984).

The validity of Gibson & Dembo's (1984) scales were examined for a sample of 182 undergraduates enrolled in teacher training programs at the elementary or secondary level (Woolfolk & Hoy, 1990). Results of a factor analysis confirmed the two dimensional hypothesis of teacher efficacy. The two factor solution accounted for 27% of the variance, and again, the two scales were found to be uncorrelated (r=.07).

Although the two items used by Berman et al. (1977) have been found to be uncorrelated and presumed to measure two separate dimensions of efficacy, the scores on the two items are often combined to form a total efficacy score. Ashton & Webb (1986), when comparing teachers based on this composite score, found high efficacy teachers hold high achievement expectations for their students. Low efficacy teachers, on the other hand, were found to hold low expectations of achievement for their students. Whereas high efficacy teachers stress learning and teaching, low efficacy teachers' instructional behaviors and thoughts often center around the control and containment of their students (Ashton, 1985).

Low efficacy teachers appeared to work from a conflict model of instruction in which the teacher's main objective was to contain the students. High efficacy teachers, on the other hand, stressed cooperation, seeking out contact and engagement with their students. High efficacy teachers' classroom environments were characterized as warm and harmonious.

Low efficacy teachers tended to categorize students by ability levels, and used the students' ability level as a reason why the students cannot learn from instruction. High efficacy teachers, although aware of the same limitations, used the students' ability as a reason to try harder with these students. High efficacy teachers stressed whole group instruction because it maximizes the number of students that are engaged in instruction.

In line with Bandura's findings, low efficacy teachers tended to avoid situations in which they do not feel efficacious. Low efficacy teachers avoided direct confrontation with students they found threatening (low ability). Ashton and Webb (1986) reported that low ability students received less attention from their teachers and engaged in fewer positive interactions with low efficacy teachers. Low efficacy teachers gave the impression of being defensive and rejecting of low ability students (Ashton, 1985).

Efficacy and Grade Level Taught

A teachers' sense of efficacy is affected by different teacher and student characteristics. Teachers in elementary school have been found to possess a higher sense of efficacy when compared to junior high school teachers (Midgley, Feldlaufer,& Eccles, 1989) and when compared to high school teachers (Fuller and Izu, 1986). This higher sense of efficacy in elementary school teachers is believed to be related to the amount of time the teacher has with the class. Elementary teachers typically have a full day with a limited number of students.

Efficacy and Experience

A teacher's sense of efficacy is also influenced by experience. Here the research findings are inconsistent. Studies have found a negative relationship between years of experience and teachers' efficacy (Beady & Hansell, 1981; Berman, et al, 1977). However, one study by Glickman & Tamashiro (1982) examined efficacy beliefs in first year, fifth year and former teachers, and found fifth year teachers reported higher efficacy ratings than either a group of first year teachers or a group of former teachers who left teaching before the fifth year. The relationship between efficacy and experience appears to be an area in need of further investigation.

Efficacy and Student Ability

Several studies have found students' ability level to be the most salient characteristic affecting a teacher's sense of efficacy (Cooper & Good, 1983; Prawat & Jarvis, 1980).

The belief that ability is a fixed entity that can not be changed through instruction has been suggested as being closely related to the belief in the efficacy of teaching (Eccles & Wigfield, 1985; Midgley, Feldlaufer, & Eccles, 1988).

Beliefs about the Malleability of Mathematics Ability.

It has been suggested that one's belief in general teaching efficacy is related to one's belief in ability as fixed or malleable (Ashton & Webb, 1986; Eccles & Wigfield, 1985). Both beliefs, the belief in teaching efficacy and a teacher's belief in student ability as fixed or malleable, are important determinants of a teacher's expectations. According to Brophy (1985), teacher expectations have consequences in the setting of instructional objectives and subsequently in the attainment of instructional outcomes.

In a related line of research, Dweck & Bempechat (1983) describe children as holding one of two implicit theories of intelligence. A child who believes that intelligence is a fixed trait that can not be modified through instruction holds an entity theory of intelligence. A child who sees intelligence as being malleable, on the other hand, holds an incremental theory of intelligence.

Although Dweck & Bempechat's (1983) original work focused on children's theories of intelligence, the authors have extended the application of the model to include adults, as well as children, and to encompass other domains, such as personality characteristics (Dweck & Leggett, 1988). Dweck & Bempechat (1983) theorize that a teacher who subscribes to one or the other theories of intelligence might engage students in very different forms of instructional activity. For example, a teacher who holds to an entity theory of children's ability would avoid putting low ability students in situations in which they will face failure. By brushing over mistakes, the teacher attempts to shield the students from failure and to convey the idea that they have the ability to succeed.

In doing so, however, the teacher is denying students the opportunity to be challenged and to learn from problem solving situations. The teacher is also inadvertently modelling avoidance behavior for the students (Bandura, 1986). Dweck & Bempechat (1983) summarize their work with the conclusion that a teacher's belief about a student's ability may lead them to adopt very different types of instructional strategies.

This finding is supported by the work of Swann & Snyder (1980) who induced differential theories of ability in a group of college students serving as instructors in a short-term training study. Half of the subjects were told ability was extrinsically developed through instruction, and the other half of the subjects were told ability is spontaneously developed by the child.

Extrinsically-oriented instructors focused their attention on the high ability students because low ability students probably could not learn the material in such a short time. The intrinsically-oriented instructors focused their attention on the low ability students because the high ability students would probably catch on for themselves. Although this study has several limitations, including a short duration, the results indicate the possible effect beliefs can have on instructional behaviors.

One study conducted by Ginsburg and Newman (1985) found the entity theory of ability to be the predominant belief among a group of thirteen preservice teachers they interviewed.

Belief in The Efficacy of Teaching and The Belief in Ability as Malleable

Ashton & Webb (1986) draw a corollary between a low efficacy teacher's view of the learner and a teacher who holds the belief that ability is fixed and unchangeable. Both beliefs, the efficacy of teaching and the belief that ability is a fixed entity, have been found to be related to the subject area of mathematics. Midgley, Feldlaufer and Eccles (1988) combined two belief systems, the belief in personal efficacy and student ability and the belief in trusting and control of students, in a study that followed the same group of students through the transition from sixth grade (elementary school) to the seventh grade (junior high school). In doing so, the authors were able to examine the relationship between beliefs among sixth (elementary) and seventh grade (junior high school) teachers and the effect these beliefs had on student achievement.

Among pre-transition teachers, efficacy, autonomy, trust and control, were found to be significantly and positively related, while ability as a fixed trait was not significantly related to the other beliefs. Among post-transition teachers, control and autonomy were not found to be related to trust and efficacy; however, the belief that ability is fixed trait was found to be correlated with efficacy and control.

Midgley, Feldlaufer and Eccles' (1988) findings support the situational-specificity of efficacy and other beliefs held by teachers, and suggest further examination of the variation in beliefs held by different groups of teachers.

Beliefs in How Students Learn Mathematics

An exemplary study by Peterson, Fennema, Carpenter and Loef (1989) provides a model of research that attempts to examine the link between teacher thought and instructional action by combining several sources of information.

In response to Shulman's (1986) criticism of cognitive research in the area of training as lacking content specificity, Peterson, et al (1989) focused their examination on teachers' pedagogical content beliefs about the teaching of word problems on addition and subtraction in the first grade.

Surveying the literature on cognitive research in training and teaching, Peterson, et al (1989) identified four salient assumptions that underlie the constructivist approach to learning and instruction. A twelve item scale was developed for each of the four assumptions and the scales were administered to a group of 39 first grade teachers.

