Relationships Among Prospective Elementary Teachers' Beliefs About Mathematics,

Mathematics Content Knowledge, and Previous Mathematics Course Experiences

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Prospective elementary teachers' beliefs about mathematics, their content knowledge, and previous experiences and how they might relate to classroom practices

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Abstract

The problem this study addresses is the relationship among the constructs content knowledge, beliefs, and previous experiences of prospective elementary teachers. The 36 participants in the study, 35 females and one male, were recent graduates from a five-year Elementary Education licensure program at a major university located in the Mid-Atlantic region. A correlational research design was used to investigate the relationships that might exist among the three constructs using Praxis I Pre-professional Math test scores, Beliefs Survey scores, and Previous Mathematics Experience Questionnaire [PMEQ] scores. Scores from the Praxis I Pre-professional Math test were self-reported and verified by the Licensure Coordinator in the Center for Teacher Education [CTE]. Scores for the Beliefs Survey and Previous Mathematics Experience Questionnaire [PMEQ] were collected from the survey and questionnaire completed by each participant and the data were analyzed using SPSS software. A frequency distribution was constructed for the Praxis I Math Test scores, the Beliefs Survey scores, and the PMEQ scores. A Pearson correlation was constructed to analyze the relationship among the following variables: Praxis I Math Test, beliefs, and previous mathematics experiences (feelings, teaching tools, and quantity of math courses taken). An alpha level of .05 was used for all statistical tests.

A significant positive correlation was found to exist between Praxis I Math Test scores and feelings about mathematics using a two-tailed test indicating that prospective elementary math teachers who have higher Praxis I math test scores tend to report having more positive feelings about mathematics. A significant negative correlation was found to exist between beliefs and teaching tools using a two-tailed test. This indicates a tendency by prospective teachers to favor more relational beliefs when their previous experiences included the use of a wide variety of teaching tools. The prospective teachers' responses to the essay question and interview questions support their stated beliefs about the importance of teachers emphasizing relational understanding. On their essay responses, all 36 participants indicated a desire to provide a relational oriented learning-environment in their future classrooms.

The findings in the study support the notion that the prospective teachers in this group with stronger content knowledge tended to report more positive feelings about mathematics. They also tended to favor a relational teaching/learning environment if they had experiences using a wide variety of teaching tools. No significant correlation was found to exist between any of the other variables that were tested.

Acknowledgement

Many people have supported my effort during this process. I would like to acknowledge and thank them for the many hours of their valuable time they have given to me. My advisor and committee chair, Dr. John K. Burton, has supported me unconditionally, guided me when I was floundering, and shared his wisdom and expertise. I have never received bad advice from him and I appreciate the faith he has always had in my ability to succeed. He recommended my research advisor and arranged for me to work with this outstanding mathematics education faculty member in the Department of Teaching and Learning and the Mathematics Department.

I would like to acknowledge and thank my research advisor and committee co-chair, Dr. Gwen Lloyd. She has been both my friend as well as a valuable source of knowledge and expertise. I wanted my study to center around prospective elementary mathematics teachers, but I was unsure about the constructs I might investigate that would make a contribution to the already large body of research on this subject. My past experiences working with prospective elementary teachers served as the foundation for this study and Dr. Lloyd guided me in the right direction. Her own research is centered in mathematics teacher education and much of her time and energy is devoted to elementary mathematics teachers. She helped me define what I considered most important to know about prospective elementary mathematics teachers, the constructs that would best fit with my interests, and questions I needed to consider as I began my study. She was there to give me advice, feedback on my work, support me when I felt overwhelmed, and to share my successes.

When beginning the dissertation process, it is important to choose a committee that can provide the best support for you and your work. It is important to have people who have an interest in your dissertation topic and who you can depend on to give you good advice and guidance. My committee members possess all of these qualities and more, including a wide range of knowledge and interests in teacher education. Their areas of expertise include educational psychology, statistics, mathematics, mathematics education, English, English education and writing, technology, and teacher education all of which have been important in completing my study. Those additional committee members include Dr. Patricia Kelly, Dr. Barbara Lockee, and Dr. Melvin (Skip) Wilson. They have spent many hours reading my work, sharing their thoughts, and providing excellent feedback and suggestions which has been invaluable to my study because they each viewed my work from a different prospective, which only served to strengthen it. In addition to my committee, I want to acknowledge and thank Danielle Donaldson, Roberta Snelling, Dr. Robert Schulman, and Dr. Ross Perkins for their invaluable assistance with my study.

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Chapter 1

We live in a time when the need to understand and use mathematics in everyday life has never been greater. The National Council of Teachers of Mathematics [NCTM] emphasizes that those who can do mathematics well will have many opportunities for success. Mathematics competence opens doors for those students, but those same doors will be closed to those who lack competence (NCTM, 1989, 2000).

Both NCTM and National Research Council [NRC] agree that the central tenet of mathematics education is that, in order to do mathematics well, students should learn important mathematics concepts and processes with understanding. Achieving this goal requires solid mathematics curricula as well as competent and knowledgeable teachers who are committed to equity and excellence. Students need and deserve the best mathematics education possible to enable them to fulfill their career goals in an ever-changing world (NCTM, 1989, 2000; NRC, 1989).

Despite efforts by educational leaders and organizations, the vision for excellence and equity is not a reality in all classrooms. Many students are not learning the mathematics that they need or are expected to learn. There are a number of reasons for this, many children are taught by teachers who lack sufficient preparation to teach mathematics effectively (Paulos, 1988). For another example, most mathematics instruction is not aligned with NCTM's (2000) six principles for school mathematics: (a) Equity …high expectations and strong support for all students; (b) curriculum ...more than a collection of activities; (c) teaching ...understanding of what students know and need to learn and then challenging and supporting them to learn it well; (d) learning ...learn mathematics with understanding, actively building new knowledge from experiences and prior knowledge; (e) Assessment ...should support the learning of important mathematics; (f) technology ...essential in teaching and learning mathematics.

These same principles apply to developing strong pedagogical content knowledge of all teachers, not just those who teach higher-level mathematics. Teachers must have the ability to draw on that knowledge in their teaching task (Shulman, 1987; Hiebert & Leferve, 1986). They also need sound, general knowledge of curriculum and ideas that are central to their grade level. They must possess knowledge about the challenges for students learning these ideas, and how to represent and effectively teach them (Shulman, 1987).

The current role of mathematics in science, business, and technology requires us to examine the mathematics being taught in today's classrooms. The traditional school practices of the past cannot prepare students for today's challenges. Teachers have a responsibility to provide experiences and opportunities for all of their students to learn in order to be adequately prepared for the twenty-first century (Steen, 1990).

Van de Walle (2001), speaking to a large group of mathematics teachers said, "Unless students are challenged, many students might find it difficult to develop the confidence or ability to learn to do mathematics." He believes that what is passing, in many classrooms, as problem solving is simply activities that extend what the teacher has demonstrated for the students. When teachers teach by telling students how to solve problems, the solution is not the result of students' ideas, but simply replication of the teachers' examples. Real problem solving develops when students are forced to use ideas of their own. To be able to distinguish between problem solving and activities depends on how well teachers understand the mathematics they are teaching. He emphasized that teachers' actions should encourage students to think, question, solve problems, and discuss their ideas, strategies and solutions.

The vision for teaching and learning mathematics described in the *Professional Standards for Teaching Mathematics* (NCTM, 1991) and *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics* (MAA, 1991) comprise an important foundation for teacher preparation programs certifying elementary school teachers. Teacher educators must be committed to the goal of teaching and learning mathematics, but they must also pay attention to prospective teachers' beliefs about mathematics (Pajares, 1992; Peterson, Fennema, Carpenter, & Loef, 1989; Prawat, 1992; Thompson, 1988).

The Problem

Three areas of interest in teacher education are investigated in this study. They are relationships among beliefs, content knowledge, and previous experiences of pre-service elementary mathematics teachers. The questions that guide the investigation are:

(1) What are the stated mathematics beliefs of prospective elementary teachers?
(2) What relationship, if any, exists between stated mathematics beliefs of prospective elementary teachers and basic mathematics content knowledge measured by Praxis I Math Test scores?
(3) What relationship, if any, exists between stated mathematics beliefs of prospective elementary teachers and previous mathematics experiences (feelings, teaching tools, and quantity of math courses taken)?
(4) What relationship, if any, exists between Praxis I Math Test scores of prospective elementary teachers and previous mathematics experiences (feelings, teaching tools, or quantity of math courses taken)?
(5) What relationship, if any, exists among the three Previous Mathematics Experience categories (feelings, teaching tools, and quantity of math courses taken)?

Purpose of the Study

The purpose of this study is to examine the relationship of stated mathematics beliefs, mathematics content knowledge, and previous mathematics experiences of prospective elementary mathematics teachers. At a time when school divisions and teachers are being pressured to provide a more expanded curriculum for all children it becomes more critical for teacher educators to prepare prospective teachers to meet the challenge. This can only be accomplished by developing a better understanding of what prospective teachers bring to teacher educations programs. It is hoped that data will be added to the already impressive body of information currently available about mathematics knowledge, beliefs, and experiences of prospective elementary teachers.

Significance of the Study

Teacher education programs are being challenged as they have never been challenged before to prepare prospective mathematics teachers in ways that will enhance the teaching and learning of mathematics for the 21st Century (Steen, 1990). It is widely accepted that what a teacher knows influences what is taught and ultimately what students learn (Ball & McDiarmid, 1990; Fennama & Franke, 1992; Grossman, Wilson, & Shulman, 1989). Research conducted in the 1980s and 1990s supports the notion that prospective teachers must have not only a broad base of knowledge about how children learn, but also a broad base of conceptual and procedural knowledge about the math they teach as well as pedagogical content knowledge (Shulman, 1987). There is growing interest in how concepts and procedures are related and how they may be mutually beneficial (Hiebert & Lefevre, 1986).

The vision for teaching and learning mathematics described in the *Professional Standards for Teaching Mathematics* (NCTM, 1991) and *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics* (MAA, 1991) comprise an important foundation for teacher preparation programs certifying elementary school teachers.

Recent reform recommended for teacher preparation programs are being implemented by colleges and universities. As an example, Virginia Polytechnic Institute and State University has restructured its PK-6 program. The program requires five years for completion and prospective teachers graduate with a Masters Degree in Curriculum and Instruction. In the five-year program, the students are required to enroll in four undergraduate content courses giving them the time and opportunities to expand their study of subject matter. They spend more time in elementary classrooms working under the supervision of a master teacher acting as their mentor. Their internship provides a venue to develop and practice instructional skills they have learned as a part of his or her course work and an opportunity to expand his or her teaching experiences.

Beliefs of prospective teachers about teaching mathematics as well as their level of pedagogical content knowledge could influence instructional decisions (Pajares, 1992; Prawat, 1992; Thompson, 1988,1992). Lortie (1975) found that beginning teachers are most likely to teach mathematics as they were taught. It is important for mathematics educators to study the beliefs of prospective elementary mathematics teachers because some research indicates beliefs are one factor that guides their instructional choices and actions (Skemp, 1971, &1976; Thompson, 1992). Research further indicates that a teacher's beliefs will be a factor in how he or she will teach, whether it is acknowledged or not (Lester & Garofalo, 1987; Skemp, 1976; Thompson, 1984). As an example, if a teacher believes that mathematics is primarily memorization and rule-bound, he or she will most likely teach in ways that stress memorization over understanding. If a teacher believes that mathematics is defined by some external authority such as textbook writers, then his or her students will more likely believe that finding the right answer is the goal of mathematics learning and students will accept the textbook as the final authority (Ball & Feiman-Nemser, 1988)).

There is some research (Lester & Garofalo, 1987; Thompson, 1984) that indicates certain beliefs of teachers will influence the beliefs of their students. For example, if a teacher believes that all mathematics problems can be solved in five minutes or less, then he or she will be unlikely to encourage his or her students to exert the effort or spend the time necessary to solve more complex problems (Thompson, 1988). If a student develops counterproductive beliefs about mathematics in the early grades he or she will be less able to think in ways necessary for success in the middle grades and beyond (Ball & Feiman-Nemser, 1988).

However, in contrast to the previous examples, if an idea is represented verbally, symbolically, graphically, or concretely it can connect one mathematical idea to another, link a concept or procedure, or connect to something in a student's own environment. Different students learn from different forms of representation and good teaching involves a wide range of activities (McDiarmid, Ball, & Anderson, 1989). The most useful form of representation is making it comprehensible to others so they can develop the ability to understand (Shulman, 1986). In addition, Brown and Borko (1992) found in their research that when mathematical reasoning, problem solving, communication, and connections are at the heart of classroom instruction all students develop mathematical literacy and power.

Teacher educators are in a position to facilitate the development of positive beliefs about mathematics and the teaching and learning of mathematics. Through their own classroom practices they have the opportunity to break the cycle of prospective teachers who were taught by rule-bound teachers from becoming rule-bound teachers themselves (Fennema, & Franke, 1992).

The result of this study is expected to add to what is already known about the beliefs, knowledge, and experiences of prospective elementary teachers and how they are related. A relationship is expected to exist between content knowledge (Praxis I Math Test scores) and beliefs about mathematics. It is also expected that a relationship will be found to exist between content knowledge (Praxis I Math Test scores) and mathematics experiences as well as between beliefs about mathematics and mathematics experience.

Definition of Terms

Two terms used throughout this study are defined in a specific way in the work of Skemp (1971,1976) in his research on teachers' understanding/beliefs about mathematics. Yackel (1984) also used those specific terms in her *Mathematical Beliefs System Survey*.

The two types of understanding defined by Skemp (1976) are *relational understanding* and *instrumental understanding*. He defines relational understanding of mathematics as the ability to use knowledge that is constructed based on what has been previously learned and problems are solved through the use of alternatives and not just reproducing an algorithm. He defines instrumental understanding of mathematics as a system driven by rules and procedures that must be memorized; instrumentalists subscribe to the notion that these rules and procedures can be plugged into any problem and the "right" answer can be found.

A third term used throughout this study is "beliefs." Teachers' beliefs have been the focus of many studies (Abelson, 1979; Carpenter et al., 1988; Nespor, 1985,1987; Thompson 1984). In this study, the beliefs of prospective teachers are examined in an effort to determine if they tend to favor beliefs based on "relational " understanding or if they tend to favor beliefs based on "instrumental" understanding of mathematics (Skemp, 1971,1976). Relational beliefs about teaching and learning mathematics in this study means the inclination to provide opportunities for students to explore, investigate, use a variety of problem solving strategies, and use prior knowledge to solve problems involving concepts that have not been previously taught. Instrumental beliefs about teaching and learning mathematics in this study means depending on direct instruction, teaching by telling, and using memorization of rules, formulas, and procedures to solve problems.

What is called beliefs in this study many call stated or claimed beliefs because they are based exclusively on written and verbal responses to specific questions. The questions included on the Beliefs Survey (Yackel, 1984), asked the participants to respond to a range of questions about their own beliefs. The questions included their beliefs about doing mathematics; learning mathematics; use of procedures and formulas in mathematics; and the amount of work involved in learning mathematics. Some questions addressed the role of grades in learning mathematics; understanding mathematics; role of previously learned mathematics information; relationship of topics and ideas in mathematics; level of frustration in doing mathematics; role of computation in mathematics; and role of creativity in mathematics. The Beliefs Survey questions were written in the direction that tend to either favor a more relational understanding or a more instrumental understanding of mathematics, as described by Skemp (1976).