Scale one contains statements concerning the assumption that children are active constructors of mathematical knowledge (Cobb, 1988; von Glasersfeld, 1987). The scale contains 12 items and a coefficient alpha reliability of .86 was reported. The second scale measures the belief that problem solving and understanding should be taught in relation to computational skills. It was also a 12 item scale and a coefficient alpha reliability of .81 was reported. The third scale measures the belief that the students' development of mathematical ideas should provide the sequential bases for instructional topics. This scale also contains 12 items and the coefficient alpha reliability was .86. The fourth scale measures the teacher's belief that instruction in mathematics should be organized to facilitate children's construction of mathematical knowledge. The scale contains 12 items and the coefficient alpha reliability was .75.

A coefficient alpha reliability of .93 was reported for the combined scales. Intercorrelations among the four scales range from .57 to .76, and the authors suggest that the scales could be thought of as measuring one construct or four very related constructs.

Using a sum score on all four scales, Peterson, et al. (1989) identified the seven highest and seven lowest scorers, who were used to make further comparisons. Along with completing the scales, each of these teachers engaged in an individual interview in which they responded to questions about their instructional behaviors. When the seven highest scorers (cognitively based teachers) were compared with the seven lowest scorers (less cognitively based teachers) consistent differences in the responses provided were found.

Cognitively based teachers, those who tended to agree to the four assumptions tested by the scales, were found to stress the relation of mathematics to real life situations, to give word problems early in the year and to continue to do so through out the year. These teachers used word problems to develop the children's understanding of mathematical concepts. The cognitively based teachers also used manipulatives to develop children's counting strategies and understanding.

Cognitively based teachers reported reading word problems to their students before the students were able to read, and they reported evaluating the students' ability to problem solve by giving them a problem and having them solve the problem out loud.

Peterson, et al. (1989) concluded that teachers' beliefs may be importantly linked to teachers' instructional activities. However, since a mean difference in the number of years teaching was found between the high (M=14.57) and low scorers (M=8.00) on the four scales, Peterson, et al, caution that the results may be due to differences in experience and not to differences in beliefs.

Summary of Literature

Summarizing this small body of research studies on teachers' beliefs, several key findings are evident. One, the beliefs held by a teacher seem to develop over time (Nespor, 1987) and therefore support the idea that the beliefs held by experienced teachers and teacher-trainees should vary. Secondly, a teacher's beliefs are often grounded in the teacher's personal experience that includes the teacher's own experience as a learner of mathematics (Ulerick & Tobin, 1989). And finally, the organization of a teacher's system of beliefs appears to change with time, moving in some cases from isolated details to well-connected sets of beliefs (Sigel, 1985).

Research studies in the area of beliefs have consistently found considerable variation among the beliefs held by teachers within a subject matter discipline (Thompson, 1984, 1985) and between subject matter disciplines (Nespor, 1987). Other researchers, such as Midgley, et al (1988) have found differences in beliefs among teachers at different grade levels. In order to control for many of these sources of variation, this study examined five beliefs as they apply to teachers in the content area of mathematics as taught in the context of the elementary school curriculum.

Specifically, this study examined the relationship of five sets of beliefs in two groups. The first group included undergraduate students enrolled in a training program that leads to certification to teach at the elementary school level, and who have no paid teaching experience. The second group included elementary level teachers with at least three years teaching experience.

Definition of Terms:

Experienced teachers. Experienced teachers are defined as teachers who hold an elementary education license (common branches) and have at least three years, but no more then twenty five years of teaching experiences at the elementary grade level.

Teacher-Trainees. Teacher-trainees are defined as undergraduate students enrolled in a education program leading to certification to teach at the elementary school level. Teacher-trainees have had no paid teaching experience.

General Teaching Efficacy. General teaching efficacy is the belief that student learning can be influenced by effective teachers.

Personal Teaching Efficacy in Mathematics. Personal teaching efficacy in mathematics is the belief that as a teacher one can perform the actions necessary to promote mathematics achievement in one's students.

Mathematics Ability as Malleable. Mathematics ability as malleable is the belief that a child's potential for performing in mathematics is increased through experience and instruction.

Personal Ability in Mathematics. Personal ability in mathematics is the individual's belief in personal abilities to perform mathematics.

Student Learning Process in Mathematics. Student Learning Process in Mathematics is the individual's belief that students actively construct mathematical knowledge.

Hypotheses:

H1: Experienced teachers will endorse each of the five belief scales more strongly than will the teacher-trainees, resulting in significantly higher mean scores on all scales.

H2: Experienced teachers will display stronger associations between belief scales than will the teacher-trainees, resulting in significantly higher correlations among the scales.

H3: Experienced teachers will account for significantly more variance when using the three areas of beliefs, (personal ability in mathematics, the two efficacy measures and the belief in the malleability of mathematical ability) are used to predict the belief about how students learn mathematics than will be accounted for when using the same beliefs to predict the teacher-trainees' beliefs about how students learn mathematics.

III. Methods

A pilot study was conducted prior to the main data collection. Results of both investigations are described in detail in the following section.

Pilot Study

A pilot study was conducted to assess the internal consistency of the survey scales prior to the main data collection. Sixty subjects, 30 teacher-trainees and 30 experienced teachers, completed the questionnaire during regularly scheduled classes at three local colleges that offer undergraduate and graduate level programs in education.

The survey responses were coded and coefficient alpha reliabilities were calculated for each of the scales. Two items, PAMS4 and MAMS5 (see Appendix A) were excluded from the analysis because of low corrected item-total correlations. Based on the satisfactory reliability estimates presented in Table 1, the main data collection was carried out.

Table 1

Coefficient Alpha Reliabilities for Survey Scales

Personal Abilities in Mathematics Scale	(PAMS)	.84
General Teacher Efficacy Scale	(EFFTS)	.66
Personal Efficacy for Teaching in Mathematics Scale	(PEFFS)	.75
Mathematical Ability as Malleable Scale	(MAMS)	.90
Student Learning Process Mathematics Scale	(SLPMS)	.91

Main Study

Subjects

Subjects for this investigation were recruited from several urban universities and colleges offering undergraduate and graduate coursework in Elementary Education. Faculty members at the institutions were contacted to assess interest level and to secure access to subjects. Two groups of subjects were obtained.

Group One, the teacher-trainees, consisted of one hundred and eight undergraduates enrolled in programs leading to certification to teach at the elementary school level at four urban universities and colleges. Of the 108 subjects included in this group, 2 were sophomores, 21 were juniors, and 85 were seniors. The mean age of the 102 females, 4 males, and two gender-unidentified subjects was 23.4 years. This age range and mean are typical of undergraduate enrollment at many public urban colleges/university. No member of this group reported having any prior paid teaching experience.

Group Two consisted of one hundred and seven elementary school teachers surveyed in Masters level Elementary Education programs at six local universities and colleges. To be included in this group a subject must have a minimum of three years, but no more than twenty-five years, of teaching experience at the elementary school level. The teachers held certificates as common branch teachers (grades N-6). Teachers with certification in the subject of Mathematics were excluded from the study. The purpose of excluding teachers with specialty licenses in mathematics was to ensure that the sample was typical of elementary school teachers. The mean age of the 94 female and 13 male teachers was 35.8. Their mean experience level was 9.9 years, and the median experience level was 8.0. Overall, the sample consisted predominantly of female teachers, a male/female ratio that is typical of elementary school teachers.