There is no universal agreement about what counts as beliefs. Relational beliefs about teaching and learning mathematics in this study means the ability to use prior knowledge to solve problems involving concepts that have not been previously taught, and to provide opportunities for students to explore, investigate, and use a variety of problem solving strategies. Instrumental beliefs about teaching and learning mathematics in this study means depending on direct instruction, teaching by telling, and using memorization of rules, formulas, and procedures to solve problems. This type of beliefs is sometimes referred to as "claimed beliefs" because they were measured by what the prospective teachers said in interviews and in essays and their written responses to specific questions on the Beliefs Survey.

A copy of the Beliefs Survey can be found in Appendix A (p.55).

Chapter 2: Review of Literature

Historical Prospective Summary

This is not a study about the history of mathematics education, however it is always helpful to know a little bit about where we have been in order to better understand how we have gotten to where we are today. It is especially useful when discussing educational reform because these are decisions that have affected the education of children in this country for decades and still affects education today. There is no general agreement about mathematics reform, but the topic has been debated, discussed, and grappled with in classrooms since the time of the earliest mathematics scholars to the present. This section is not a bibliography for mathematics education reform, but rather a snapshot of some of the more recent efforts to address this very real concern.

Mathematics educators have expressed concern about the teaching and learning of school mathematics for many years. At the beginning of the 20th Century E.H. Moore and John Perry were strong advocates for change. Moore supported the need to combine algebra, geometry, and physics concepts, while Perry urged the use of applications and laboratory teaching techniques (Cooney, 1988). In the 1940s, numerous efforts were proposed to improve teaching and learning in mathematics (Brown, Cooney, & Jones, 1990). The research of Brownell (1944,1945, & 1947) focused on the underlying meaning of mathematics. Brown, Cooney, & Jones (1990) cited Brownell's meaning theory as "…based on a conception of rationality as giving reasons to justify procedures rather than on the mechanistic mastery of procedures…" (p. 640). Following WW II, the Commission on Post-War Plans expressed concerns about the weakness of American students' mathematics knowledge (NCTM, 1970). At about this same time, progressive education began to influence teaching, this group focused on Dewey's (1896, 1898) social context of education. They believed that curriculum should be connected and mathematics should be taught as a subject related to other subjects (Brown, Cooney, & Jones, 1990).

With the launching of Sputnik in 1957 it was feared that the level of mathematics being taught in schools was not meeting the mathematics needed for post-college jobs in the science field. This created a wave of educational reform focused on improving students' performance in mathematics and science and winning the space race. In the late 1950s and1960s New Math arose out of the perceived need to strengthen the mathematical knowledge of students in the post-Sputnick era. New Math was based primarily on the notion that students should lean the structural aspects of mathematics rather than just its applications (Brown, Cooney, & Jones, 1990). Mathematicians such as Begle (1968) supported the New Math reform movement and played a significant role in the development of the curriculum for the School Mathematics Study Group (SMSG). The curriculum was one of many that emerged out of efforts to upgrade student learning and understanding and was grounded in the psychological theories of Jerome Bruner and others who supplied the rationale for teaching mathematics as a study of structure. It was perceived to be superior to others programs because it aided the memory and understanding of learners (Bruner, 1960, 1966).

Various projects, closely associated with elementary school mathematics, emerged during the New Math era. Some examples are: the Madison Project, the University of Maryland Mathematics Project, the University of Illinois Arithmetic Project, the Greater Cleveland Mathematics program, and the Minnesota Mathematics and Science Teaching Project (Brown, Cooney, & Jones, 1990). These projects focused on the use of representation to teach mathematics concepts (Nichols, 1968).

Despite a large expenditure of money to fund summer and in-service training to upgrade teachers' mathematics knowledge, provided primarily by the National Science Foundation, and the involvement of many education professionals New Math was not popular with everyone (Brown, Cooney, & Jones, 1990). Teachers felt that they were trying to teach concepts they were not prepared to teach and parents were frustrated because many did not have the mathematics background to understand the content or to help their children (Cooney, 1988; Wilderman, 1976).

Kline (1958) questioned the philosophy of New Math while others (e.g., Adler, 1972) were claiming success in curricular reform. There was general dissatisfaction with the decline in students' ability to perform basic arithmetic operations or to apply mathematics to real-life situations (Wilderman, 1976). Critics claimed that New Math produced a generation of students with weak computational skills who no longer had the ability to perform simple calculations to solve simple problems and this was pedagogically wrong (Kolata, 1977). In defense of New Math, James Fey (cited in Kolata, 1977), developer of one of the New Math Programs, stated, "Developers of the programs assumed that if they wrote good books, teachers would use them successfully to teach their programs" (Kolata, 1977, p.856).

An interest in developing students' conceptual understanding was emphasized during the New Math era, mainly due to the involvement of mathematicians. This is now giving children an opportunity to develop a better understanding of a wider variety of mathematics topics at an earlier age (NCTM, 2000). Also, an important pedagogical construct developed as a result of the New Math movement, this construct was teaching by discovery. This is a method of learning mathematics as if it was being discovered for the first time (Davis, 1967).

Dissatisfaction with the educational system grew in the mid-1970s and so did support for the Back-to-Basics movement (Cooney, 1988). It has never been quite understood exactly what "Back-to- Basics" meant except that it was different from New Math. While students were engaged in doing mindless pages of computation, teachers were reduced to technicians of mandates (Cooney, 1990). The concern about declining test scores, lack of discipline in the schools, and the rising cost of education created a social mood demanding a change in educational policies. Those who opposed the Back-to-Basics movement thought it was a desire to recapture values of the past and perhaps revert to teaching practices of the past (Kolata, 1977).

In the 1980s, several reports were published regarding the state of public education. These reports included *A Nation at Risk (National Commission on Excellence in Education, 1983), Tomorrow's Teachers (*Holms Group*, 1986), A Nation Prepared: Teachers for the 21st Century* (Carnegie Forum on Education and the Economy, Task Force on Teaching as a Profession, 1986). Results of the Second International Mathematics Study reported that eighth-grade students in the United States were just barely scoring at the international mean on algebra concepts that were to be part of a middle school curriculum (Travers et al., 1985). The growing concern about declining achievement in mathematics in general prompted the National Council of Teachers of Mathematics [NCTM] (1989) to develop recommendations for school mathematics, declaring problem solving to be the focus of instruction.

In pursuit of reform in mathematics education, the National Council of Teachers of Mathematics [NCTM] produced three standards documents: *Curriculum and Evaluation Standards for School Mathematics* (1989), *Professional Standards for Teaching Mathematics* (1991), *Assessment Standards for School Mathematics* (1995). The more recent *Principles and Standards for School Mathematics* (2000) attempts to consolidate the other three volumes. All of the standards documents were written in an effort to insure quality mathematics education for all students, to communicate sound mathematical goals, and to promote change in mathematics practices.

The NCTM (1989) *Curriculum and Evaluation Standards for School Mathematics* encourages students to become mathematical problem solvers with the ability to communicate and reason mathematically. The NCTM (1991) *Professional Standards for Teaching Mathematics* recommends that problem solving, communication, and reasoning become a part of the mathematics educational experience of all teachers. The NCTM (1995) *Assessment Standards for School Mathematics* was written and published in an effort to enable teachers to assess students' achievement in a way that reflects reform in mathematics education. The vision for mathematics education described in the NCTM (2000) *Principles and Standards for School Mathematics* "...requires solid mathematics curricula, competent and knowledgeable teachers who can integrate instruction with assessment, education policies that enhance and support learning, classrooms with ready access to technology, and a commitment to both equity and excellence" (p.3).

The Mathematical Association of America [MAA] (1991) document, *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics* called for change in how and what mathematics is taught to prospective teachers. It recommended an undergraduate core curriculum of at least nine semester hours of mathematics for prospective elementary school teachers as well as expanded methods courses and greater learning opportunities in elementary classrooms.

The NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989) recommending specific strands to be taught grades K-4, 5-8, and 9-12. Following the publication of the *Curriculum and Evaluation Standards for School Mathematics (*1989) and Professional Standards for Teaching Mathematics (NCTM, 1991) many states adopted state standards embracing these recommendations.

In 1992 work began on revision of the Standards of Learning of Mathematics used to guide mathematics instruction in Virginia Public Schools, the original document was written and adopted in the mid-1980s. In 1995 the Board of Education, Commonwealth of Virginia adopted the revised Standards of Learning [SOL] in Mathematics for Virginia Public Schools. The revised SOL is based on the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989). Like NCTM, the Board of Education, Commonwealth of Virginia (1995) believed that some level of algebraic reasoning is necessary to carry out everyday mathematics tasks. They believed it was important for students to begin at an early age to develop skills and understanding in this area, so one strand that was included for all grade levels K-8 is Patterns, Functions and Algebra.

In 1995, the NCTM published *Assessment Standards for School Mathematic,* more recently NCTM (2000) published *Principles and Standards for School Mathematics*, "...which is intended to be a resource guide for all who make decisions about mathematics education. *Principles and Standards for School Mathematics* recommendations are grounded in the belief that all students should learn important mathematical concepts and processes with understanding" (p. ix). NCTM (2000) further states that implementation of the standards "…requires solid mathematics curricula, competent and knowledgeable teachers who can integrate instruction with assessment, education policies that enhance and support learning, classrooms with ready access to technology, and a commitment to both equity and excellence" (p.3).

Many changes in teaching and learning of mathematics have taken place over the past 50 or so years, none more important than the use of technology. New technology has made it possible to expand teaching and learning of mathematics concepts, even for very young children, in ways that were never dreamed possible just a few years ago. New teaching tools have been developed for teaching mathematics, but teachers must receive professional development and training in order to use them as effectively (NCTM, 2000). However, "...change is not necessarily always better, and the introduction of new topics and teaching materials will not automatically bring about better understanding, if they are taught in the same old way" (Skemp, 1971, p.13).

Educators have learned that past mistakes associated with reform can be avoided by providing on-going training and support for teachers (Cooney, 1988). It is also important that textbooks reflect instructional changes and grade level appropriate support materials are developed for use in the classroom (NCTM, 2000).

Content Knowledge

In much of the literature knowledge and learning are used interchangeably. Like many other topics in education there is no general agreement on how to best define or measure either. In an effort to measure knowledge some studies used the number of math courses taken, others observed teachers classroom practices over an extended period of time, others have compared U.S. student achievement to the achievement of international students, while others have studied the affects of early classroom experiences on learning. In almost all of the studies there is agreement that young students are dependent on learning their mathematical ideas from teachers and teachers must have the ability to effectively represent and communicate these ideas to their students.

There are numerous studies that support the notion that some elementary teachers do not have the content knowledge necessary to teach the mathematics recommended by professional organizations such as NCTM (Post, Harel, Behr, & Lesh, 1988). The studies varied in nature, one example is the National Longitudinal Study of Mathematical Abilities [NLSMA] (School Mathematics Study Group, 1972). It was based on the number of math courses taken and student achievement. A correlation was computed and no significant relationship was found to exist (Fennema & Franke, 1992).

Another study (Fennema, Carpenter, & Peterson (1989) investigated what teachers do in the classroom over an extended period of time. They observed the classroom instructional methods of a teacher who was working with the Cognitively Guided Instruction [CGI] project. Her instructional methods were found to be very different from one domain to another. For example, when teaching addition and subtraction, she used a variety of strategies and problem types. When teaching fractions, she used only one basic type of problem: part-to-whole. The classroom discourse was also very different. When tested, the students' ability in addition and subtraction increased to a greater degree than their ability to do fractions. It was concluded that the domain in which the teacher had the most content knowledge resulted in greater student learning.

Content knowledge and learning are sometimes used interchangeably. However, many kinds of learning exist; two kinds are habit learning or rote-memorization and learning involving conceptual understanding. Rote-memorization can be replicated using laboratory rats, but learning involving conceptual understanding is the kind in which humans excel (Skemp, 1971). Hiebert and Lefevre (1986) define habit learning as procedural knowledge made up of two parts;

one part is the representation system and the second part is algorithms and rules. They define learning that involves conceptual understanding as a "connected web of knowledge" (p.3) that links relationships.

Prior to formal teacher education pre-service teachers have many classroom experiences, they bring certain knowledge, beliefs, and attitudes they develop as students (Lortie, 1975). Wright and Tuske (1968) conducted a study about how these early experiences influences future classroom practices. One area of their investigation included a passive learning environment in which many students failed to develop an understanding of mathematics concepts. In a similar study, Ball, (cited in Fennema & Franke, 1992), found that many students simply follow rules, memorize formulas, and use prescribed procedures to find solutions. Many teachers who learned in this manner tend to teach their students in the same way they were taught (Lortie, 1975).

Students are largely dependent on their teachers for learning mathematical ideas and teachers must have the pedagogical content knowledge to communicate these ideas to their students (Shulman, 1987). As mathematical ideas and concepts become more strongly established within the students, they become less dependent on the teacher. As students develop an understanding of mathematical concepts they are able to use those concepts intuitively without being aware of it; this applies to the most basic and frequently used concepts that children acquire at an early age (McDiarmid, Ball, & Anderson, 1989). Their understanding of the underlying principles is imperfect and they depend on good teaching to guide them to that understanding (Bruner, 1960).

The elementary years (K-6) are critical for young people developing understanding of mathematics. "...The experiences that children have in those early years will have a great impact on essential decisions they will make in later years--decisions that will expand or limit their career choices and affect their ability to function at a high level in an increasingly technical society" (Thorpe, 2001, April, p. 1).

The National Research Council [NRC] (1989) recommended that educators, at all levels, provide a mathematics curriculum in which all students develop a strong knowledge and understanding of mathematics concepts. "Effective teaching of mathematics requires an appropriate pedagogical and mathematical foundation..."(NRC, 1989, p.57). "Evidence from many sources show the least effective mode for mathematics learning is the one that prevails in most of America's classrooms; lecturing and listening" (NRC, 1989, p. 57), and so for many students, learning mathematics continues to be a passive activity. Repetition helps students do well on standardized test and lower-order skills, however, this mode of instruction is ineffective for long-term learning, higher-order thinking skills and for problem solving (NRC, 1989).

In order to improve mathematics education for all students, teachers must be able to engage and motivate students as they struggle; effective teachers are those who can stimulate their students to learn (McDiarmid, Ball, & Anderson, 1989)). Students must be allowed and encouraged to construct their own understanding. They must be given the opportunity to examine, represent, solve, apply, prove, and communicate mathematical concepts and ideas. This happens more readily when students are allowed to work in groups, discuss ideas and problems, construct models, create real world situations that are relevant, and take charge of their own learning (McDiarmid, Ball, & Anderson, 1989; NRC, 1989).

Most students, particularly young students, use a great deal of invention as they begin to learn mathematics; they impose their own interpretations in order to make sense of what they have been asked to learn. They develop a close relationship between conceptual and procedural knowledge based on what they observe in their environment (Hiebert & Lefevre, 1986).

Students construct understanding through processes of assimilation and accommodation based on prior knowledge or experiences. Examples of this can be found in the work of Piaget and other cognitive scientists (Carpenter & Peterson, 1988; NRC, 1989). In order for teachers to be effective, they must listen as well as speak, build on the prior knowledge and experiences of students, and resist the need to control classroom ideas. In this type of learning environment, students gain a sense of ownership of what they are learning (Fennema & Franke, 1992; NRC, 1989).

Classes where active learning is taking place require more time and energy from both teachers and students than in traditional classrooms. The role of the teacher is multifaceted, consultant, moderator, and one who engages in discussion, not just lecturer and authority (Brown & Borko, 1992; NRC, 1989). Students must be encouraged to express their ideas and thoughts, they must learn to work cooperatively in teams to solve problems and to present their ideas convincingly even though there may be conflicting ideas and strategies. One of the most effective ways to develop thinking skills is to encourage students to engage in open discussion (Brown & Borko, 1992; NRC, 1989).

When using less direct instructional strategies, greater instructional efforts are required and students may not move through the curriculum at the expected rate (NRC, 1989). This can be problematic for teachers who are under pressure to prepare students for testing. However, in the long run, less teaching will yield more learning as students take more responsibility for their own work. They learn how to learn as well as what they need to learn (NRC, 1989).

The results of the Third International Mathematics and Science Study [TIMSS] have been widely studied by educators in the United States as well as in other countries around the world (USDOE, 1996). Eighth-grade students from Asian countries out-scored students from the United States in all six tested strands: fractions & number sense; geometry; algebra; data representation, analysis, & probability; measurement; and proportionally (USDOE, 1996, pp.28-29). U.S. students scored below the mean in four of the six strands, the two strands in which U.S. students scored above the mean were fractions and number sense, one point above the mean and data representation, analysis and probability where they scored three points above the mean. Eighth-grade students from Singapore, Japan, and Korea consistently scored the highest percentage correct in all six strands (USDOE, 1996, pp. 28-29).

Before drawing any conclusions when comparing U.S. student achievement with student achievement in the top-scoring Asian countries, one must be reminded that not all U.S. school systems are the same and that wide difference in achievement exists even between states. Each state is responsible for its own educational system and many instructional decisions are left to the individual localities (USDOE, 1996). When "...comparing eighth-grade mathematics test scores on the National Assessment of Educational Progress [NAEP] with TIMSS scores it was found that mathematics scores in Iowa, North Dakota and Minnesota were similar to the top-scoring Asian countries..." (USDOE, 1996, p. 32).

When the mathematics curricula in the U.S. was compared with the curricula of the three top Asian countries, the following was found: curricula in the U.S. was found to be taught one year later than in the Asian countries, the U.S. does not have a national curriculum, U.S. students spend more hours in the classroom per year; and the number of topics covered in U.S. classrooms was greater than the international average (USDOE, 1996). Evidence from the TIMSS indicates that the U. S. mathematics curricula are less focused than the curricula in Asian nations.

Learning is closely related to what students are taught (Hiebert & Lefevre, 1986) and this is a challenge for teacher education programs in this country. Prospective teachers need to have a wide variety of opportunities to experience doing mathematics; they need to explore, guess, test, argue, and prove in order to develop the confidence to effectively teach mathematics (Grossman, Wilson, & Shulman, 1989; NRC, 1989). It is further recommended that all colleges of education, as part of teacher preparation provide these experiences for prospective teachers (NCATE, 2000).

Ball (1990) states that her own research with elementary teacher candidates reveals that the mathematical understanding brought with them from previous mathematics experiences is primarily weak and rule-bound. Simply because a student understands mathematics does not mean they have the kind of mathematical understanding to teach it and to help students learn. Prospective teachers should possess conceptual and procedural knowledge and understand the benefits of their relationship (Hiebert & Lefevre, 1986). “Neither a perfect textbook lesson nor a smooth procedure for calling on pupils will bail out the teacher who is confronted with students who want to know why...” (Ball, 1990 p. 458).

A teacher should understand mathematics concepts well enough to represent them appropriately in a variety of ways; they should have the ability to interpret students’ understanding or lack of understanding and be able to challenge incorrect notions (Ball, 1990; Hiebert & Lefevre, 1986). To engage in effective instruction, teachers must be able to describe the steps in an algorithm and discuss the reasons for certain procedures; they must be able to provide explanations in response to students’ questions (Hiebert & Lefevre, 1986). It is important for prospective teachers to develop an understanding of how concepts connect and relate to each other. Most mathematics textbooks treat each concept as a discrete bit of knowledge and rarely do they make connections among the different ideas and procedures (Ball, 1990).

Prospective teachers have been studying mathematics long before entering college (Wright & Tuske, 1968)). Pre-college mathematics comprises the major part of their formal education and the time spent in college study is a relatively brief period in comparison. The content studied in elementary and high school will more closely represent the mathematics that prospective teachers will teach (Ball & McDiarmid, 1990).

Mathews (1999), a staff writer for the Washington Post, stated that colleges of education in the nation face very close scrutiny from lawmakers and state school boards to improve the quality of teacher training. Within the next ten years, over 40% of the teaching force will retire or leave teaching and these experienced teachers will be replaced with beginning teachers. Teachers must have the skills to not only teach the course content, but the pedagogical knowledge to help their students learn (Hiebert & Lefefre, 1986). There are currently many “...poorly educated teachers struggling to teach things they don’t know” (Mathews, 1999, p. B7). Many states have adopted tough standards and student testing, so it has become critical for prospective teachers to develop an understanding of basic subject matter content as well as an understanding of how children learn (Brown & Borko, 1992).

There is a critical teacher shortage in many parts of the country and there is fear that mediocre graduates will be hired to fill the classrooms without the benefit of a teacher preparation program. A number of states have already approved programs fast-tracking college graduates for emergency licensure without the benefit of completing a state approved teacher education program (NCATE, 2000).

There are approximately 1200 colleges of education in the country, but only 512 are accredited. An Educational Testing Services study in 1999 found that graduates of National Council for Accreditation of Teacher Education [NCATE] accredited institutions outperformed graduates of non-accredited institutions as well as those who had not completed a teacher preparation program. NCATE (September, 2000) recommends multiple measures of performance regarding licensure; they believe that subject matter content knowledge as well as classroom practices greatly influences student achievement. Teachers who are trained in developing higher-order thinking skills, who have the ability to implement hands-on experiences in the classroom, and who have received training to work with special populations will be the most successful in helping students to achieve success (NCATE, September, 2000).

In order to become a successful teacher, prospective teachers must receive a balanced introduction to teaching. The need for pedagogy content knowledge, the "how to teach", is as necessary as subject matter knowledge in order to teach effectively (Shulman, 1987; NCATE, October, 2000). NCATE accredited institutions help ensure that teacher candidates know the content and how to teach it effectively.

Teachers need adequate preparation and those who are granted emergency licensure without preparation and who are unprepared for their role in the classroom "...do not raise student achievement levels". "...Unprepared individuals who are placed in the classroom..." "...Will subject children to a fifty-percent likelihood that an untrained person will teach them math..." (Wise, 2000, p. 3). "Emergency credentialing keeps teaching as a low-level job one can "fall back on" if no other job is available" (Wise, 2000, p. 3). Children "need to be taught by those knowledgeable in their field, who are dedicated to teaching and care about their students. They need fully licensed teachers who have demonstrated they are worthy of the license" (NCATE, 2000, p.3.). Children need teachers who have chosen teaching as their first career.

There a numerous studies about teacher's subject matter content knowledge, pedagogical content knowledge, teaching and learning of mathematics, and knowledge necessary for prospective teachers to teach effectively. There is no argument that in order for students to learn mathematics, teachers must not only possess content knowledge they must also know how to represent and communicate mathematics ideas. Knowledge and learning are closely related and just getting the "right answer" does not always indicate the level of knowledge one has about a concept nor does it necessarily indicate that a student has learned or understands the concept.

Beliefs

As with other constructs, there is no general agreement about what constitutes beliefs and how they can be measured. Some studies refer to beliefs as conceptions, others claimed beliefs, some studies refer to held beliefs, and still others stated beliefs. This is another construct where two terms, beliefs and knowledge, are used interchangeably. Researchers do not agree just what "beliefs" mean. Some studies provide information about beliefs of students and teachers, some involve one specific area such as problem solving, while others investigate the over-all beliefs of prospective teachers about mathematics. Some researchers argue that knowledge is stored information and beliefs develop from prior experiences and they operate independently of each other while other research compares beliefs and knowledge. Some studies argue the beliefs cannot be observed, but must be measured by what people say and do. All of the research has important implications for teacher education.

Research on teachers' beliefs has become an important link to studies in mathematics education about how beliefs affect teachers' classroom instruction. Some examples include:

Thompson's (1984) study about teachers' conceptions, Schoenfeld's (1985) study about student problem solvers, and Silver's (1985) study about students beliefs about mathematics as a discipline. There have been other studies which investigated differences in beliefs (Fennema & Peterson, 1985), connections between beliefs and knowledge of problem solving (Lester, Garofalo, & Kroll, 1989), and whether beliefs about mathematics were rule-oriented or concept-oriented (Underhill, 1988), much like the work of Skemp (1976,1978) (McLeod, 1992).

Additional studies have provided important information about the beliefs of students and teachers (Barr, 1988; Grouws & Cramer, 1989; Marcilo, 1987; Peterson, Fennema, Carpenter, & Loef, 1989; Sowder, 1989). All of these studies and many more have contributed significantly to the body of knowledge we have about the important role beliefs play in teaching and learning of mathematics. However, it has been recommended that more work be done in this area (McLeod, 1992).

One research area of interest is the broad, overall beliefs of pre-service mathematics teachers. Ball (1990) has conducted extensive research involving prospective teachers when they enter teacher education. She suggests they must sometimes "unlearn" and "discard" some of their beliefs in order to become an effective mathematics teacher. For this reason, Thompson (1992) recommends that student teaching placements be carefully chosen as well as the cooperating teacher in an effort to be sure they have the same goals as the teacher education program.

There is no argument that beliefs influences teachers' classroom decisions and behavior. So, a better understanding of the beliefs structure of prospective teachers is important for professional preparation (Ashton, 1990; Brookhart & Freeman, 1992; Munby, 1992; Nespor, 1987; Tabachnick, Popkewitz, & Seichner, 1979).

Beliefs about specific subject matter is the key to understanding how children learn to do mathematics. However, in order for this to happen, researchers must agree what beliefs mean (Pajares, 1992). Defining beliefs is not an easy task; there is some confusion between what constitutes beliefs and what constitutes knowledge. It is difficult to distinguish where knowledge ends and beliefs begin (Clandinin & Connelly, 1987).

Nespor (1987) argues that beliefs have stronger affective components that operate independently of the cognition associated with knowledge. He further contends that knowledge is stored information that has been learned, while beliefs developed from prior experiences or events that tend to influence similar events. An example might include previous memories of classroom experiences.

Calderhead and Robson (1991) agree -- they found that pre-service teachers held strong images of their experiences as students and often referred to those experiences in interviews. Nespor (1987) also found that a "crucial experience with some particularly influential teacher produces a richly, detailed episodic memory which later serves the student as an inspiration and a template for his or her own teaching practice (p. 320).

In her research on problem solving, Thompson (1988) found the main difficulties encountered were beliefs of both teachers and students. In discussion of problem solving with teachers their responses ranged from: it is the right answer that counts, the answer is usually a number, use a procedure to get the answer, and remember what to do. The same beliefs were also held by most of the students. This indicates that teachers communicate their beliefs to their students. This might also indicate their beliefs are based on their own experiences. It is important to find a way to break this cycle and change or modify these beliefs (Thompson, 1988)

Ernest (1989) found, in his research, that two teachers might have similar knowledge, but teach in very different ways based on their individual beliefs. Brown and Cooney (1982) found in their studies that prospective mathematics teachers often did not use the knowledge they had leaned, but their beliefs to guide classroom practices. Thompson (1984) also asserts that beliefs can have a profound effect on teachers' classroom decisions and performance.

Other research suggests that beliefs of pre-service teachers play an important role in teaching behavior and may be responsible for ineffectual teaching practices (Schommer, 1990). Research findings on the beliefs of pre-service teachers can provide important information to teacher educators that may help them to determine curricular and program design (Weinstein, 1988, 1989).

Beliefs are not always clearly defined in some studies, but rather researchers compare beliefs and knowledge. The work of Ableson (1979), Brown & Cooney (1982), Sigel (1985), Harvey (1986), Nisbett & Rose (1980) are all examples of research about how beliefs differ from knowledge. Basically they all seem to agree that beliefs are based on individual evaluation and judgment, while knowledge is based on learned facts.

Rokeach (1968) argued that beliefs have a knowledge component and that understanding beliefs requires making inferences about an individual. Rokeach further states that beliefs cannot be observed directly, but must be measured by what people say and do.

Munby (1982) found in his studies that the earlier a belief is incorporated into a person's belief structure the more difficult it is to change. He also found that some individuals tend to hold on to incorrect or incomplete information even after they have been presented with scientifically correct information. Many students have misconceptions about mathematics and often these misconceptions are so deeply ingrained it is difficult to correct. Beliefs generally do not change easily (Nisbett & Ross, 1980).

The results of these studies have important implications for teacher education. Mathematics educators should emphasize the benefits for prospective teachers to question their beliefs about teaching mathematics. Doing so may be difficult for some because many perceive teaching as replicating their own classroom experiences. "...Most pre-service teachers look to teachers as experts in both content and pedagogy" (Raymond & Santos, 1995, p.68). Posner et al. (1982) suggested that a person must be dissatisfied with their current beliefs and convinced that new beliefs fit better with their needs. Old beliefs must be challenged and proven unsatisfactory in order to assimilate new beliefs into existing conceptions (Rokeach, 1968). So, when pre-service teachers re-appraise their existing beliefs, attitudes, and knowledge, they are also forced into a learning situation that provides opportunities to reflect on and re-conceptualize their beliefs about their vision for mathematics teaching (Langrall, Thornton, Jones, & Malone, 1996).

The hours that prospective teachers spend in the classroom as K-12 students far outweigh the time spent in teacher education (Lortie, 1975). Beliefs are well established by the time students get to college and they carry these beliefs with them into teacher education and into their own classrooms (Wilson, 1990; Buchmann, 1987).

Teacher education researchers have long been aware of the power of beliefs and the resistant-to-change beliefs of many pre-service teachers as well as experienced teachers (Brown & Cooney, 1982; Buchmann, 1984; Lasley, 1980; Lortie, 1975). Some important things we have learned from research about teachers' beliefs are: (a) Beliefs are formed early (Ableson, 1979; Buchmann, 1984; Lortie, 1975; Munby, 1982; Nespor, 1987; Rokeach, 1968; Wilson, 1990); (b) individuals develop belief systems through culture transmission (Ableson, 1979; Brown & Cooney, 1982; Posner et al., 1982; Rokeach, 1968); (c) beliefs systems help individuals understand themselves (Ableson, 1979; Lewis, 1990; Rokeach, 1968; Schutz, 1970); (d) knowledge and beliefs are intertwined, but beliefs act as a filter for new information (Abelson, 1979; Calderhead & Robson, 1991; Nespor, 1987; Nisbett & Ross, 1980); (e) beliefs play a key role in knowledge interpretation (Nespor, 1987: Peterman, 1991; Posner et al., 1982); (f) the earlier a belief becomes a part of the belief structure, the more difficult it is to change (Abelson, 1979; Clark, 1988; Munby, 1982; Nespor, 1987; Posner et.al., 1982); (g) individual beliefs affect behavior (Abelson, 1979; Brown & Cooney, 1992; Clark & Peterson, 1986; Eisenhart et al., 1988); and (h) beliefs about teaching are well established by the time students get to college (Buchmann, 1984; Clark & Peterson, 1986; Lortie, 1975; Nespor, 1987; Wilson, 1990).

Almost all educational researchers agree that beliefs are an important link to understanding how beliefs affect teachers' classroom instruction. Teacher educators are aware of the power of beliefs and the difficulty of changing well-established beliefs. Most prospective teachers have well-established beliefs before coming to college and many carry them into their own classrooms. Some beliefs are positive and some are negative and they all become a part of individual beliefs structure. Old beliefs are difficult to change unless they are proven unsatisfactory and this is the challenge for teacher educators if the old beliefs prove to be counterproductive to effective mathematics instruction.