Instruments

The survey instrument (see Appendix A) was administered in college classrooms. The instrument included two major sections: a cover page and a survey of beliefs made-up of 78 items distributed over five subscales. The cover page, which was read by the researcher, provides a description of the survey, as well as statements of informed consent, voluntary participation, and withdrawal from the study. Teachers were asked to supply demographic data (sex and age), teaching experience, and educational background. This information was used to describe the sample and to determine eligibility. The teacher-trainees and experienced teachers differed as follows.

The teacher-trainees group was questioned about paid teaching experience (substitute teaching, tutoring, para or aide). Any teacher-trainee with more than one year of full-time experience in any of these positions was excluded from the final data analysis. Questions concerning type of education (enrollment in teacher-training program) were used to exclude undergraduates not seeking certification at the elementary school level.

In the experienced teacher group, questions concerning years of teaching experience at the elementary school level were used to included/exclude subjects from the final data analysis. Experienced teachers must have had at least three, but no more than 25 years of teaching experience at the elementary school level to be included in the sample. Questions concerning type of certification held were used to exclude teachers with a specialty license in mathematics.

The survey instrument proper contains 78 items from five scales developed by different researchers. Items as they appear in the current experimental protocol and as they appear in their original form are provided in Appendixes A and B, respectively. Each scale will be fully explained below.

Scale One: The Teaching and Learning of Mathematics Scale (PAMS) was developed by researchers at the National Center for Research on Teaching and Education (NCRTE, 1987). The scale contains nine items that measure a teacher's perceptions of personal ability as a learner of mathematics. The response categories are a seven point Likert-type scale ranging from strongly agree (1) to strongly disagree (7). High scores on this scale indicate confidence in one's personal mathematics ability.

Since no reliability information was available for the original scale, the data collected during the main study was used to estimate a coefficient alpha reliability. A content analysis of the nine item scale reveal two sets of items. The first set, items 1 through 5, measure personal ability as a learner of mathematics. The second set, items 6 through 9, measure various beliefs about mathematics as a subject area. The second set of items were dropped from the final version of the scale. Of the remaining five items, item 4 was dropped from the scale because of low corrected item-total intercorrelation (r_{it}=.03). A reliability estimate of .675 was obtained for the four items (PAMS1, PAMS2, PAMS3, and PAMS5) retained as the final measure of Personal Ability in Mathematics.

Scale Two: The Teacher Efficacy Scale (EFFTS) is based on the belief that teaching, in general, can promote positive gains in student achievement. This seven-item scale was developed by Gibson & Dembo (1984). The response categories are on a six point Likert-type scale ranging from strongly disagree (1) to strongly agree (6). High scores on this scale indicate the belief that even good teachers may not influence some students.

A coefficient alpha reliability of .75 was reported by Gibson & Dembo (1984) for the seven items from the Teacher Efficacy Scale. However, the reliability estimate of data from the current sample indicate a low corrected item-total correlation (r_{it} =.12) for item 14, and a subsequent increase in the reliability estimate (.55 to .64) when item 14 is deleted from the scale. Based on these findings item 14 was dropped, and the EFFT scale was reduced to six items.

Scale Three: The Personal Efficacy for Teaching in Mathematics Scale (PEFFS) contains nine items that measure the teacher's belief that he/she is personally capable of performing the skills necessary to insure student achievement in mathematics. Items on this scale are from Gibson & Dembo's (1984) efficacy scale, but have been adapted specifically to the teaching of mathematics. The response categories are on a six point Likert-type scale ranging from strongly disagree (1) to strongly agree (6). A high score on this scale indicate the belief that, as a teacher, one possesses the skills necessary to influence student achievement in mathematics. A coefficient alpha reliability of .78 for the nine-item scale was reported by Gibson & Dembo (1984), and a similar reliability estimate of .78 was obtained in the current analysis. All nine items were retained for the final analysis.

Scale Four: The Mathematical Ability as Malleable Scale (MAMS) contains five items. The scale measures the degree to which a teacher believes that a student's mathematical ability is a fixed and unchanging entity, as opposed to the belief that mathematical ability can be increased through instruction. The scale contains three items adapted from Dweck and Henderson (1988). One additional item from the work of Midgley, Feldlaufer and Eccles (1988) and one original item have been added to the scale. The response categories are on a six point Likert-type scale ranging from strongly agree (1) to strongly disagree (6). A high score on this scale indicates the belief that students mathematical ability is malleable. Midgley, et al (1988) report a coefficient alpha reliability of .5 for three items. Dweck and Henderson (1988) provide no reliability data.

The current reliability estimate for the five items from the MAM Scale indicate that item five, the author's original item, was ill-suited for inclusion in the scale. Based on a relatively low corrected item-total correlation (r_{it} =.35) and the increase in the alpha reliability estimate if deleted from the scale (.83 to .91) item five was dropped from the final analysis.

Scale Five: The Student Learning Process Mathematics Scale was developed by Peterson, Fennema, Carpenter and Loef (1989). The scale contains four subscales. Each is based on one of four fundamental assumptions that underlies the constructivist/cognitive framework of mathematical learning and instruction.

Scale Five-A measures a teacher's belief that students actively construct mathematics knowledge (Cobb, 1988; von Glasersfeld, 1987). The scale contains 12 items and has a reported alpha reliability of .86.

Scale Five-B measures the teacher's belief that mathematical skills should be taught in relation to understanding and problem solving. This scale also contains 12 items and has an alpha reliability of .81.

Scale Five-C measures the teacher's beliefs that the sequencing of instructional topics should be based on a child's natural development of mathematical ideas. This scale also has 12 items and a reported reliability of .86.

Scale Fiver-D measures a teacher's belief that mathematics instruction should be organized to facilitate the child's construction of knowledge. This scale contains 12 items and has an alpha of .75.

Combining the four scales together raises the coefficient alpha reliability to .93. This fact, plus the high level of intercorrelation among the scales (from .57 to .76), suggests that the four scales be considered a measure of one construct or a measure of four very related constructs (Peterson, et al, 1989).

An analysis of the correlation matrix reported by Peterson, et al (1989) was performed by the author (Moore, 1990) as part of the instrument selection process. Applying a principle component exploratory factor analysis, a one factor structure was found to account for 66% of the variance. One eigen value (2.92) exceeded the 1.0 limit. Several smaller eigen values were derived; however, all fell within the 1.0 cutoff.

Based on these findings, scale four A through D were considered as one scale for this study. The response categories are a five point Likert-type scale ranging from strongly agree (1) to strongly disagree (5). A low score on this scale indicates the belief that mathematics is actively constructed by students. An alpha reliability estimate of .92 was obtained for the 48 items collected on the sample of this study.

In summary, the final survey questionnaire consisted of five scales and a total of 78 items as follows.

Personal Ability in Mathematics Scale	(PAMS)	9 items.
Teacher Efficacy Scale	(EFFTS)	7 items.
Personal Efficacy for Teaching in Mathematics Scale	(PEFFS)	9 items.
Mathematical Ability as Malleable Scale	(MAMS)	5 items.
Student Learning Process Mathematics Scale	(SLPMS)	48 items.

The amount of time required to complete the survey instrument ranged from 15 minutes to 35 minutes. The average time was 25 minutes.

Procedure

Participation for this study was obtained by canvassing faculty members from four urban colleges and universities. Appointments were arranged with interested faculty members and class time was allocated for data collection. The teacher-trainees were generally education or liberal arts majors enrolled in early childhood education or methods classes for teaching elementary school mathematics. Experienced teachers were masters' level students generally enrolled in a educational research class.

The teacher-trainee group were surveyed during a regularly scheduled class period. The researcher introduced himself and described the purpose of the study as follows:

> We are interested in the beliefs you have about teaching mathematics at the elementary school level. The scales included in this survey are an attempt to measure some of these beliefs. Please read all directions carefully and answer each item honestly. Your name is not required and your responses will be kept confidential.
>
> Remember, participation is voluntary, and you have the option to skip any question you chose not to answer.