Previous Experiences

Previous experiences of prospective teachers have not been studied as extensively as their knowledge and beliefs even though most prospective teachers are committed to teaching long before they enter college. Lortie (1975) identified the pre-college years as "apprenticeship of observation" because most prospective teachers come to teacher education with well-defined ideas about the role of teachers based on their prior experiences in the classroom. Several studies used multiple sources of data to study the affect of previous experiences on classroom practices. In some cases, pervious experiences were found to influence pedagogical development of pre-service teachers. Even though fewer studies have been done about prior experiences of pre-service teachers, most teacher educators have begun to understand and agree that they generate powerful feelings about teaching and learning mathematics (Holt-Reynolds, 1992). Most of their conceptions are linked, to some degree, with those prior experiences (Ball, 1988; Holt-Reynolds, 1992).

Commitment of prospective mathematics teachers to teaching are generally adopted prior to university courses and mathematics education courses (Ball, 1990a; 1990b; Borko, et al., 1992; Holt-Reynolds, 1992; Wilcox, et al. 1991). Overall, most students see little variation in their mathematics experiences, even when they have some courses that promote deeper mathematical understanding, they do not always practice this style of instruction in their own classrooms. Teachers who choose tasks that engage students in meaningful mathematics content play a critical role in the students' experience (Borko, et al., 1992).

In the past, textbook designers have made the decisions about content, sequence, and representation. They have provided the sequence of procedures, leaving the task of presenting the procedures and assigning practice to the teacher. If there are any gaps in the teachers' knowledge, they should refer to the textbook (Smith, 1996). Many teachers seem willing to defer to experts when making curricular decisions because they feel like they have to stick to the textbook (Prawat, 1992). They have a core set of beliefs about school mathematics and how teachers should teach it and how student learn. Some studies of prospective teachers' practices (Ball, 1990; Borko et al., 1992; Eisenhart et al., 1993; Wilson, 1994) provide support for this claim (smith, 1996).

Based on their prior experiences, most pre-service teachers begin their teacher education program thinking their role is to tell students what they need to know and then give them time to practice (McDiarmid, Ball, & Anderson, 1989). Prospective teachers also think that the best way to find out what their students' have learned is by asking them to replicate what they have been told (Feinman-Nemser, 1983). It is not surprising that prospective teachers hold these views about teaching and learning, because this style of instruction has dominated classrooms since the time of the common schools (Cuban, 1984; Jackson, 1986). In order to change this type of classroom practice, it is critical for prospective teachers to develop flexible understanding of subject matter and the ability to use a wide variety of representation to convey meaning to learners (McDiarmid, Ball, & Anderson, 1989).

Since the late 1970s more mathematics teacher education research has focused on the content knowledge of elementary teachers. The findings have caused some concern for teacher educators. Some of the research studies have left the impression that pre-service elementary teachers do not have the level of content knowledge necessary to teach the mathematics recommended by various educational professional organizations (e.g., NCTM) (Brown, Cooney, & Jones, 1990). For example, Wheeler and Feghali (1983) found that many elementary teachers had an inadequate concept of zero. Graeber, Tirosh, and Glover (1986) found that some pre-service elementary teachers were unable to select the operation necessary to solve some story problems. Fisher (1988) found that other elementary teachers did not fully understand the concept of inverse operations. Mayberry (1983) found that some pre-service elementary teachers did not have the geometric understanding to teach some elementary school geometry concepts even though more than 65% of the group studied high school geometry.

A study conducted by Ginther, Pigge, & Gibney (1987) compared the content knowledge of elementary teachers, who trained between 1967-1969 and 1983-1985. Thirty-one percent of the group who trained between 1983-1985 took four or more mathematics courses on high school and three or more college mathematics courses. Sixteen percent of the groups who trained between 1967-1969 took four or more mathematics courses in high school and only 4% took three or more college mathematics courses. Based on their finding, it was concluded that taking more mathematics courses alone does not necessarily mean an increase in knowledge nor does it address mathematics deficiencies that are sometimes associated with elementary mathematics teachers (Ginther, Pigge, & Gibney, 1987).

Another area of research on pre-service teachers experiences is the use of various teaching tools in mathematics classroom instruction. A study by Eastman and Barnett, (1979) found that a group of pre-service teachers using manipulatives did not perform any better on an assigned task than the group using pencil-paper tests. However, the study results did suggest there was an attitudinal difference between the groups; the group using manipulatives exhibited a more positive attitude about mathematics. Charles (1980) reported greater success in training a group of pre-service teachers to use specific techniques and manipulatives to teach certain geometry concepts. Another study with beginning elementary teachers using technology (Bitter1980), found that novice teachers were more comfortable using calculators when they became more familiar with their potential use in elementary school mathematics. These studies indicate that both pre-service teachers and beginning teachers tended to be more receptive to the use of teaching tools when they felt more comfortable with their own ability to be successful.

Galbraith (1984) studied the feelings of prospective elementary teachers enrolled in graduate mathematics education courses and undergraduates enrolled in first-year math courses. He found the more mathematics courses the students took, the less they liked it. More than 50%

of the prospective teachers surveyed had less than a "lukewarm" feeling about mathematics. However, the prospective teachers had more positive feelings about mathematics than the undergraduate students, but most of the prospective teachers viewed school mathematics as significantly different from college mathematics. Galbraith (1984) asked the important question: "If mathematics is not seen as a continuum…then for the teacher, which is the real mathematics?" (p.684). Quilter and Harper (1988) investigated the reasons given by a group of undergraduate college students for their difficulties, fears, and inability to do mathematics at more than a basic level. They found that 33% cited "instrumental learning" (p.125) as the reason for their negative feelings about mathematics. Theses studies illustrate some of the challenges that teacher educators are facing and the need for additional research about the prior experiences that prospective elementary teachers bring to teacher education programs.

A study by Powell (1992) examined the influence of prior experiences of pre-service teachers on their pedagogical development. Many pre-service teachers have well-established teacher role identity developed from many years of interacting with their own teachers (Lortie, 1975; Weinstein, 1989). Though ideas are under developed and uninformed, they serve as a filter for new information acquired during the teacher preparation process (Anderson, 1984; Buchmann & Schwille, 1983; Shulman, 1987).

Powell (1992) used a theoretical framework of personal construct theory [PCT] to examine the influence of prior experience of pre-service teachers. Sigel (1978) describes personal constructs as perspectives that pre-service teachers have acquired about teaching. These perspectives continue to develop from experiences with school environments. Powell (1992) examined the decisions pre-service teachers' make in an effort to determine if those decisions were based on prior experiences.

Powell (1992) explored the relationship between pre-service teachers' prior experience and classroom practice. He used multiple sources of data to increase the credibility of this relationship. Using multiple sources of data provides the triangulation necessary to address limitations when using only one source of data (Kagan, 1990). Concept maps, surveys, and stimulated recall interviews were used in this study. The interviews were audio taped and transcribed. The preliminary analysis compared school experiences, personal beliefs/value systems, and beliefs about students. Their non-classroom teaching experiences and content knowledge was also used as a means of looking for general trends of prior experience influence (Powell, 1992).

The pre-service teachers' responses to the interviews were found to be representative of their classroom teaching. They referred to former teachers as either a positive or negative role model. Some of them referred to college experiences and teacher education courses as an important influence for them, while other pre-service teachers' planning and teaching was influenced by their own learning styles. All of the pre-service teachers expressed specific beliefs about students, but did not appear to be able to transfer these beliefs to their classroom practice. However, the primary influence on all of the pre-service teachers was their content knowledge, many felt insecure about their level of both subject matter and pedagogical knowledge (Powell, 1992).

All of the participants in Powell's (1992) study held specific theories about teaching when they began their teacher education program and most of the theories were influenced by prior experiences. The knowledge they acquired from personal experiences also influenced their pedagogical knowledge and has value for them as future teachers.

The use of multiple sources of data has been used in other studies that explore how teachers think and to examine the knowledge that underlies their thinking (Borko et al, 1989; Calderhead, 1981).

Learning to teach is complex and requires an awareness of classroom routine, lesson structure, and subject matter knowledge (Leinhardt & Greeno, 1986). Powell's (1992) study suggests that teaching is grounded in prior experiences. Similar findings have been reported in the work of Lortie (1975), Ost (1989), and Weinstein, (1989).

Most of the studies found that prospective teachers have implicit theories about teaching when they begin their teacher preparation program and most of their theories are acquired through their own experiences and influence their pedagogical knowledge. So, it is valuable for teacher educators to know and understand those theories in order to understand why a teacher might choose or reject an instructional approach or certain teaching materials (Powell, 1992). It can also help to better understand particular or unique professional practices sometimes associated with beginning teachers (Mumby, 1984).

Most research on knowledge, beliefs, and previous experiences is overlapping, it is uncertain where one ends and the other begins. There is also no clear agreement on a definition of any of these constructs. Highly regarded educators conducted the research studies referenced in the literature review, yet they don't agree with what constitutes knowledge, beliefs, or prior experiences. However, they all agree they are important constructs and valuable for teacher educators.

Chapter 3: Research Methods

Participants

The 36 participants in this study, 35 females and one male, were pre-service elementary teachers from a major university with an enrollment of approximately 25,000 students and located in the Mid-Atlantic Region. They were recent graduates of a five-year licensure program. The participants all earned a Bachelor of Science degree in Family and Child Development at the end of the first semester of the fourth year of the program. They completed their graduate course work, a field experience, an internship, and student teaching during the final three semesters of the program. They graduated with a Masters Degree in Curriculum and Instruction and are certified to teach grades PK-6.These participants were representative of the population of pre-service elementary teachers at this university with an average age of 22 years at graduation. The average age was 21 years when the Praxis I Math test was taken and 22 years when the Beliefs Survey and PMEQ were administered. They were also 22 years when the interviews were conducted.

During the first three and one-half years of the program the prospective teachers had numerous opportunities to spend time in the University Lab School as well as several public elementary school placements. They observed experienced teachers in the classroom, interacted with students in small groups, and participated in one-on-one tutoring. They acted as aids to assist teachers in preparing instructional materials and assisted with classroom activities. The three final semesters of their program were spent in the public school classroom where they completed the requirements for their field experience, internship, and student teaching.

There was no sample selection bias because all of the participants were part of the same group of 40 students. Thirty-six of the 40 prospective teachers responded to the invitation to participate by completing and returning the following: Beliefs Survey (See Appendix A, pp.55-56), Previous Mathematics Experiences Questionnaire (PMEQ) (See Appendix B, pp. 57-59), and signed Informed Consent (See Appendix D, pp.61-63).

Instruments

Data collected from the Beliefs Survey and the PMEQ and scores from the Praxis I: Pre-Professional Skills Math Test was used for the study. The table below identifies the constructs investigated and the method of measurement used in the study.

Table 1.
Construct Measurement

Factor under investigation	Method of measurement
Mathematics content knowledge	Praxis I test
Beliefs about mathematics	Beliefs survey
Prior course experience	Experience questionnaire

Praxis I Test

Scores from the Praxis I test were used as a measure of mathematics, content knowledge, this test aligns with the six content areas identified by TIMSS, (USDOE, 1996), as critical for higher-level mathematics success. A total of 40 items was included on the Praxis I test.

Educational Testing Service calculated one numeric score for each student by converting the number of right answers to a scale score. The possible "scale scoring range is 150-190, a mean of 178, and Standard Error of Measurement 2.7" (The Praxis Professional Assessment for Beginning Teachers, 2000-01, p.21). "Scale scores range from 0 correct, converted to a scale score of 150, to 40 correct, converted to a scale score of 190", resulting in a "score interval of 1" (The Praxis Professional Assessment for Beginning Teachers, 2000-01, p. 21).

In a sample test, the item categories included "6 questions measuring conceptual knowledge, 12 questions measure procedural knowledge, 12 questions measure representations of quantitative information, 6 questions measure informal geometry and measurement, and 4 questions measure mathematical reasoning in a quantitative context. Questions in each category are considered easy, average, and difficult " (PPST, 2001, p.56). Different editions of the test are given at each sitting, so items on individual tests taken by participants in this study may have been slightly more or less difficult. It should also be noted, based on the types of questions included on the test, it is largely instrumental/procedural in structure.

The test scores (Praxis I Mathematics) were self reported by the participants and verified by the Licensure Coordinator at the University's Center for Teacher Education. Thirty-two of fifty states require passing scores on the Praxis I: Academic Skills Assessments, Pre-Professional Skills Test. Passing scores for the tests are set by the individual states and for the "mathematics test the range is169 to 178" (Praxis Series: Professional Assessments for Beginning Teachers, 2000-01, p. 8). The passing mathematics test score set by Virginia is 178. The Praxis I math test scores for participants in this study range from 178-190.

The reliability level for the Praxis I mathematics test is considered strong, and it is found to be consistent from one edition of the test to another. Statistical information was calculated from the records of students who took the test between 10/1/97 and 7/31/00; "75,102 records of the mathematics test were examined and the standard error of measurement was found to be 2.7 and the standard error of scoring was found to be 0" (Praxis Series: Professional Assessments for Beginning Teachers, 2000-01, p. 21). "The Praxis Series tests are intended to measure the knowledge, skills or abilities that groups of experts have determine to be necessary for a beginning teacher (Praxis Series: Professional Assessments for Beginning Teachers, 2000-01, p. 6). Some of those groups of experts include NCTM (1989, 2000), MAA 1991), and TIMSS (DOE, 1996).

Beliefs Survey

The Beliefs Survey was designed on a five-point value scale and used to examine the beliefs about mathematics held by prospective elementary teachers. The survey instrument was developed by Yackel (1984) to determine the expressed beliefs of college students at Purdue University about mathematics, and to measure how likely they are to favor rule following (instrumental understanding) versus reasoning (relational understanding). Yackel (1984) based the design of her instrument, Beliefs Survey, on the long-time research of Skemp (1976).

Skemp (1976) defines and compares mathematics beliefs expressed by "relational" learners to those beliefs expressed by "instrumental" learners. For the relational learner, mathematics involves more than memorizing and knowledge is constructed based on what has been previously learned. Problems are solved through the use of alternatives and not just reproducing an algorithm. Learners take responsibility for their own learning, not just getting the right answer. Instrumental learners believe mathematics is a system driven by rules and procedures that must be memorized, that rules and procedures can be plugged into problems and the "right answer" can be found (Carter & Yackel, 1989).

Yackel, (personal correspondence, October 16, 2001), stated that she developed the Beliefs Survey because she was interested in applying Skemp's (1976) "relational" versus" instrumental" beliefs about mathematics to undergraduate students in her own classroom. Each item on the survey is based on that distinction. It was developed directly from her own interactions with students and her attempts to differentiate between various types of beliefs that she had noted. She was sometimes surprised by the responses to items and how they contrasted with one another. Some of the responses "seemed" inconsistent, students might indicate that they believed that mathematics should make sense, but also believed that it is about rules and procedures. She believes that students who respond in this way really want math to make sense, but the use of rules and procedures is what "mathematics is to them" in their experience. She used the survey instrument primarily as a way to develop a better understanding of students who were enrolled in her undergraduate mathematics classes.

Yackel, (personal correspondence, October 16, 2001), stated that she had used the survey in a number of classes, but had never published anything regarding the reliability of the instrument. However, she used the survey with many different groups of students and found the results to be very similar between groups. These observations led her to conclude that the instrument did identify the beliefs stated by the prospective teachers. A Reliability Analysis was constructed for the data collected for this study to determine the strength of the Alpha.

Mathematics Experience Questionnaire

A 15-item, Previous Mathematics Experience Questionnaire [PMEQ] was developed to examine the prospective elementary teachers' prior experiences and was based on prior experiences as a classroom teacher, as a cooperating teacher for student interns, and as a University supervisor for pre-service, elementary teachers. The individual information categories included in the questionnaire are important for teacher educators to know and to understand in order to better prepare prospective teachers to become successful professionals. The questionnaire includes information about their prior K-8 classroom experiences; number of mathematics courses taken in high school, methods of instruction and assessment in high school; use of technology in high school; number of mathematics courses taken in college (undergraduate and graduate); methods of instructions and assessment in college; use of technology in college classes; and their self-reported Praxis I math test scores. One essay question was posed to all participants: *Compare past course experiences to the kind of math classroom that you wish to create as a future teacher*. Responses to this question are compared with the results of the experience questionnaire as well as interview responses (see Table 3, p. 24).

The PMEQ is divided into three categories: general feelings about mathematics following completion of 8th grade, high school, undergraduate school and graduate school and include PMEQ items 1, 6, 11, and 15; the category teaching tools includes instructional style (lecture, textbooks, discussion, discovery, inquiry, exploration, group work, projects, K-12 technology [calculators and computers], or manipulatives); assessment style (paper/pencil tests/quizzes, presentations, portfolios, writing activities, or projects); and use of technology (undergraduate and graduate courses) include PMEQ items 2, 4, 5, 8, 9, 10, 12, 13, and 14; and the number of mathematics courses taken in high school and college include PMEQ items 3 and 7.

The categories and specific questions were selected from similar topics included in studies by other educational researchers, from information learned through previous course-work in educational research, and from personal experiences as a classroom teacher. Most students either have positive or negative feelings about mathematics and they usually have opinions about the instructional style of teachers (e.g., great, my favorite class, boring, or I hate math). They also have definite ideas about assessment (e.g., tests too hard, don't remember going over this, why do I have to know this, I aced the test, or portfolios are cool, better than same old tests we usually have). Most students like to use new and different learning materials, it helps them to focus on what is being taught and they usually equate using teaching tools as fun and not "just learning math". No matter how old they are or what type of learner they are, most students tend to develop a better understanding of mathematics concepts when they use concrete models. The use of technology has become valuable as both a teaching tool and an assessment tool at all educational levels. The category, number of math courses taken, was included because of the commonly held myth that the more math courses a student takes the more knowledge he or she will acquire and the greater their level of achievement. However, no research was found to support this myth. The PMEQ expanded the overall study allowing more information to from all 36 prospective teachers and not just information from the four prospective teachers whose interviews are reported in the study. A copy of the PMEQ can be found in Appendix B p. 56.

Interviews

Selected interviews were conducted as a means of providing more detailed data and expand the understanding of the thinking that is in the minds of prospective teachers. The interviews also provided additional information that is a significant part of how and why teachers make certain choices that might alter professional practices.

Early qualitative works by Kelly (1970), Sigel (1978), Pope (1982) and later work by Munby (1984), Thompson (1984), Powell, (1992) have made valuable contributions to an extensive body of knowledge about qualitative research in teacher education. This is especially important in developing a better understanding of what prospective teachers bring with them to teacher education programs.

Interview data for this study were obtained from eight participants who were selected based on their Praxis I math test scores and scores on the Beliefs Survey. The participants were selected as follows: two participants with a high Praxis I math test score and relational beliefs score; two participants with a high Praxis I math test score and somewhat relational to somewhat instrumental beliefs score; two participants with a passing Praxis I math test score and relational beliefs score; and two participants with a passing Praxis I math test score and somewhat relational to somewhat instrumental beliefs score. The four interviews selected to report in the study were based on the best fit within the matrix of Praxis I test scores and average Beliefs Survey scores. Praxis I test scores ranged from 178 to 190 and the highest test scores fell within the range of 188-190 and the lowest test scores fell within the range of 178-180. The Beliefs Survey scores were determined by using the following scale: relational score 1-2, somewhat relational score 2-3, somewhat instrumental score 3-4, and instrumental score 4-5. The relational beliefs scores fell within the range of 1.7-1.75 and the somewhat relational/somewhat instrumental beliefs scores fell within the range of 2.53-3.29.

The following statements/questions guided the interviews:

(1) Describe your general feelings/beliefs about mathematics following your classroom experience as a teacher.
(2) Describe changes, if any, in your feelings/beliefs about mathematics during this period.
(3) What do you envision for your future mathematics classroom practice?
(4) Is there any relationship between your own experiences and your vision for teaching?

Table 2.
Interview Matrix

Beliefs Favored	High Praxis Score	Required Praxis Score
Likely to favor Relational Beliefs	(1) Paula (2) Sandy	(1) Leann (2) Rita
Likely to favor Instrumental Beliefs	(1) Jackie (2) Ellen	(1) Nicole (2) Martha

Procedure

Research packets were prepared and mailed to 40 prospective participants. The packet included a cover letter (see Appendix C, p. 60), inviting the prospective teachers to participate in the study. The following were included in the packet: an Informed Consent for Prospective Participants in Investigative Project (See Appendix D, pp. 61-63), Beliefs Survey (See Appendix A, pp. 55-56), and Mathematics Experience Questionnaire (See Appendix B, pp. 57-59). The participants were asked to return the completed beliefs survey, experience questionnaire, and the signed informed consent to the researcher as soon as possible.

After two weeks a reminder e-mail message was sent to non -respondents. A second reminder, a written Memo (see Appendix E, p. 64), was mailed two weeks later to remaining non-respondents. Two weeks later, a telephone call was made to the remaining non–respondents. Those who could not be contacted by telephone were automatically sent a duplicate research packet. Following the two previous contacts, five participants requested a second research packet be sent to them because the original had been misplaced during moving and relocation following graduation. A second packet was mailed to these five participants. Thirty-six of the 40 prospective participants returned their completed beliefs survey, experience questionnaire, and signed informed consent in about 12 weeks. Four prospective participants did not respond.

Upon receipt of the 36 participants' completed information, Praxis I math scores were entered into the data file. The beliefs survey scores were entered into the data file, the scores for item numbers 3, 8, 9, 13, and 19 were reversed because they were worded to measure positive relational beliefs and all other questions were worded to measure positive instrumental beliefs. It was necessary to have all questions/responses worded in the same direction. The scores for each of the 36 respondents to the 20 items were averaged and entered as a summed score under the new variable Beliefs Average. The scores were averaged in order to obtain a summed score for each participant on the Beliefs Survey; this was necessary to be able to examine the various relationships that are included in the study.

Twenty-three of the 36 respondents agreed to participate in an interview if selected. Thirteen of the 23 respondents had scores that placed them in one of the eight cells of the interview matrix. The scores from the Praxis I math test and the Beliefs Average were matched to identification numbers and then matched to a master list of participants. Once these were matched, the prospective interviewees were contacted by telephone. Two of the prospective teachers who were contacted were unable to participate in an interview, the remaining 11 agreed to participate if selected and eight participants were selected from that pool. Five of the prospective participants selected were living within a reasonable driving distance and a face-to-face interview was scheduled for the date, time, and location chosen by the participant. Three interviews were conducted by telephone and scheduled for the date and time chosen by the participants.

Design and Analysis

A correlational design was used in this study, as described by Ary, Jacobs, & Razavich (1996) in *Introduction to Research in Education.* Correlational design is concerned with determining if relationship(s) exist among variables, and if so, to what extent. This study investigated the relationships among the mathematics beliefs favored by prospective elementary mathematics teachers, mathematics content knowledge of prospective elementary mathematics teachers, and previous mathematics experiences of the prospective elementary mathematics teachers.

A non-experimental approach was used in this study and descriptive and associational questions were investigated. There were no active or manipulated independent variables. The following research questions were examined.

1. What mathematics beliefs are likely to be favored by prospective elementary teachers? A frequency distribution was constructed to determine the beliefs mean, standard deviation, the skewness, and kurtosis as well as a histogram to determine normal distribution.
2. What relationship, if any, exists between stated mathematics beliefs of prospective elementary teachers and content knowledge measured by their Praxis I Math Test scores? Pearson correlation was used to examine the relationship between Beliefs Survey scores and the Praxis I Math Test scores because the variables are approximately normally distributed and other assumptions are not violated.
3. What relationship, if any, exists between stated mathematics beliefs of prospective elementary teachers and previous mathematics experiences?
   Mathematics experiences were separated into three categories: feelings, teaching tools, and quantity of math courses taken. Responses to PMEQ items 1, 6, 11, and 13 were included in the feelings category; PMEQ items 2, 4, 5, 8, 9, 10, 12, 13, and 14 were

included in the teaching tools category; and PMEQ items 3 and 7 were included in the quantity of math courses taken category (see Appendix B, PMEQ pp. 56-58). Pearson correlation was used to examine the relationship between the variables beliefs average vs. feelings average, beliefs average vs. teaching tools average, and beliefs average vs. quantity of math courses taken because the variables are approximately normally distributed and other assumptions are not violated.

4. What relationship, if any, exists between Praxis I Math Test scores of prospective elementary teachers and previous mathematics experiences (feelings, teaching tools, and quantity of math courses taken)?
   Pearson correlation was used to examine the relationship between Praxis I Math Test scores vs. feelings average, Praxis I Math Test scores vs. teaching tools average, and Praxis I Math Test scores vs. quantity of math courses taken because the variables are approximately normally distributed and other assumptions are not violated.
5. What relationship, if any, exists among the three categories of Previous Mathematics Experiences (feelings, teaching tools, and quantity of math courses taken)?
   Pearson correlation was used to examine the variables feelings average vs. teaching tools average, feelings average vs. quantity of math courses taken average, and teaching tools average vs. quantity of math courses taken average because variables are approximately normally distributed and other assumptions are not violated.

Analysis of Interviews and Essays

The interviews were conducted over a period of eight weeks, each one was audio taped and lasted between 30 to 60 minutes. The face-to-face interviews lasted approximately 45-60 minutes each and the three telephone interviews lasted approximately 30 minutes each. The recorded interviews were transcribed, analyzed and compared to the summed responses to each PMEQ category and the essay question.

Four interviews were selected to report in this study because they were the best fit in each of the four cells of the Interview Matrix (Table 2, p.24). The interviews were transcribed and responses were placed into the following categories: beliefs, knowledge, and previous experiences and were reported in the Interpretation of Interviews section of the study. Responses by the four interviewees to the essay question included in the PMEQ Questionnaire were transcribed and reported in the Interpretation of PMEQ Essay Questions section of the study.

The following table was constructed to compare the interview responses and the essay responses.

Table 3.
Interview and Essay Responses

Name	Interview	Essay
Paula	*I think students should be able to use different strategies to solve problems. I believe that courses for elementary math teachers should use the same style of instructions and content they will use in their classrooms. Learning mathematics should depend on using just rules, rote memorization, procedures and formulas, or drill and practice.*	*Relational instructional style: I will use hands-on activities, partners and group collaboration. I will use lots of manipulatives and inquiry-based, problem-solving strategies. I value the teaching strategies and methods I have learned.*
Rita	*I believe it is important to create a classroom community that promotes positive feelings about mathematics. I also believe that students should have many opportunities to learn many problem-solving strategies. I believe that using many methods of instruction, not just direct instruction, will help students develop their own "Math Power".*	*Relational instructions style: Most of my elementary and high school experiences were negative. Teachers used direct instruction, memorization, and worksheets in most of my classes. I want to use discovery, cooperative learning, discussion, and hands-on activities in my classroom.*
Jackie	*I believe that all math classes for teachers should include beliefs and philosophy about teaching math. I also believe that learning math well is extremely important and it should be fun and exciting for kids, not intimidating. Teachers can help students become comfortable with math if they are comfortable themselves.*	*Relational instructions style: I wish to create a fun and exciting learning environment for my students. I will use many manipulatives, and hands-on activities will be incorporated into all of my instruction. I will use lots of visual aids for those students who need to see in order to understand.*
Martha	*I believe it is important for students to enjoy math and have fun while learning. I also believe that students should be able to discuss things they don't understand and not be scared or intimidated if they make a mistake when they don't understand. I believe that using manipulatives to connect problems reinforces what students are leaning. I believe it is important for students to use lots of hands-on. I know what I want to do in my own classroom and What I definitely don't want to do!*	*Relational instructional style: The classes I learned the most from used lots of hands-on activities. I will use small groups and discussion because the math classes I became the most frustrated in were those that were mainly lecture. I will make sure that my classes have lots of manipulatived, lots of hands-on activities, and lots of discussion. I want my students to enjoy math and have fun while learning.*

The following table was constructed to compare responses from the interviews and essays to Beliefs Survey average score in an effort to determine if there were any inconsistencies. The Beliefs Survey 5-point scale is as follows:
1-2 – relational, 2-3 – somewhat relational, 3-4 – somewhat instrumental, 4-5 - instrumental

Table 4.
Beliefs Construct Comparison

Name	Beliefs Survey (Scores)	Interview Responses	Essay Responses
Paula	1.71	Relational *	Relational *
Rita	1.75	Relational *	Relational *
Jackie	2.53	Relational *	Relational *
Martha	3.29	Relational *	Relational *

* See Table 3 for interpretation of responses

Using the information in Table 4, Paula and Rita's Beliefs Survey scores fall into the relational category (1-2), Jackie's Beliefs Survey score falls into the somewhat relational category (2-3), and Martha's Beliefs Survey score falls into the somewhat instrumental category (3-4). Paula, Rita, and Jackie's scores are either relational or somewhat relational which is a pretty good fit with their interview and essay responses. However, a discrepancy was found to exist between Martha's Beliefs Survey score and her interview and essay responses. She states very strong relational beliefs in her essay responses and her interview responses.

Chapter 4: Results

The purpose of this study was to investigate and determine if there is a relationship among mathematics content knowledge, beliefs held about mathematics, and previous mathematics experiences of prospective elementary teachers. The results of the investigation were determined from the statistical analysis and selected interviews using the methods described in Chapter 3, Procedure section of this document.

Interpretation of Statistical Data

Correlational Research

In correlational research, skewness is defined as a lack of symmetry in a frequency distribution. Distribution with a long "tail" to the right will have a positive skew and a long "tail" to the left will have a negative skew. Kurtosis is defined as the measure of whether the peak of the distribution is taller or shorter than the ideal normal curve and also whether the tails are higher or lower than the normal curve. Very peaked curves have a positive kurtosis. If a large (plus or minus) skewness and/or kurtosis are found to exist, relative to the standard error, it is said to deviates from normality. The skewness and kurtosis statistics were divided by their standard error, and in each category it was found to be approximately 2.5 or less, thereby, supporting the assumption of approximate normal distribution.

A two-tailed test was used for all correlations because it was not certain if positive or negative correlation would be found, particularly those involving the Beliefs Survey because of the direction in which the questions were written.

Frequency distribution/Content knowledge

To broaden the scope of understanding about the Praxis I Pre-Professional Skills Test: Mathematics and how it applies to this particular group, a frequency distribution and histogram was constructed.

The mean Praxis I score for the participants was 184.5 (above the national mean of 178), standard deviation = 3.65, skewness = -.135, standard error of skewness = .393, kurtosis = -.828, and the standard error of kurtosis = .768. The skewness or kurtosis was not significantly different from normal and the histogram appeared to be approximately normally distributed. The accepted rule of thumb is that if the skewness and/or kurtosis measure is no more than 2.5 times its standard error then a normal distribution may be assumed to exist.