The data collection instrument was distributed with the stipulation that any questions should be addressed to the researcher who remained in the room to answer questions, collect the surveys, and to check the surveys for completion.

The experienced groups of teachers were also surveyed during a regularly scheduled class period. The researcher introduced himself and the purpose of the study. The data collection instrument was distributed and the researcher stayed in the room to answer any questions, to collect and to check the surveys as they were returned.

Data Analysis

Responses to the surveys were coded, checked and edited. The scoring of negatively worded items was reversed, and a score was calculated for each scale. Descriptive statistics were obtained as an initial examination of the sample distribution. Correlations and regression coefficients were obtained using SPSS-X (1986). The frequency distributions of the scores were also examined.

The means, standard deviations, minimum and maximum range values, and sample size for group one, the teacher-trainees, and for group two, the experienced teachers, are presented in Table 2. The number of participants answering all questions on a scale ranges from 93 to 107 in group one and from 97 to 106 in group two. The remaining data analysis were carried out based on the number of cases with complete data in each group: 93 in group one and 97 in group two. Three hypotheses were tested.

As indicated above, the reported sample sizes vary because of missing data. This variability is negligible in most cases. However, in the SLPMS, the final and longest scale (48 items), the number of missing cases were 15 in group one and 10 in group two. The respondents were not included when 3 or more items were omitted.

Table 2

Means, Standard Deviations, Minimum and Maximum Values and Sample Size for Sums Scores of Survey Scales by Group

Group One: Teacher-Trainees

Scale	Mean	SD	Min	Max	n
PAMS	18.4	5.6	7.0	28.0	106
EFFTS	21.3	5.2	8.0	33.0	107
PEFFS	38.3	6.7	11.0	53.0	104
MAMS	9.7	4.1	4.0	23.0	106
SLPMS	129.2	22.6	72.0	176.0	93

Group Two: Experienced Teachers

Scale	Mean	SD	Min	Max	n
PAMS	21.0	5.0	9.0	28.0	105
EFFTS	21.3	5.9	9.0	35.0	105
PEFFS	41.8	5.7	24.0	54.0	105
MAMS	8.6	3.6	4.0	20.0	106
SLPMS	121.2	24.0	69.0	176.0	97

Hypothesis One

Hypothesis One was a test of mean differences between the teacher-trainees (Group One, N = 93) and the experienced teachers (Group Two, N= 97) on the five survey scales. A multivariate analysis of variance (MANOVA) procedure was performed using SPSS-X (1986), and the results indicate the main effect for Group was significant, $F(5, 173) = 5.16$, $p<.001$.

Univariate F-tests for each of the five survey scales examined are provided in Table 3. The mean differences for the PAMS and the PEFFS were significant at the .001 level. The mean differences for the MAMS and the SLPMS were significant at the .05 level. However, the Group effect for the EFFTS was not significant.

Table 3

Univariate F-tests for Survey Scales

Variable	F	Sig. of F
PAMS	12.56	.001**
EFFTS	.15	.696
PEFFS	16.12	.001**
MAMS	4.61	.033*
SLPMS	5.25	.023*

Note: df 1,177, * p<.05 ** p< .001

Hypothesis One was supported for the PAMS, PEFFS, and the SLPMS. It is important to note, however, that group two's lower average score on the Student Learning Process in Mathematics Scale (SLPMS) is an artifact of the reversed scoring - a lower score on this scale indicates a stronger belief in the constructivist approach to mathematics learning. In addition, contrary to hypothesis one, group one, the teacher-trainees, scored higher on the Mathematical Ability as Malleable Scale (MANS). No difference was found between the two groups on the Teacher Efficacy Scale (EFFTS).

Hypothesis Two

Hypothesis Two stated that experienced teachers would display significantly higher correlations among the scales than would the teacher-trainees. The equality of the correlation matrices was examined using LISREL (Joreskog & Sorbom, 1986) to perform a multi-sample analysis based on the correlation matrices for the scales for the two groups. This analysis yields a X^2 (10, $\underline{N}$ = 88,93) = 12.88, p =.231 and a goodness of fit index of .971. Both statistics indicate that, overall, the correlation matrices do not differ significantly for the two groups.

Equality of the correlation matrices was also tested using The intercorrelations between the scales in the two groups were also examined using a Fischer Z transformation. The correlation coefficients were converted using a Fischer's Z transformation, and the transformed correlations were entered into the following formula to test differences between the correlations for group one and two.

$$Z_{obs} = \frac{Z_r 1 - Z_r 2}{\sqrt{\frac{1}{N_1 - 3} + \frac{1}{N_2 - 3}}}$$

A Z_{obs} score exceeding +1.96 or falling below -1.96 indicates a correlation that is significantly different at the .05 level. However, none of the Z_{obs} scores for the five survey scales exceeded this value. The zero-order correlations between the scales are presented in Table 4.

Table 4

Zero-order Correlations for Groups One and Two

	PAMS	EFFTS	PEFFS	MAMS	SLPMS
PAMS	-	-.165	.307	-.267	-.185
EFFTS	-.231	-	-.090	.188	.269
PEFFS	.078	.245	-	-.217	-.240
MAMS	-.095	.261	-.033	-	.196
SLPMS	-.289	.117	-.108	.271	-

Note: Intercorrelations for group one are below the diagonal and the intercorrelations for group two are above the diagonal.

Hypothesis Two was not supported. Experienced teachers did not have significantly higher correlations among the scales, than did the teacher-trainees.

Hypothesis Three

Hypothesis Three stated that the variance accounted for (as indicated by higher multiple correlations) in a criterion variable - the total score on the Student Learning Process in Mathematics scale (SLPMS) - using the two efficacy scores (PEFFS, EFFTS), the belief in personal ability in mathematics score (PAMS), and the belief in mathematical ability as malleable score (MAMS) as predictor variables would be greater for the experienced teachers than for the teacher-trainees.

This hypothesis was tested by running separate regression equations for each of the two groups using a forced entry procedure (SPSS-X, 1986). The results of the regression equations indicate that both Group One, the teacher-trainees, and Group Two, the experienced teachers, accounted for a similar amount of the variance of the SLPMS scores, 12% and 15%, respectively. Thus, hypothesis three was not supported. However, differences were noted on the weights of individual predictor scores.

The b weights, standard error of b weights, t values and significance level of t values for the two groups are presented in Table 5. As indicated in Table 5, two scales, the PAMS with a t value of -2.69 and the MAMS with a t value of 2.15, contributed significantly to the variance accounted for in group one's SLPMS scores. However, in group two, neither of these two scales contributed significantly to the variance accounted for in the SLPMS scores. Instead, the two remaining variables, the EFFTS with a t value of 2.37 and the PEFFS with a t value of -1.98, contributed significantly to the variance accounted for on the SLPMS.

Table 5

B weights, Standard Errors of B Weights, t-Values, Significance Level of t values for Groups

Group One: Teacher-Trainees

Variable	b	SE b	t	Sig t
PAMS	-.799	.297	-2.69	.008
EFFTS	-.043	.291	-0.13	.899
PEFFS	-.195	.250	-0.78	.437
MAMS	.871	.405	2.15	.034

Group Two: Experienced Teachers

Variable	b	SE b	t	Sig t
PAMS	-.228	.367	-0.62	.535
EFFTS	.703	.296	2.37	.019
PEFFS	-.625	.315	-1.98	.049
MAMS	.689	.493	1.39	.166

R^2 group one = 15%, R^2 group two =12%.