Frequency distribution/Beliefs

A frequency distribution and a histogram was constructed for the Beliefs Survey, the mean score for the Beliefs Survey was 2.28, standard deviation = .567, skewness = .888, standard error of skewness = .393, kurtosis = -.114, and standard error of kurtosis = .768. Skewness or kurtosis was not significantly different from normal. The histogram was approximately normally distributed.

Reliability Analysis/Beliefs Survey

No measure of reliability analysis scale (Alpha) existed for the 20-item Beliefs Survey, so one was constructed to determine the internal consistency reliability of the instrument. The inter-item correlation for four items, 13, 15, 16, and 19 was found to be low and did not fit well into the scale psychometrically (see Appendix A, Beliefs Survey, pp. 55-56). These four items were deleted, leaving the Beliefs Survey a 16-item document. The Alpha for the revised 16-item document was 0.89. The strong alpha indicated strong reliability of the Beliefs Survey.

Relationship between beliefs and knowledge

To analyze the relationship between mathematics beliefs and content knowledge (Praxis I math test scores) of prospective elementary teachers, a correlation matrix was computed. The Pearson correlation coefficient or $r = -.21$; the statistical level of significance or $p = .219$ for a two-tailed test and the number of participants for both variables, $N = 36$, $r\ (34) = -.21$, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded that prospective elementary teachers with high Praxis I math test scores do not necessarily tend to favor more relational-oriented beliefs. The lack of correlation between knowledge and beliefs may be due to the type of instruments used to measure each construct. On the Beliefs Survey the prospective teachers were asked to respond to specific questions that might or might not have been interpreted as they were intended. The Praxis I Math test was a standardized test that could be completed successfully using instrumental learning.

Relationship between beliefs and mathematics experiences

To analyze the relationship between mathematics beliefs and the previous mathematics experiences of prospective elementary teachers, a correlation matrix was computed for each of the three experience categories.

Relationship between beliefs and feelings

The Pearson correlation coefficient for the categories mathematics beliefs vs. feelings or $r = -.189$; the statistical level of significance or $p = .271$ for a two-tailed test and the number of participants for both variables, $N = 36$, $r\ (34) = -.189$, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it is concluded there was no significant correlation between mathematics beliefs and feelings about mathematics held by prospective elementary teachers. Again, the lack of a significant correlation between mathematics beliefs and feelings about mathematics may be due to individual interpretation of the questions on each of the instruments.

Relationship between beliefs and teaching tools

The Pearson correlation coefficient for the categories mathematics beliefs vs. teaching tools or $r = -.348$; the statistical level of significance or $p = .037$ for a two-tailed test and the number of participants for both variables, $N = 36$, $r\ (34) = -.348$, $p < .05$. A significant negative correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was rejected and it was concluded that a significant negative correlation was found to exist between mathematics beliefs and the types and number of teaching tools used in classroom experiences of prospective elementary teachers. This result leads one to believe that when students have an opportunity to experience a variety of classroom instructional styles, use a variety of learning materials, experience a variety of assessment tools, and use technology as part of their instruction, they tend to favor relational beliefs about mathematics.

Relationship between beliefs and number of math courses taken

The Pearson correlation coefficient for the categories mathematics beliefs vs. number of math courses taken or $r = .201$; the statistical level of significance or $p = .339$ for a two-tailed test and the number of participants for both variables, $N = 36$, $r(34) = .201$, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded that no significant correlation was found to exist between mathematics beliefs and the number of math courses taken by prospective elementary teachers. This is not surprising, because no research was found to support the notion that taking more mathematics courses will change the beliefs of students about math. One reason might be that in most mathematics classrooms instructional style does not vary much from course to course, so students find little reason to change their beliefs.

Relationship between knowledge and experiences

To analyze the relationship between Praxis I math test scores and previous mathematics experiences of prospective elementary teachers, a correlation matrix was computed for each of the three experience categories.

Relationship between knowledge and feelings

The Pearson correlation coefficient for the categories Praxis I math test scores vs. feelings or $r = .367$; the statistical level of significance or $p = .028$ for a two-tailed test and the number of participants for both variables, $N = 36$, $r(34) = .367$, $p < .05$. A significant positive correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was rejected and it is concluded that a significant positive correlation was found to exist between Praxis I math test scores and feelings about mathematics expressed by prospective elementary teachers. Prospective elementary teachers who had high Praxis I math test scores tended to report more positive feelings about mathematics. However, it is not possible to say if the test score were responsible for the more positive feelings about mathematics or if the positive feelings about mathematics helped to elevate the test score.

Relationship between knowledge and teaching tools

The Pearson correlation coefficient for the categories two, Praxis I math test scores vs. teaching tools or $r = .114$; the statistical level of significance or $p = .509$ for a two-tailed test and the number of participants for both variables, $N = 36$, $r(34) = .114$, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded that no significant correlation was found to exist between Praxis I math test scores and teaching tools used in classroom experiences of prospective elementary teachers. It was expected that a relationship would be found to exist because test scores are usually associated with classroom experiences or the lack of, but in this case no relationship was found. This leads one to believe that perhaps by using another means of testing knowledge or prior experiences of prospective teachers might yield different results.

Relationship between knowledge and number of math courses

The Pearson correlation coefficient for the categories, Praxis I math test scores vs. number of math courses taken or $r = .218$; the statistical level of significance or $p = .201$ for a two-tailed test and the number of participants for both variables, $N = 36$, $\underline{r}(34) = .218$, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded there was no significant correlation found to exist between Praxis I math test scores and number of math courses taken by prospective elementary teachers. This is not unexpected because no studies were found that support the notion that taking more math courses necessarily elevates knowledge or achievement.

Frequency distribution of three experience categories

A frequency distribution and histogram was constructed for each of the three experience categories.

Frequency distribution/feelings

The mean was 2.5 for feelings average, the standard deviation = .513, skewness = -.997, standard error of skewness = -.393, kurtosis = 1.424, and the standard error kurtosis = .768. The histogram appeared to be approximately normally distributed.

Frequency distribution/teaching tools

The mean was 1.49 for teaching tools average, the standard deviation = .143, skewness = .174, standard error of skewness = .393, kurtosis = -.448, and the standard error of kurtosis = .768. The histogram appeared to be approximately normally distributed.

Frequency distribution/# of math courses

The mean was 2.3 for number of math courses taken average, the standard deviation = .296, skewness = .294, standard error of skewness = .393, kurtosis = -.617, and the standard error of kurtosis = .768. The histogram appeared to be approximately normally distributed.

Relationship among three experience categories

To analyze the relationship among the three experience categories of the prospective elementary teachers, a correlation matrix was computed.

Relationship between feelings and teaching tools

The Pearson correlation coefficient for the categories, feelings vs. teaching tools or r = .244; the statistical level of significance or p = .152 for a two-tailed test and the number of participants for both variables, N = 36, r (34)= .244, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded there was no significant correlation between feelings about mathematics and teaching tools used in the classroom experiences of prospective elementary teachers. Based on responses to the essay question and the interviews, it was expected that a correlation would be found because the prospective teachers expressed the importance of positive feelings about learning mathematics and the impact of many of their own experiences in pre-college classes and some college courses.

Relationship between feelings and number of math courses

The Pearson correlation coefficient for the categories, feelings vs. number of math courses taken or r = .246; the statistical level of significance or p = .148 for a two-tailed test and the number of participants for both variables, N = 36, r (34)= .246, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded that no significant correlation existed between feelings about mathematics and the number of math courses taken by prospective elementary teachers. This was the expected result for this category because there was very little support in the literature about relationships between feelings and number of math courses taken. One study found that some students liked math less after taking several classes. However, most of the literature supports the notion that the number of math courses one takes has little impact on achievement.

Relationship between teaching tools and number of math courses

The Pearson correlation coefficient for the categories, teaching tools vs. number of math courses taken or $r = -.200$, the statistical level of significance or $p = .241$ for a two-tailed test and the number of participants for both variables, $N = 36$, r (34)= -.200, $p > .05$. No significant correlation was found to exist at the alpha level .05 using a two-tailed test. The null hypothesis was retained and it was concluded there was no significant correlation between teaching tools and number of math courses taken by prospective elementary teachers.

Summary of statistical findings

In spite of the original hypothesis that a correlation was expected to exist among the three constructs being investigated, beliefs, knowledge, and prior experiences, only two significant correlations were found to exist at the alpha level .05. A significant positive correlation of .028 was found to exist between knowledge (Praxis I test scores) and feelings (previous experiences). A significant negative correlation of .037 was found to exist between beliefs and teaching tools (prior experiences).

Interpretation of PMEQ essay question

The PMEQ Essay item asked the respondents to choose either Relational or Instrumental to describe the type of mathematics learning environment they wished to create for students in your own classroom. All 36 prospective elementary teachers overwhelmingly chose Relational and they went on to explain that they wanted their students to understand what they were doing and not just depend on rules, procedures, and memorization. They wanted their students to feel comfortable with mathematics, develop the ability to use a variety of problem solving strategies, develop the ability to solve problems through the use of manipulatives and representation, and to take responsibility for their own learning. Examples of essay responses from the four participants whose interviews are reported in the study are:

Paula:

I want my classes to be similar to my undergraduate courses taught by Professor G. I want my children to be able to connect their prior knowledge to new content and ideas. I will use hands-on methods whenever possible and appropriate to help my students visualize the concepts. I want to use what I have learned about using partners and group collaboration in my classes with Professor G and Professor J. I will also use lots of manipulatives and inquiry based problem solving. I value all of the teaching strategies and methods that I have learned and I will use them in my classroom.

Rita:

Most of my mathematics experiences in elementary and high school were negative; my teachers used direct instruction, memorization of facts, and worksheets. The focus was always to get the right answer. I do not remember learning very many problem-solving strategies, the *activities we did do were not very meaningful to me. I want to create a classroom community that promotes positive feelings about mathematics. I want to use discovery, cooperative learning, discussion, and hands-on activities in my classroom. I want my student to learn many problem-solving strategies. I want them to understand that making a mistake can be a great learning experience and not the end of the world. I want to integrate math with other subject area making learning more meaningful for my students. I believe that using this type of instruction will help students develop their own "Math Power".*

Jackie:

I feel that many of my math courses have coincided with my beliefs and philosophy about teaching math. I wish to create a fun and exciting learning atmosphere for my students. I will use many manipulatives, and hands-on activities will be incorporated into all of my instruction. I will use lots of visual aids for those students who need to see something in order to understand it. My students will learn many problem-solving strategies because word problems will be a part of all of my instruction.

Martha:

The math classes that I enjoyed and learned the most from used a lot of hands-on activities. I learn better when I can physically see the math problem modeled with manipulatives. I will use small groups and discussion because the math classes that I became most frustrated in were the ones that were mainly lecture. I would sit and listen and have no idea what he or she was talking about. The worst part would be when they gave an assignment that I had no idea how to do. I will make sure that my classes have lots of manipulatives, lots of hands-on activities, and lots of discussion. I want my student to enjoy math and have fun while learning.

Summary of Essays

Most of the responses reported were similar. The prospective teachers' previous experiences were primarily instrumental in nature and they did not find this type of instruction either productive or enjoyable. They all expressed a desire to provide a more Relational learning-environment for students in their own future classrooms. Essay responses from four of the prospective elementary teachers were reported in the study, three of the responses were a good fit with their Beliefs Survey scores. However, one of the prospective elementary teachers response to the essay question was not a good fit with her score on the Beliefs Survey (see Table 4. p.28).

Interpretation of Interviews

The eight prospective elementary teachers who participated in the interviews were representative of the group. Their Praxis I Math Test scores ranged from 178-190, Beliefs about mathematics scores ranged from strong Relational Beliefs to somewhat weak Relational Beliefs. Their feelings about mathematics, based on their previous experiences, ranged from negative to positive. Their classroom experiences (teaching tools category) that included instructional style, type of assessment, type of teaching tools used, and use of technology ranged from somewhat Relational to strongly Instrumental (Skemp 1976). The number of math courses taken in high school, undergraduate courses, and graduate courses ranged from two required courses to more than four (including some AP courses) in high school; four courses in undergraduate school, two of which were core mathematics courses and two were math education courses (one prospective teacher took five undergraduate courses); and all participants took one math methods course (only one offered/required) in graduate school.

When participant's Praxis I Math Test scores, Beliefs Survey scores, and Previous Mathematics Experience Questionnaire responses were compared to their interview responses, some relationships were found, however, there were also some inconsistencies. Responses from the all four reported interviews indicated the prospective teachers expected to create a strong relational learning environment for their students while their scores on the Beliefs Survey ranged from 1.71, relational to 3.29, somewhat instrumental. The findings suggest there were some inconsistencies between the beliefs of these four teachers and their beliefs about the learning environment they wish to provide for their students. The mean beliefs average for the four teachers was 2.32, just slightly above the average for the whole group, 2.28. Both groups fell into the somewhat relational category.

The four prospective teachers who participated in the interviews reported that their pre-college experiences were strongly instrumental and some of their undergraduate, course experiences were some-what instrumental. Some of their undergraduate course experiences were strongly relational and all of their graduate course experiences were strongly relational. Their mean Praxis I Math Test score was 184.125, just under the group mean of 184.5, but still well above the national mean of 178. In the case of these four students, whose pre-college experiences were primarily instrumental, they were not disadvantaged when taking the Praxis I Pre-Professional Skills Test: Mathematics. The test is a standardized test that is largely instrumental/procedural.

Responses from the interviews were placed in the following construct categories: knowledge, beliefs, and previous experiences.

Knowledge

All of the prospective teachers who were interviewed agreed that content knowledge was one, if not the most, important factor necessary in teach effective effectively.

Paula's Praxis I score was very high and she indicated that math was always easy for her.
I remember most of my elementary math classes were easy for me. I could always figure out how to solve problems that were new or different. My goal is to help my children connect their prior knowledge to new math content and ideas. Knowing why a problem is solved a certain way is important to understanding. If a teacher doesn't know/understand the concept then the children are not going to learn it.

Rita's Praxis I score was not as high, but it did not seem to be a factor in her ideas about the importance for a prospective teacher to have strong knowledge of math concepts. She states:
Before coming to college, my math experiences were very negative. My classes were all direct instruction, memorization, drill and practice. I never remember any of my teachers ever using the investigative/inquiry approach of teaching. I believe this is one reason I did not understand math concepts. Since coming to college my confidence and my content knowledge has improved.

Jackie's Praxis I math test score was very high and she had very definite ideas about what prospective teachers need to know about teaching mathematics. She shared the following:

Students need to have a lot of opportunities to learn and understand math. I will use a lot of visual aids to help students who need to see mathematics in order to understand it. One of the most important things a teacher must have is knowledge of the math concepts they will be teaching. College classes should focus on the concepts that we will be teaching in elementary school. Students learn math by doing what is relevant and meaningful. Strong content knowledge helped me to learn to use hand-on instruction when I was student teaching.

Martha said that she struggled with math throughout her pre-college experience and in her college core mathematics classes. She shares the following thoughts:

My classes were mainly lecture and I was always frustrated because I would sit and listen and have no understanding about what we were supposed to do. It is important to learn mathematics well in the early grades. If you have some basic knowledge you can build on, it makes learning easier. Knowledge of math concepts is one of the most important things you need to be a good teacher.

Beliefs

Paula's Beliefs Survey score indicated that her beliefs were somewhat relational, however responses about her beliefs in her interview were strongly relational. The following are some examples of her beliefs that she shared in her interview:

I think a student should be able to use different strategies to solve problems. I believe that when a student can explain their strategy and get the correct end result, it strengthens their concept of math and how it works. I believe that courses for math teachers should follow the same style of instruction and concepts they will be teaching. I do not believe that learning mathematics should depend on using just rules, rote memorization, procedures and formulas, or drill and practice.

Rita expressed strong beliefs about how to improve students' learning. The following was shared in her interview:

I believe it is important to create a classroom community that promotes positive feelings about mathematics. I also believe that students should have many opportunities to learn many problem-solving strategies. I believe that using many methods of instruction, not just direct instruction, will help students' develop their own 'Math Power'.

Jackie was very excited about teaching math because of her own love of the subject and she wanted to share that love with her students. Following are some examples of her beliefs:

I believe that math classes for prospective teachers should include beliefs and philosophy about teaching math. I also believe that learning math well is extremely important and it should be fun and exciting for kids, not intimidating. Teachers can help students become comfortable with math if they are comfortable themselves. I believe that kindness and understanding from one teacher can make a difference, especially in a subject like math.

In her interview, Martha said that math had always been a problem for her after her early primary grades. She always struggled just to keep up and never really liked math after those early years. She has strong beliefs about how she wants to teach math.

I believe it is important for students to enjoy math and have fun while learning. I also believe students should be able to discuss things they don't understand and not be scared or intimidated if they make a mistake when they don't understand what is being taught. I believe that using manipulatives to connect problems on the board or in the book reinforces what students are learning. I believe it is important for students to use a lot of hands-on. I know what I want to do in my own classroom and what I definitely don't want to do.

The essay responses reinforced the belief that all of the prospective teachers understand the need to provide a relational oriented learning-environment for elementary students. They all expressed a desire to have a classroom that reflected the same kind of learning environment they experienced in Professor G and Professor J's courses.

Previous Experiences

The area that the prospective teachers were most passionate about was their previous mathematics experiences, both in pre-college and in college. They expressed very definite ideas about how past negative experiences shaped their beliefs and feelings about mathematics and how positive experiences changed many of those beliefs and feelings. They also shared their thoughts about how teachers have the power to impact how their students feel about subject matter.

All of the prospective teachers reported previous experiences in pre-college math classes as negative or somewhat negative. However, most of them reported positive experiences in their undergraduate mathematics courses and they all reported positive experiences in their graduate mathematics courses. They credited the change in their feelings about mathematics to two college professors, one from their undergraduate courses and one from their graduate courses.

According to their interview responses, the teaching style of the two professors met the following recommendations of MAA (1991): (a) Their students were active participants not just passive recipients of information, (b) recognized the relationship between what should be taught at different levels, (c) were able to communicate ideas easily and clearly, (d) provided many experiences using models, (e) used technology to represent ideas and construct representation, (f) developed perspective of mathematical ideas and their significant role in society, (g) provided many opportunities to explore basic concepts and use physical and visual models, (h) they had a substantial background in both mathematics and mathematics education, (i) they had a strong interest and expertise in school teaching, (j) they maintained regular contact with public school faculty, (k) they understood the need for qualified mathematics teachers, (l) they provided a learning environment that was comparable to the one where the prospective elementary teachers would be teaching (MAA, 1991).

Their own classroom experiences with Professor G and Professor J impacted not only their behavior as student teachers, but also their feelings and beliefs about teaching and learning mathematics. One pre-service teacher, Paula, described the following,

> *Paula: I want my own classroom to be similar to my math courses that were taught by Professor G and Professor J. I want to use partners and collaborative groups, scaffolding, and lots of hands-on. I want to use the ideas and things I experienced in Professor G and Professor J's classes.*

I remember thinking at the beginning of my Junior year, 'What great professors I have, they are creative and great communicators' and I realized, of course they are great, they are teachers.

This is only one example of the passion the teachers' expressed about their classroom experiences in the two undergraduate courses and the graduate course taught by Professor G and Professor J.

Rita expressed some concern about not having the level of self-confidence she thought was necessary to be a successful elementary math teacher. Rita said that her pre-college experiences did not provide the experiences or support she needed to be successful in mathematics. She shared the following:

Rita: Most of my elementary and high school experiences were negative. My teachers used direct instruction, memorization of facts, and worksheets, the focus was to get the right answer. I was always apprehensive and nervous, I felt stupid because I could not seem to understand it.

I came to college scared of math and feeling inadequate, but I am leaving college able to teach it. When I got to my math education courses, I was in Professor G's classes and Professor J's class for my math methods course. I enjoyed math more and was able to understand the importance of using the investigative approach to teaching instead of direct instruction.

The change in Rita's feelings about mathematics was obvious as well as the reasons for the change. This is another good example of how a teacher can promote success or failure. Rita left the program with many new ideas and teaching strategies as well as the confidence to implement them into her own classroom.

Jackie made very good grades in math and if she had difficulty solving a problem, she could usually figure out what to do to get the right answer. She thought she "understood" math because she could always get the answer. She said that she was surprised when she realized that she really did not understand what she was doing, only following rules or procedures she had learned in her pre-college classes. Some of her thoughts about her transition are:

Jackie: In elementary school I remember a lot of drill and practice. We had a lot of worksheets and tests, but few opportunities to ask questions or share our work. I was always strong in math, so I could usually figure out the answers. I guess I never really understood math until I was in Professor G's class and then Professor J's class. I used their teaching strategies when I went into the classroom to do my student teaching. When I was in Professor J's class I was introduced to integrating literature into math classes. He would bring books into our class and set up centers using different concepts and we would choose the book to use to introduce that concept. It was fun and I learned another teaching method that made learning interesting and fun. The 'moments' I experienced in Professor G and Professor J' s classes impacted me as a learner. I want to learn to create those same kinds of 'moments' for my own students.

Jackie has all of the qualities to be a competent and successful teacher. Her students will benefit not only from her strong mathematics content knowledge, but her own experiences in her classes with Professor G and Professor J. She will replicate all of those "moments" she experienced in her own classroom for her students.

Martha's experiences are a good example of what happens to far too many students in our schools. She began her math learning experience with so much interest and enthusiasm it seemed impossible that she would soon begin to hate math. Her teachers were wonderful in the primary grades, she was having fun with all the math activities, and she was learning to "do" mathematics. So, how did this happen? Martha shared her all too familiar experiences in the interview.

Martha: I loved math in primary school, the teachers used a lot of different activities and teaching materials and made math fun. That changed when I got to sixth grade, it began to be all lecture. There was no discussion and we only used textbooks and worksheets. I began to loose interest in math because I just couldn't understand what we were doing in class. By the time I got to high school, I was so intimidated by math that I hated going to class. They always told us they were preparing us for college and this really scared me.

In college, my first two classes were just what I expected, lecture in the classroom about once a week and the rest of the time we spent at the Math Emporium doing homework practice problems on the computer. The teacher did not really know our names and I did not feel comfortable asking questions about things I did not understand. Needless to say, I did not do very well in those two classes.

When I began my math education classes, I was able to register for Professor G's class (some of my friends told me she was great and to try to get in her class). This experience was so different, she made me feel comfortable, she was interested in us, and she wanted us to succeed. I gained confidence in my ability and I learned to use a lot of different manipulatives. These classes reminded me of my experiences in primary school.

I had similar experiences in Professor J's class, he taught us how to use a lot of different teaching strategies and materials. He used children's book to teach math concepts. I love books and this is something I want to do in my own classes.

Because of the experiences I had in Professor G and Professor J's classes, I feel good about going into my own classroom and about teaching math. I know that I never want my kids to be intimidated or scared of math.

Other pre-service teachers shared similar experiences from their early grades, but once they reached the middle grades and high school they began having difficulties. The instruction became more structured and rigid and they had few opportunities to explore and share their understanding of mathematics. This is not the kind of classrooms they want to create for their own students. Martha expressed her feelings about her memories of her primary grade experiences and how she felt that same comfort level when she was in Professor G's math education classes and her mathematics methods course taught by Professor J. The pre-service teachers shared their feelings numerous times about the changes they experienced in their feelings and beliefs about mathematics because of two professors.

Summary of Interviews

The four interviews reported in the study reflect the overall findings in the Beliefs Survey and PMEQ. The content knowledge of the prospective teachers, as measured by the Praxis I Math test scores, were above the national average. Two of the teachers had very high scores and two had somewhat lower scores, but still above the national average.

Responses to interview questions by two of the prospective elementary teachers were a good fit with their interview responses indicating favoring relational learning style. There were some discrepancies between the results of the Beliefs Survey score and the responses given in the interview of two of the prospective elementary teachers. The Beliefs Survey score of the third teacher indicated favoring somewhat relational beliefs, which was not a bad fit with the interview responses favoring a relational learning style. But, there was a wider margin of discrepancy found between the Beliefs Survey score and the interview responses of the fourth teacher. The Beliefs Survey score indicated favoring somewhat instrumental beliefs while her stated beliefs in the interview responses indicated favoring relational learning style. It is possible that they were influenced by earlier instrumental experiences, but expressed a desire to provide a relational learning environment for their own students.

They reported having negative to somewhat negative experiences in elementary and high school, some negative experiences and some positive experiences in their college core mathematics courses. All of the teachers reported having very positive experiences in their math education courses. Their responses were similar in both the PMEQ and in their interviews

Chapter 5: Discussion

The hypothesis for this study, involving 36 prospective elementary teachers, was that a relationship was expected to exist between Praxis I Math Test scores (content knowledge) and Beliefs Survey scores; between the Praxis I Math Test scores and the three Previous Mathematics Experience categories (feelings, teaching tools, and number of math courses taken); and Beliefs Survey scores and the three Previous Mathematics Experience categories (feelings, teaching tools, and number of math courses taken). However, when all of the statistical analysis was completed, it was found that only two relationships existed. A significant relationship was found to exist between the Praxis I Math Test scores (knowledge) and feelings about mathematics. The second, significant relationship was found to exist between the Beliefs Survey scores and the types of teaching tools used in classroom instruction (instructional style, assessment, use of manipulatives, and use of technology).

The results may not surprise most educators, based on findings in *Everybody Counts: A Report to the Nation on Mathematics Education* (NRC, 1989). The report stated, "Evidence from many sources shows the least effective mode of mathematics learning is the one that prevails in most of America's classrooms; lecturing and listening" (p.57). Students do not retain what they learn in this type of passive learning environment, it is ineffective for long-term learning (NRC, 1989).

The repetition in a passive, pre-college learning environment was reported by most of the participants involved in this study and this may account for the high mean on the Praxis I Math Test scores (overall, 7.5 points above the national mean). The ability to score well on standardized tests that are largely instrumental/procedural may in some cases have influenced the participant's feelings about mathematics and the relationship that was found to exist between their Praxis I Math Test scores and feelings about mathematics.

In the TIMSS (USDOE, 1996), it was reported that learning is closely related to what students are taught. The participants in this study attended school in a number of different school divisions in several different states, so it is possible that the participant's feelings about mathematics were influenced by a variety of factors, including actions and choices in instructional style of teachers, use of textbooks, use of technology, use of different teaching tools, as well as local school division instructional policy.

Ball (1990) found in her research that the previous mathematics experiences of many elementary teacher candidates primarily weak and rule-bound. Most of the students understand mathematics well enough to do well on standardized tests, but do not possess the kind of mathematics understanding to teach it effectively or to help students learn. This seems to fit the responses from the participants in this study.

The relationship found to exist between Beliefs Survey scores and teaching tools used in the classroom could have been influenced by previous classroom experiences. Their responses about their experiences in mathematics education courses and the teaching style of both Professor G and Professor J. might have influenced the feelings and beliefs of the prospective teachers. Their choice of teaching materials, the ability to communicate effectively, the use of technology in the classroom, knowledge of both mathematics and mathematics education, interest and expertise in school teaching, and the learning environment in their classrooms undoubtedly contributed to the prospective teachers' positive experience.

According to the responses of the participants to the PMEQ essay question and in the interviews, their beliefs and feelings about mathematics changed if they were in Professor G's undergraduate classes and they all reported changes in their beliefs and feelings following their mathematics methods course taught by Professor J.

The data collected in this study indicates that all students need a strong foundation in basic, mathematics concepts during their elementary years. Therefore, it is important for all prospective elementary teachers to have a firm grasp of the content they are expected to teach their students. Teachers' teach what they are comfortable with and the more they know about the content and how to teach it, the more comfortable they will be with their instruction.

Prospective teachers are in a unique position of being both a student and a teacher; they are college students, but they become increasingly more involved in teaching through their field experiences and student teaching. One factor that contributes to different interpretations of mathematical content is a teacher's beliefs. The beliefs of the teacher, both productive and counterproductive, can influence students through direct instruction and through instructional decisions (Thompson, 1984). Counterproductive beliefs held by a teacher can also affect the students' mathematics learning. Teachers can have a strong influence on the beliefs of their students and a teacher's actions and choices send a powerful message about what is important. If a teacher's beliefs about mathematics are at the instrumental end of the continuum, students will most likely spend a majority of their mathematics time on rote skills. This is one reason many students' view of mathematics as memorization of rules and facts that can be recalled when needed (Schram, Wilcox, Lanier, & Lappan, 1988). However, if the teacher's beliefs about mathematics are at the relational end of the continuum, then students will spend most of their mathematics time on problem solving, developing thinking skills, discovering, learning, and constructing mathematics (Schram, Wilcox, Lanier, & Lappen, 1988).

The participants' level of mathematics content knowledge, based on the Praxis I math test scores, was found to be above the national mean and their beliefs, based on the results of the beliefs survey, tended to favor a somewhat Relational learning style. A Relational learning style is a belief that mathematics involves knowledge that is constructed on what has been previously learned, problems are solved by developing the ability to use alternatives, and not just by reproducing an algorithm. Learners take responsibility for their own learning and understanding.

A significant correlation was found to exist between beliefs about mathematics and the teaching tools used in the classroom (manipulatives, technology, assessment, and instructional style). If students have numerous opportunities to experience using representation, current technology tools, a relational style of instruction, and a variety of assessment methods it would be expected their beliefs would favor a relational learning style. This result is somewhat surprising when most of the prospective teachers' classroom experiences in K-12 tended to follow a more instrumental instructional style. Several participants also reported that some undergraduate math courses also followed an instrumental instructional style. The prospective elementary teachers who were enrolled in Professor G's undergraduate math courses experienced a strong relational learning environment that provided opportunities to develop their mathematics understanding. All of the prospective elementary teachers were enrolled in Professor J's graduate mathematics methods courses and according to the data they all had the opportunity to appreciate the importance of strong content knowledge and the opportunity to begin to develop the pedagogical content skills to share that knowledge with students. The results of the correlation between beliefs and experiences/teaching tools and the individual participant responses in their essay tend to support the notion that teachers believe they have the power to shape the beliefs of their students through their instructional decisions and choices.

A significant correlation was found to exist between Praxis I math test scores and feelings about mathematics. When content knowledge (Praxis I math test scores) and feelings about mathematics (PMEQ scores) of the prospective teachers were compared it was found that their K-12 feelings ranged from somewhat negative to positive. The same range of feelings carried over to undergraduate courses, however the feelings about mathematics of the participants enrolled in Professor G's undergraduate math courses changed from negative to positive. The response from all the participants was positive for their graduate methods courses with Professor J. The results of this study support the notion that a teacher has the power to not only teach content, but to influence the feelings of their students in a positive way.