It is important to note the direction of the scoring for the individual scales when interpreting the b weights. A low score on the SLPMS indicates that a subject is more likely to support the belief that students actively construct mathematical knowledge. On the other hand, a high score on the PAMS, the PEFFS, and the MAMS indicates that the subject is more likely to believe that he/she is confident in his/her mathematical ability, to believe his/herself to be a capable teacher of mathematics, and to believe that mathematical ability is malleable. Finally, a high score on the EFFTS indicates that a subject believes that even good teachers may not be able to overcome a student's home environment. Thus, for teacher-trainees the belief in personal mathematical ability (PAMS) and the belief in the malleability of mathematical ability (MAMS) contributed significantly to the criterion variable - the score on the Student Learning Process in Mathematics Scale (SLPMS). For the experienced teachers, however, the belief in the efficacy of teaching (EFFTS) and the personal efficacy for teaching mathematics (PEFFS) contributed significantly to the score on the criterion variable - the score on the Student Learning Process in Mathematics Scale (SLPMS).

The individual b weights for each of the two groups were compared using the following the equation.

$$t = \frac{(b1 - b2)}{\sqrt{SEb_1^2 + SEb_2^2}}$$

Results of the t-test comparisons (see Table 6) indicate that only the EFFTS, *t* (180) = -6.62, *p*<.01, was statistically significant.

Table 6

B Weights, Standard Errors of B Weights, T Values for Group Comparisons.

	Group One		Group Two		
Variable	b	SE b	b	SE b	t
PAMS	-.799	.297	-.228	.367	-1.39
EFFTS	-.043	.291	.703	.296	-6.62*
PEFFTS	-.195	.250	-.625	.315	1.24
MAMS	.871	.405	.689	.493	.91

* *p*<.01

In summary, Hypothesis Three was not supported. Similar amounts of variance were accounted for in each of the two groups. However, the scales that contributed to the variance accounted for in the SLPMS, the criterion variable differed between the two groups. A t-test comparison of the b weights for the two groups indicate that only the EFFTS, an external attribution, was statistically different between the two groups. In other words, the EFFTS did not predict the criterion variable - the score on the Student Learning Process in Mathematics Scale (SLPMS) - for the teacher-trainees (group one), but added significantly to the the variance accounted for on the criterion variable for the experienced teachers (group two).

Discussion

Any discussion of results must be framed within the context of the theoretical underpinnings that support the study being undertaken. The current study was an attempt to examine teachers' beliefs in relation to professional experience. Although the belief system is said to include all sets, hypotheses or expectations that a person holds to be true at a given time (Rokeach, 1960), the present investigation was limited to a set of four beliefs identified in the educational research literature for their relevance to instructional activity in mathematics. Each of the beliefs is measured on a Likert-type response scale, and each is situated within the content area of mathematics as taught in the context of the elementary school curriculum.

In order to examine this set of beliefs in relation to professional experience a two group cross-sectional design [1] was employed. The first group, the non-experienced comparison group, consisted of one hundred and eight undergraduate students enrolled in programs leading to certification at the elementary school level. Any undergraduate with more than one year of professional teaching experience was excluded from this group. The second group, the experienced teachers, in comparison, consisted of one hundred and seven teachers. All of these teachers had at least three years teaching experience at the elementary level. The final sample for data analysis included 93 in group one and 97 in group two.

Three hypotheses were tested to examine the relationship between professional experience and personal beliefs. The first hypothesis tested mean differences and predicted that the experienced teachers would agree more strongly on all of the measured beliefs. The results of the MANOVA procedure indicate that Group Two, the experienced teachers, scored significantly higher ($p<.001$) on the scales that measure personal ability in mathematics (PAMS) and personal efficacy for teaching mathematics (PEFFS). In addition, the experienced teachers scored significantly lower ($p<.05$) on the scale that measure beliefs about the students learning process in mathematics (SLPMS). A low score on this scale indicates the belief that students actively construct mathematical knowledge and supports the constructivist viewpoint of mathematical learning (von Glasersfeld, 1987).

However, on the other hand, group one, the teacher-trainees, scored significantly higher (.05) on the scale that measures the belief that mathematical ability is malleable. This finding could be related to the status of the constructivist agenda in the curriculum of the institutions where the data was collected. This finding could also support the idea that more experienced teachers perceive mathematical ability as fixed. The final scale (EFFTS) which measures beliefs about the efficacy of teaching in general showed no significant difference between groups.

Although mean differences between groups prove to be informative and significant, the intent of the study was to examine the structure of the four belief scales at two time points in professional development. It was hypothesized that a greater level of association would exist between the scales in the experienced teachers. Hypothesis two tested the correlations between the scales. Again, it was predicted that experienced teachers, holding firmer opinions, would exhibit significantly stronger intercorrelations between the set of measured beliefs.

Several analyses were conducted to compare the intercorrelations of the scales in the different groups. The largest difference noted between the two groups - the intercorrelations between the PAMS and PEFFS - was subjected to a z-score conversion; however, the comparison did not prove to be significant in the statistical sense.

One reason for this lack of significance could be that the frame (mathematics at the elementary school level) adopted for the study was too broad. Although a conscious effort was made to keep the context of the investigation within a medium-level of specificity rather than restricting the study to one mathematical topic as taught at one grade level, this decision may have provided too much room for mediating variables to affect the correlations.

A second reason for lower than expected correlations could be the high number of young teachers: 28 of the 97 teachers in the experienced teacher group had five or less years of experience. The original design of the study was modelled on the novice/expert research literature. However, operationally defining an expert teacher is a difficult and elusive task, and the sample was drawn from the available population.

A third reason why these differences in correlations may not have reached statistical significance could be the individual differences related to teaching at different grade levels. Clear differences have been noted between elementary, junior high, and high school teachers. However, specific differences in beliefs in mathematics between experienced and inexperienced teachers in the elementary grades were not found in the research literature.

A fourth and final reason for this lack of significant differences in the strength of intercorrelation between the groups for the scales may be the differing level of specificity in the scales themselves. Respectively, the PAMS is a general measure of personal mathematical ability, and the MAMS is a general measure of mathematical ability as related to classroom activity. On the other hand, the efficacy scale has two dimensions or subscales. The first dimension (EFFTS) measures the general belief that teachers may not overcome the effect of the home environment, and the second dimension (EFFPS) measures the personal beliefs about the teacher's capacity to handle specific issues related to mathematical classroom instruction. The final scale (SLPMS) asks very pointed questions about mathematical instruction related to the teaching of word problems on addition and subtraction. This variability in scale specificity could have diminished the intercorrelations between the scale.

Nevertheless, some indication of difference in the structure of the belief variables was found in the results of the third and final hypothesis. The third hypothesis tested the amount of variance accounted for in the SLPMS, the most specific of the survey scales. The original hypothesis was that the scores of the predictor scales (PAMS, EFFTS, PEFFS, MAMS) for the experienced teachers (Group Two) would account for more of the variance on the criterion scale (SLPMS) than would the scores of the predictor variables for the teacher-trainees.

In fact, similar amounts of variance (15% in group one and 12% in group two) were accounted for in the scores on the SLPMS for both groups, and the null hypothesis was not rejected. However, what is of interest is that for the teacher-trainees the PAMS and the MAMS were the significant contributors to the variance accounted for on the criterion variable. For the experienced teachers, the efficacy scores, PEFFS and EFFTS, accounted for the variance in the criterion variable. This suggests that the interrelationship of the beliefs differ in the two groups.

A post-hoc comparison of the regression coefficients for groups one and two indicated a significant difference in the b weight for EFFTS, t (180) = -6.62, $p<.01$. This finding suggest that the Efficacy of Teaching Scale (EFFTS) has a different relationship to the Student Learning Process in Mathematics scale (SLPMS) for the two groups. Although both groups have the same mean score on this scale, in group one, the teacher-trainees, the b weight is near zero. However, in group two, the experienced teachers, the b weight of .703 is positively and significantly ($t = 2.37$, $p<.02$) related to the criterion variable, the Student Learning Process in Mathematics scale. The experienced teachers (group two) belief that good teaching can effect student learning is predictive of the belief in the constructivist approach to mathematical learning.

The results of the separate regressions and the post-hoc comparisons suggests that the members of the two groups construe the situation differently. Among the experienced teachers the two efficacy scores predict their score on the

SLPMS, and among the teacher trainees, the belief in self as a learner of mathematics and the belief in the malleability of mathematical ability predict the score on the SLPMS. In addition, according to the post-hoc comparison of individual b weights for the two groups, a low score on EFFTS, indicating the belief that good teachers can overcome the effects of a student's home environment, is predictive of experienced teachers' score on the SLPMS, or the belief that students actively construct mathematical knowledge.

V. Summary and Educational Implications

In summary, only the first of the three hypotheses was supported by the findings of this study. The statistically significant differences in the means for the survey scales between the teacher-trainees and the experienced teachers indicate that, on average, the two groups of subjects respond differentially to the questions posed. The experienced teachers report themselves to be more efficacious in classroom instruction (EFFPS), to be more confident in their personal mathematical ability (PAMS), and to be more likely to agree with statements that support the constructivist viewpoint of mathematical instruction (SLPMS). On the other hand, the experienced teachers were also less likely to believe that mathematical ability is malleable (MAMS).

Clearly, the mean differences are a significant and noteworthy source of information. However, reliance on means as a method of analysis can serve to mask individual differences in teachers' belief systems. One of the main purposes of this study was to examine the variability in scale responses and to relate this hypothesized increase in variability to teaching experience. Unfortunately, as a psychological construct, the term experience is abstract and broadly defined. In addition, the self-report nature of scales, a pencil and paper task, does not assess the relationship that may exist between teachers' belief systems and their pedagogical practice.

The current investigation was an attempt examine the content as well as the structure of the belief system. In an effort to do so, several pieces of information (scale scores) were gathered from each subject. These pieces of information were examined relative to two broad groups based on the number of years of professional experience, none versus 3 to twenty five years. These pieces of information served as data points by which the structure of the belief system could be mapped for the two groups. The results of this analysis were disappointing. One conclusion that can be drawn from this study is the need to reexamine what constitutes appropriate information or what information would better serve as data point in the study of the belief systems of teachers and teacher-trainees.

In future research, it would be advisable to use scales as a preliminary measure or as a pre-screening device. Once teachers with a targeted belief or set of beliefs have been identified they could be studied in greater detail. The focus of such research endeavors would be to examine the words and constructs teachers use to describe their work in the classroom. This could be accomplished by engaging the teachers in an extended interview/discussion format to explore, in depth, the extent of the teacher's personal belief system.

In addition, these discussions could be coupled with direct observations of the teacher-in-action. Behavioral observations could be made during daily classroom activity or the observations could be linked to an enactment of a specific instructional task, i.e., a lesson on word problems. These interviews and observations would provide the researcher with both, a measure of individual language and behavior. Examining these measure across a specific level of experience and embedded within a given content area would help to differentiate the individual teacher's personal construct system, and also to denote communalities in thought and action that exist among groups of teachers.

Footnotes

[1] The claim that data collection followed a cross-sectional design warrants a note of caution. The teacher-trainee group consisted of undergraduates with little or no professional teaching experience. For the most part, the group is a homogeneous sampling of a typical urban college population. However, in relation to the experienced teachers group, whose subjects range from three to twenty five years of teaching experience, the teacher-trainee group is narrow. The narrowness of this sample warrants a note of caution concerning the restriction of range that could affect the correlations between scales discussed below.

Appendix A

A Survey of Beliefs about Teaching and Learning Mathematics.

A-1 Instructions.

A-2 Sample of the Teacher-Trainee's Data Sheet.

A-3 Sample of the Experienced Teacher's Data Sheet.

A-4 The Survey Instruments.

- A-4-1 Personal Ability in Mathematics Scale.
- A-4-2 Efficacy Scales.
- A-4-3 Mathematical Ability as Malleable Scale.
- A-4-4 Student Learning Process in Mathematics Scale.

A-1 Instructions:

We are interested in the beliefs you have about teaching mathematics at the elementary school level. The scales included in this survey are an attempt to measure some of these beliefs. Please read all instructions carefully and answer each item honestly. Your name is not required and your responses will be kept confidential.

Remember, participation is voluntary, and you have the option to skip any question you chose not to answer.

Thank you for your cooperation.

A-2 Sample of the Teacher-Trainee's Data Sheet.

Id____________________(Leave blank)

Age___________ Sex (circle one) Male Female

Today's Date______________ Course Title____________________

Instructor____________________________ Time________________

TEACHING EXPERIENCE:

Have you ever been employed in any of the following positions? If so, indicate how long (in years) you were employed in that position? Check as many as apply.

Tutor/Remedial Services Yes____ No____ How long?______Years

Teacher's Aide/Para Yes____ No____ How long?______Years

Per Diem Substitute Yes____ No____ How long?______Years

Substitute Teacher Yes____ No____ How long?______Years

Other(explain)____

EDUCATIONAL EXPERIENCE:

What college do you attend?_________________________________

Current Year in College? Fr. Soph. Jr. Sr.
(circle one)

Are you seeking certification to teach at the elementary school level?

Yes____ No____

How many education credits do you have? (include education courses in which you are currently enrolled.________________

A-3 Sample of the Experiences Teacher's Data Sheet.

Id____________________ (leave blank)

Age___________________ Sex (circle one) Male Female

TEACHING EXPERIENCE:

As of today, what is your assignment at your school?

____

____

How many school years long have you been in this assignment? (Include the current year as one year.)______________________

Circle the grade level(s) you currently teach.(Circle as many as apply.)

Pre-K K 1 2 3 4 5 6 7 8

How many school years have you taught full-time?_____________ (Include this year as one.)

EDUCATION:

Did you complete an Elementary and/or Early Childhood Education Teacher Preparation program?

Yes____ No____

As of today, do you hold a New York State Elementary (N THRU 6) provisional certificate?

Yes____ No____

As of today, do you hold a New York State Elementary (N THRU 6) permanent certificate?

Yes____ No____

A-4-1 The Personal Mathematics Ability Scale.

In this section we will focus on the teaching and learning of mathematics. For the statements below, indicate your agreement or disagreement by circling the number that best expresses what you think about the statement. Your replies to these statements can range from STRONGLY AGREE (SA or 1) to STRONGLY DISAGREE (SD or 7).

```
          1    2    3    4    5    6    7
          o----o----o----o----o----o----o
  Strongly           Not           Strongly
  Agree (SA)         Sure          Disagree (SD)
```

Your views about mathematics:

	SA						SD
1. Math just isn't my strength and I avoid it whenever possible.	1	2	3	4	5	6	7
2. I'm pretty good at math and enjoy the challenge of it.	1	2	3	4	5	6	7
3. I can handle basic math, but I don't have the kind of mind needed to do advanced mathematics.	1	2	3	4	5	6	7
4. I feel okay about math. While I'm not especially strong at it, I'm not fearful of it either.	1	2	3	4	5	6	7
5. If I would gave it full effort, I know I could learn advanced math.	1	2	3	4	5	6	7
6. Doing math allows room for original thinking and creativity.	1	2	3	4	5	6	7
7. Doing math is usually a matter of working logically in a step-by-step fashion.	1	2	3	4	5	6	7
8. A lot of things in math must simply be accepted as true and remembered; there aren't explanations for them.	1	2	3	4	5	6	7
9. High school algebra is totally unlike anything presented to students in the lower grades.	1	2	3	4	5	6	7

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Appendix A-4-2
The Efficacy Scale, 66-67

Appendix A-4-4
The Student Learning Process in Mathematics Scale, 69-73

Appendix B
Teacher Efficacy Scale, 76-77

Scale I through Scale IV, 80-83

A-4-3 The Mathematical Ability as Malleable Scale.

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate number to the right of each statement.

Very Strongly Agree	Strongly Agree	Agree Mostly	Disagree Mostly	Strongly Disagree	Very Strongly Disagree
(1)	(2)	(3)	(4)	(5)	(6)

1. Students can learn new things, but their math ability stays pretty much the same. @	1	2	3	4	5	6
2. Students' math ability is something that they can't change very much. @	1	2	3	4	5	6
3. Students' math ability is pretty much a stable trait. &	1	2	3	4	5	6
4. Student have a certain amount of math ability, and they really can't do much to change it. @	1	2	3	4	5	6
5. Some students are born with more math ability than other students. #	1	2	3	4	5	6

Source: @ Dweck & Henderson, (1988). # Midgley, et al, (1988). & Original item.

Appendix B

The Original Scales.

B. The Teaching and Learning of Mathematics

In this section, we focus specifically on the teaching and learning of mathematics. For the statements below, indicate your agreement or disagreement by circling the number that best expresses what you think about the statement. Your replies to these statements can range from **strongly agree (SA or 1)** *to* **strongly disagree (SD or 7).**

1	2	3	4	5	6	7
Strongly Agree (SA)			Not Sure			Strongly Disagree (SD)

I. Your views about mathematics

		SA						SD
1.	Math just isn't my strength and I avoid it whenever possible.	1	2	3	4	5	6	7
2.	I'm pretty good at math and I enjoy the challenge of it.	1	2	3	4	5	6	7
3.	I can handle basic math, but I don't have the kind of mind needed to do advanced mathematics.	1	2	3	4	5	6	7
4.	I feel okay about math. While I'm not especially strong at it, I'm not fearful of it either.	1	2	3	4	5	6	7
5.	If I would give it full effort, I know I could learn advanced math.	1	2	3	4	5	6	7
6.	Doing math allows room for original thinking and creativity.	1	2	3	4	5	6	7
7.	Doing math is usually a matter of working logically in a step-by-step fashion.	1	2	3	4	5	6	7
8.	A lot of things in math must simply be accepted as true and remembered; there aren't explanations for them.	1	2	3	4	5	6	7
9.	High school algebra is totally unlike anything presented to students in the lower grades.	1	2	3	4	5	6	7

Source: National Center for Research on Teacher Education. (1987). Michigan State University. East Lansing, Michigan.

MEASURE 1

People have different ideas about their intelligence. Read each statement below and then circle the one mark that shows how much you agree with the statement.

You have a certain amount of intelligence and you really can't do much to change it.

strongly agree	agree	sort of agree	sort of disagree	disagree	strongly disagree
(1)	(2)	(3)	(4)	(5)	(6)

Your intelligence is something about you that you can't change very much.

strongly agree	agree	sort of agree	sort of disagree	disagree	strongly disagree
(1)	(2)	(3)	(4)	(5)	(6)

You can learn new things, but you can't really change your basic intelligence.

strongly agree	agree	sort of agree	sort of disagree	disagree	strongly disagree
(1)	(2)	(3)	(4)	(5)	(6)

SUITABLE FOR AGE 10 AND OLDER.

SCORING IN PARENTHESES, LOW SCORES INDICATE ENTITY THEORY.

Source: Dweck, C. & Henderson, V. L. (1988). Theories of Intelligence: Backround and measures. Unpublished manuscript. University of Illinois.

Table I. Comparison of Pre- and Posttransition Teachers' Beliefs[a-d]

Items in composite	Pre Mean	Pre *SD*	Post Mean	Post *SD*	*F* ratio	r^2
Trust	12.88	2.82	9.24	2.38	72.32[g]	.30
Most students will waste free time if they're not given something to do. O	3.49	.98	4.05	.74	15.33[g]	.08
Students can be trusted to use the lavatory without getting permission. P	3.79	1.25	2.15	1.01	77.41[g]	.32
Students can be trusted to work together without supervision. P	3.33	1.03	2.58	.96	22.43[g]	.12
Students can be trusted to correct their own tests. O	3.28	1.02	2.57	1.15	17.50[g]	.09
Control	16.30	4.03	19.54	4.67	22.53[g]	.12
Principals should give unquestioning support to teachers in disciplining students. P	3.08	1.18	3.44	1.15	3.62	.02
Students should not be permitted to contradict the statements of teachers in class. P	2.27	.91	2.75	1.21	8.50[e]	.05
Being friendly with students often leads them to become too familiar. P	2.23	1.13	2.78	1.00	10.25[f]	.06
Student governments are a good safety valve but should not have much influence on school policy. P	2.73	.94	2.78	.86	.14	.00
A few students are just troublemakers and should be treated accordingly. P	2.17	1.09	2.80	1.13	12.84[g]	.07
It is often necessary to remind students that their status in school differs from that of teachers. P	2.23	1.10	3.13	1.02	27.38[g]	.14
Students often misbehave in order to make teachers look bad. P	1.52	.60	1.88	.81	10.50[f]	.06
Efficacy	20.09	2.85	17.57	2.91	30.12[g]	.15
If I try really hard, I can get through to even the most difficult or unmotivated student. R	3.78	1.05	3.06	1.05	18.74[g]	.10
If some students in my class are not doing well in math, I feel that I should change my approach to the subject. O	3.90	.98	3.39	1.02	10.26[f]	.06
By trying a different teaching method, I can significantly affect a student's achievement. B	3.97	.97	3.77	.85	2.00	.01
There is really very little I can do to insure that most of my students achieve at a high level. B	1.79	.74	2.22	.92	11.48[f]	.06
I am certain I am making a difference in the lives of my students. W	4.21	.83	3.67	.90	15.67[g]	.09
Fixed ability	9.06	2.07	9.56	2.11	2.27	.01
How much a student learns about math in my class depends more on a student's natural ability than on my teaching strategies. O	2.36	.88	2.44	.87	.28	.00
If students in my class are having trouble with math, they will probably continue to have trouble with math in the future. O	2.74	1.07	3.05	.97	3.59	.02
Some of my students were born with more math potential than other students. O	3.95	1.08	4.08	1.04	.55	.00
Autonomy	2.99	3.27	1.74	2.32	6.78[e]	.04

[a]The Trust, Control, Efficacy, and Fixed Ability composites were created by summing the item scores. Items in those composites are scored on a 5-point scale from (1) *Strongly Disagree* to (5) *Strongly Agree*.
[b]Scoring procedures for the Autonomy composite followed the guidelines suggested by Deci *et al.* (1981). A total score for the four vignettes was computed ranging from −18 (*highly controlling*) to +18 (*highly autonomous*).
[c]Pretransition $N = 107$, posttransition $N = 64$.
[d]O indicates the item is original. P indicates the item is adapted from the Pupil Control Ideology form (Willower *et al.* (1973). R indicates the item is from the Rand Corporation Study (Armor *et al.* (1976). B indicates the item is adapted from Brookover *et al.* (1979). W indicates the item is adapted from the Webb Efficacy Scale (Ashton *et al.* (1982).
[e]$p < .01$.
[f]$p < .001$.
[g]$p < .0001$.

Source: Midgley, C.,,Feldlaufer, H. & Eccles, J. S. (1988). Journal of Youth and Adolescence. 17, 543-561.

References

Armour, D., Conry-Oseguera, P., Cox, M., King, N., Mc Donnell, L., Pascal, A., Pauly, E., & Zellman, G. (1976). *Analysis of the school preferred reading program in selected los angeles minority schools*. (Report No. R-2007-LAUSD). Santa Monica, CA: The Rand Corporation. (ERIC Document Service No. ED 130 243).

Ashton, P. (1985). Motivation and the teacher's sense of efficacy. In C. Ames & R. Ames (Eds.), *Motivation in education Vol 2: The classroom milieu*. Pp.141-171. New York: Academic Press.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York: Longman Inc.

Ashton, P., Webb, R., & Doda, N. (1983). *A study of teachers' sense of efficacy*.(Final report. National Institute of Education Contract No. 400-79-0075). Gainsville, FL: University of Florida. (ERIC Documant Reproduction Service No. ED 231 834).

Bandura, A. (1986). *Social foundations of thought and action: A Social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, *37*, 122-147.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191-215.

Beady, C. H., & Hansell, S. (1981). Teacher race and expectations for student achievement. *American Educational Research Journal*, *18* (2), 191-206.

Berman, P., McLaughlin, M., Bass, G., Pauly, E.,& Zellman, G. (1977). *Federal programs supporting educational change*. *Vol. 7: Factors affecting implementation and continuation*. Santa Monica, CA: The Rand Corporation. (ERIC Document Reproduction Service No. ED 140 432).

Brookover, W., Beady, c., Flood, P., Schweitzer, J., & Wisenbaker, J. (1979). *School social systems and student achievement: Schools can make a difference*. New York: Praeger.

Brophy, J. (1985). Teachers' expectations, motives, and goals for working with problem students. In C. Ames & R. Ames (Eds.), Motivation in education Vol 2: The classroom milieu. New York: Academic Press. Pp. 175-214.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M. C. Wittrock (Ed.), Handbook of research on teaching. (Third ed.,pp. 255-296). New York: Macmillan.

Cobb, P. (1988). The tension between theories of learning and instruction in mathematics education. Educational Psychologist, 23, 87-103.

Cooper, H, & Good, T. (1983). Pygmalian grows up: Studies in the expectation communication process. White Plains, NY: Longman.

Dweck, C. S., & Bempechat, J. (1983). Children's theories of intelligence: Consequences for learning. In S. Paris, G. Olson & H. Stevenson (Eds.) Learning and motivation in the classroom (pp.239-256). Erlbaum: Hillsdale,NJ.

Dweck, C. S. & Henderson, (1988). Unpublished manuscript. University of Illinois

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. Psychological Review, 95, 256-273.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values and academic behaviors. In J. T. Spence (Ed.), Perspectives on achievement and achievement motivation. San Fransisco, CA: Freeman Press.

Eccles, J. S., & Wigfield, A. (1985). Teacher expectations and student motivation. In J. Dusek (ed.), Teacher expectancies (pp. 185-217). Hillsdale, NJ: Erlbaum.

Edwards, A. L. (1965). Statistical methods for the behavioral sciences, New York: Holt, Rinehart and Winston.

Elbaz, F. (1981). The teacher's "practical knowledge": Report of a case study. Curriculum Inquiry, 11, 43-71.

Gibson, S., & Dembo, M. (1984). Teacher efficacy: A construct validation. Journal of Educational

Psychology, 76, 569-582.

Glickman, C. D., & Tamashiro, R. T. (1982). A comparison of first-year, fifth-year and former teachers on efficacy, ego development, and problem solving. Psychology in the Schools, 19, 558-562.

Jackson, P. W. (1968). Life in classrooms. New York: Holt, Rinehart & Winston.

Joreskog, K. G. & Sorbom, D. (1986). Analysis of linear structural relationships by maximum likelihood, instrumental variables and least squares methods. Mooresvillle, Indiana: Scientific Software.

Lortie, D. C. (1975). School teacher: A sociological study. Chicago: University of Chicago Press.

Meece, J. L., Parsons, J. E.,Kaczala, C. M., Goff, S. B., & Futterman, R. (1982). Sex differences in mathematics achievement: Towards a model of academic choice. Psychological Bulletin, 91, 324-348.

Midgley, C., Feldlaufer, H. & Eccles, J. S. (1989). Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. Journal of Educational Psychology, 81, 2, 247-258.

Midgley, C., Feldlaufer, H. & Eccles, J. S. (1988). The transition to junior high school: Beliefs of pre- and posttransition teachers. Journal of youth and adolescence, 17, 543-560.

National Center for Research on Teacher Education. (1987). NCRTE Questionnaire. Michigan State University. East Lansing Michigan.

National Institute of Education. (1975). Teaching as clinical information processing: Report of panel 6, National conference of studies in teaching. Washington, DC: National Institute of Education.

Nespor, J. (1987). The role of beliefs in the practice of teaching. Journal of Curriculum Studies, 19, 317-328.

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

Prawat, R. S., & Jarvis, R. (1980). Gender differences as a factor in teachers' perceptions of students.

Journal of Educational Psychology, 72, 743-749.

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

Rokeach, M. (1956). On the unity of thought and belief. Journal of Personality, 25, 224-250.

Sarason, S. B. (1982). The culture of school and the problem of change. (2nd Ed.). Boston: Allsyn & Bacon.

Schoenfeld, A. H. (1985). Mathematical problem solving. New York: Academic Press.

Shulman, L. S. (1986). Paradigms and research programs in the study of teaching: A contemporary perspective. In M. C. Wittrock (Ed.), Handbook of research on teaching (3rd Ed., pp 3-36). New York: Macmillan.

Shulman, L. S. & Elstein, A. S. (1975). Studies of problem solving, judgement and decision making: Implications for educational research. In F. N. Kerlinger (Ed.), Review of research in education (vol. 3). Itasca, Il: Peacock.

Sigel, I. E. (1985). A conceptual analysis of beliefs. In I. E. Sigel (Ed.), Parental belief systems: The psychological consequences for children. Hillsdale, NJ: Erlbaum Associates.

SPSS Inc. (1986). SPSS-X User's Guide, 2nd ed. New York: McGraw Hill.

Swann, W., & Synder, M. (1980). On translating belief into action: Theories of ability and their application in an instructional setting. Journal of Personality and Social Psychology, 38, 879-888.

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

Thompson, A. G. (1985). Teachers' conceptions of mathematics and the teaching of problem solving. In E. A. Silver (Ed.) Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives. (pp. 267-279). Hillsdale, NJ: Erlbaum Associates.

Ulerick, S. & Tobin, K. (1989, March). The influence of a teacher's beliefs on classroom management. Paper presented at the annual meeting of the American educational research Association, San Francisco, CA.

Underhill, R. G. (1988). Mathematics teacher beliefs: Review and reflections. Focus on learning problems in mathematics, 10(3),43-58.

Von Glasersfeld, E. (1987). Learning as a constructive activity. In C. Janvier (Ed.), Problems of representation in the teaching and learning of mathematics. (pp. 215-225). Hillsdale, NJ: Erlbaum.

Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teachers' sense of efficacy and beliefs about control. Journal of Educational Psychology, 82, 81-91.