The lack of a significant correlation in several of the categories tested seems to indicate there might be other factors, not controlled totally within classroom practice, that influence a learning environment. One can only say that each prospective elementary teacher, like the students in their classrooms, is unique and it is not easy to predict what works and why it works for some and not for everyone.

The above average scores of the prospective teachers on the Praxis I Math test opens the possibility that some memorization may be necessary to meet certain objectives such as scoring well on high stakes standardized tests that are largely instrumental/procedural in nature.

The relationship that was found to exist between beliefs and teaching tools tends to reflect earlier research findings about the power of a teacher to influence the beliefs of students, both productive and counter-productive through classroom practices. There are numerous studies related to the impact of early classroom experiences, this study only reinforces and expands the importance of a teacher's power to influence students' feelings and beliefs about mathematics.

It is concluded that we know a lot about what makes a good teacher, but we also need to know more. We have the ability to change some of the misconceptions, beliefs, and underdeveloped knowledge (both content and pedagogy) that prospective teachers bring with them to teacher education programs. We have the opportunity to bring about reform that continues to be recommended for mathematics instruction in our schools.

Limitations

One limitation of this study was no observation data were collected when the students were in the classroom during their field experience and student teaching assignments. This would have been an opportunity to expand this study to include some data about their pedagogical content knowledge and if any changes occurred as the result of their experience in the classroom. Further studies of these constructs seem to be called for and a follow-up study that would extend through the first year of their teaching assignment.

Another limitation of the study involves the interviews, three of the prospective teachers were well acquainted with the interviewer and may have responded in ways that they thought were expected. The interviewer also observed the participants numerous times in the classroom and had contact with them at frequent seminars.

No link was found between content knowledge and relational beliefs and this could be due to the fact that content knowledge was measured by Praxis I test scores and the Praxis I is a test of instrumental understanding, not relational understanding. Different results may have been found if a different method had been used to measure content knowledge.

The results might have been entirely different with a different program or with a different group of prospective teachers who had had no previous contact with anyone connected to the study.

Conclusions

The prospective elementary teachers who participated in this study provided an opportunity for me to look at the knowledge, beliefs, and previous experiences of a group of prospective teachers who were selected to participate in the first five-year teacher licensure program offered at the University. The selection of these teachers to become a part of the first cohort was based on high performance prior to college and the enrollment was limited to 50 students with the best performance records. This group may or may not be representative of elementary teacher candidates at other institutions, I suspect a wider range of ability and achievement would be found in the general population. It was, however, representative of the prospective elementary teachers at this University, because it was the only program for elementary teachers offered.

I believe the implications for the findings from this study can benefit other programs, for example, the descriptions in the interviews of the learning environment in Professor G's two undergraduate math courses could serve as a model for other undergraduate courses. I believe strong consideration should be given to the recommendations, made by the prospective elementary teachers, regarding the design and implementation of all mathematics courses for elementary teachers. They recommended that the courses be structured to better reflect the content and pedagogy they are expected to use in their own classrooms.

I believe this study only scratches the surface of the relationships among prospective elementary teachers' knowledge, beliefs, and previous experiences. I believe that more research is needed on all three constructs investigated in this study, especially the beliefs of prospective elementary teachers. Most of the literature reviewed in this study supported the notion that beliefs do affect the classroom practices and decisions teachers make. Average Beliefs Survey scores for the 36 participants were found to be relational (2.28), but when scores for the four prospective elementary teachers that were reported in the study were compared to their responses to the essay question and interview questions, some individual discrepancies were found. There is a possibility that the questions included in the survey may not have been interpreted as intended by these individuals. The overall beliefs scores do tend to reflect the recommendations by professional organizations, but this is a unique group of prospective elementary teachers and this may not be the finding for all prospective elementary teachers. Because of the lack of availability of other studies about the relationship among theses three constructs, I would recommend a similar study of the beliefs, knowledge, and previous experiences of other prospective elementary teacher who are not part of a cohort to compare with the results of this study. Based on the numerous studies that have been published on each individual construct, it is obvious they are an important part of what teaching is about. The current challenges for teacher education programs and beginning teachers have never been greater and it is critical that we continue to study all of these important constructs in an effort to continue to provide the best educational opportunity for prospective elementary teachers possible.

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Appendices

Appendix A

Mathematical Beliefs Survey

SURVEY #________________________

Date______________________________

All individual responses on this survey will be kept strictly confidential. Your responses will be used to study the relationships between beliefs held by students about mathematics, mathematics content knowledge, and certain other variables such as previous mathematics experiences.

For each item, circle the response that indicates how you feel about the item as indicated below.

Strongly Diagree	Disagree	Undecided	Agree	Strongly Agree
SD	D	U	A	SA

Part I

1. Doing mathematics consists mainly of using rules. SD D U A SA

2. Learning mathematics mainly involves memorizing procedures and formulas. SD D U A SA

3. Mathematics involves relating many different ideas. SD D U A SA

4. Getting the right answer is the most important part of mathematics. SD D U A SA

5. In mathematics it is impossible to do a problem unless you've first been taught how to do one like it. SD D U A SA

6. One reason learning mathematics is so much work is that you need to learn a different method for each new class of problems. SD D U A SA

7. Getting good grades in mathematics is more of a motivation than is the satisfaction of learning the mathematics content. SD D U A SA

8. When I learn something new in mathematics I often continue exploring and developing it on my own. SD D U A SA

9. I usually try to understand the reasoning behind all of the rules I use in mathematics. SD D U A SA

10. Being able to successfully use a rule or formula in mathematics

is more important to me than understanding why and how it works. SD D U A SA

11. A common difficulty with taking quizzes and exams in mathematics is that if you forget relevant formulas and rules you are lost. SD D U A SA

12. It is difficult to talk about mathematical ideas because all you can really do is explain how to do specific problems. SD D U A SA

13. Solving mathematics problems frequently involves exploration. SD D U A SA

14. Most mathematics problems are best solved by deciding on the type of problem and then using a previously learned solution for that type problem. SD D U A SA

15. I forget most of the mathematics I learn in a course soon after the course is over. SD D U A SA

16. Mathematics consists of many unrelated topics. SD D U A SA

17. Mathematics is a rigid, uncreative subject. SD D U A SA

18. In mathematics there is always a rule to follow. SD D U A SA

19. I get frustrated if I don't understand what I am studying in mathematics. SD D U A SA

20. The most important part of mathematics is computation. SD D U A SA

Yackel (1984)

Appendix B

Previous Mathematics Experiences Questionnaire

Please read each item carefully and circle only one number that best fits your mathematical experiences

SURVEY #: ______________

PRE-COLLEGE EXPERIENCES

1. How do you remember feeling about your mathematics experiences in grades K-8?

    (1) negative

    (2) somewhat negative

    (3) somewhat positive

    (4) positive

2. In your mathematics classes in grades K-8, how often did your teachers use manipulatives/teaching tools?

    (1) never

    (2) sometimes

    (3) always

3. How many math courses did you take in high school?

    (1) 1-2 (required courses)

    (2) 3-4 (required courses, plus some upper level courses)

    (3) more than 4 (including advanced level/AP courses)

4. Which methods of instruction did you experience in mathematics courses taken in high school?

    (1) mainly lecture/textbook driven

    (2) besides lecture/textbooks, discussion/discovery/exploration/group work/use of manipulatives

5. What method of assessment was used in your mathematics courses taken in high schools?

    (1) mainly tests/quizzes, homework

    (2) besides tests/quizzes, class presentations/portfolios/writing activities/ or projects

6. What was your general feeling about mathematics when you graduated from high school?

(1) negative

(2) somewhat negative

(3) somewhat positive

(4) positive

COLLEGE EXPERIENCES

7. How many undergraduate mathematics courses did you take in college?

(1) 1-2 (required courses)

(2) 3-4 (including required courses and some upper level courses)

(3) more than 4 (including required courses and advanced courses)

8. What method of instruction did you experience in undergraduate college mathematics content courses?

(1) mainly lecture/textbook driven

(2) besides lecture/textbooks, discussion/discovery/exploration/group work/ and use of manipulatives

9. What methods of assessment did you experience in undergraduate college mathematics content courses?

(1) mainly tests/quizzes

(2) besides tests/quizzes, class presentations/portfolios/writing activities/or projects

10. To what extent was technology incorporated into your undergraduate college mathematics content courses?

(1) occasionally

(2) often

11. What were your general feeling about mathematics after taking the undergraduate college mathematics content courses?

(1) negative

(2) somewhat negative

(3) somewhat positive

(4) positive

MATH METHODS GRADUATE COURSES

12. What methods of instruction did you experience in your graduate mathematics methods courses?

(1) mainly lecture/textbook driven

(2) besides lecture/textbooks, discussion/discovery/exploration/group work/ or use of manipulatives

13. What methods of assessment did you experience in your graduate mathematics method courses?

(1) mainly tests/quizzes

(2) besides tests/quizzes, class presentations/portfolios/writing activities/or projects

14. To what extent was technology incorporated into your graduate mathematics method course?

(1) occasionally

(2) often

15. What were your general feelings about mathematics after taking the graduate mathematics methods courses?

(1) negative

(2) somewhat negative

(3) somewhat positive

(4) positive

Praxis I Mathematics Test Score ________

16. Essay Question:

Describe the type of mathematics learning environment you wish to create for students in your own classroom.

1) Instrumental (driven by rules/procedures/memorization)

(2) Relational (driven by knowledge constructed based on what has been previously learned)

Explain in your own words.

Appendix C

May 20, 2002

Dear Colleague:

You have been selected to participate in a research study of the preparation of prospective elementary teachers. This study examines the beliefs about mathematics held by prospective elementary teachers, basic mathematics content knowledge and previous mathematics course experiences as recommended by the National Council of Teachers of Mathematics, the Mathematical Association of America and the National Council for Accreditation of Teacher Education. You represent the beginning of a new vision for elementary teacher education. You are a recent graduate, May 2002, of the first five-year program from the University with a B.S. Degree in Family and Child Development and a Masters Degree in Curriculum and Instruction, certified to teach grades PK-6.

Your participation in this study represents an opportunity for you to share your experiences as a student, your mathematics content knowledge and your beliefs about mathematics. Sharing your experiences will help teacher educators, like myself, better understand elementary teacher preparation as we develop and design programs, courses and field experiences for future prospective elementary teachers.

Please complete the Beliefs Survey and Experience Questionnaire that is enclosed and return them along with the signed informed consent in the self-addressed, stamped envelope **ASAP**. In order to insure an accurate assessment of the mathematical preparation of prospective elementary teachers, your participation in this study is critical. Without your assistance, this study would not be possible.

I am aware that this is a very busy time for all of you and I sincerely appreciate your willingness to share your expertise in an effort to further the understanding of the mathematical preparation of elementary teachers. All responses will remain strictly confidential. Results will be available upon completion of the study and can be obtained by contacting me at 540-961-2359.

Sincerely,

Mary A. Quillen	Dr. Gwen Lloyd	Dr. John K. Burton
Doctoral Candidate	Research Advisor	Advisor

Appendix D

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Prospective Participants
In Investigative Project

Title of Project: The Relationships Among Prospective Elementary Teachers' Beliefs About Mathematics, Mathematics Content Knowledge, and Previous Mathematics Course Experiences

Investigator (s): Principal: Mary Addington Quillen, Doctoral Candidate
Faculty Advisor: Dr. John K. Burton, Division Director, Department of Teaching & Learning, College of Human Resources and Education Research Advisor: Dr. Gwen Lloyd, College of Human Resources and Education, Department of Mathematics

I. The Purpose of the Research

The purpose of this study is to better understand the beliefs about mathematics held by prospective elementary teachers, their mathematics content knowledge and their previous mathematics course experiences. Research tells us that beginning teachers teach the way they have been taught and many of their instructional decisions are based on these experiences. Research further states that beliefs held by beginning teachers will determine if their instructional practices will follow "rule bound" or "reasoning" models. A beginning teacher's level of content knowledge of material they are expected to teach will greatly influence how well they understand and teach that content. This study will involve 40 prospective elementary teachers who are enrolled in the first five-year graduate level cohort and will be graduating May 2002. They have had an opportunity to engage in more content courses, more experiences in the classroom setting and more opportunities to develop their teaching skills than graduates in the previous four-year degree programs. This study will provide more information about the students who complete this program, how the additional course work and experiences enhance their skills and abilities as beginning teachers. It will also help me, as a teacher educator, to learn more about and understand the level of knowledge and experiences prospective elementary teachers bring to a teacher education program. Most prospective teachers are products of our public schools and it is believed that this study will help to better understand the nature of instruction in the public school classrooms.

There is a terrific shortage of teachers across the country, many schools are facing retirement of their experiences teachers at the rate of up to 40% a year. These beginning teachers are the future of our schools and our children's education and we must be very sure we are addressing all of their needs in order to provide the most effective teaching force possible. I believe that the only way to achieve this goal is to better understand our prospective teachers and their needs and this can only be done through continued research.

II. Procedures

A packet of information will be mailed to each of the 40 prospective participants. Included will be an Informed Consent to be signed and dated by the prospective participants, it includes the name and contact number for the principal investigator, the faculty & research advisors, the department reviewer and the Chair, IRB Research Division. The packet will include a Mathematical Beliefs Survey of 20 items and a Mathematics Background Survey of 18 items to measure past mathematics course experiences. It is estimated that both surveys can be completed in about one hour. After completion, they will be returned to the principal investigator in the self-addressed, stamped enveloped included in the packet.

III. Risks

There are no physical or mental risks to the prospective participants. The questions on the two surveys are questions the subjects have addressed in their course of study over the past five years as they began to think of themselves as teachers.

IV. Benefits of this Research

There are no benefits promised to you as individuals in return for your participation in this research study.

V. Extent of Anonymity and Confidentiality

Each prospective participant can be assured of anonymity and confidentiality. You will be assigned a survey number and all correspondence will be identified through that number. Mary A. Quillen, principal investigator will maintain a complete list of the names of all prospective participants and their assigned number and this list will not be shared with anyone. After the surveys are returned, the data entered into the statistical database the list of names and matching survey numbers will be destroyed. Any candidate selected to participate in an audio taped interview will only be identified by their survey number. Mary A. Quillen, principal investigator, will transcribe the interviews and the audiotapes will be erased.

VI. Compensation

It is understood that no form of compensation has been offered to the prospective participants as a means of encouraging their participation in this research study.

VII. Freedom to Withdraw

Prospective participants are free to withdraw from the study at any time without penalty. If you choose to withdraw, you will not be penalized in any way. It is requested that you notify Mary A. Quillen, principal investigator of your intention not to participate.

VII. Approval of Research

This research project has been approved, as required by the Institutional Review Board for Research involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department of Teaching and Learning.

IX. Prospective Participant's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities:

1. I will return the two completed surveys and signed informed consent to the principal investigator in the enclosed self-addressed, stamped envelope.
2. If I choose not to participate in the study I will advise the principal investigator in a timely manner.

X. Prospective Participant's Permission

I have read and understand the Informed Consent and conditions of this research project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

______________________________________ ________________________

Participant's Signature **Date**

Should I have any questions about this research or its conduct, I may contact:

Mary Addington Quillen 961-2359 mquillen@vt.edu
Principal Investigator **Phone** **e-mail**

John K. Burton, PhD / Gwen Lloyd, PhD 231-7020 / 231-5053
Research Faculty Advisor(s) **Phone**

Jan Nespor, PhD 231-8327
Departmental Reviewer **Phone**

David M. Moore, PhD 231-4991
Chair, IRB **Phone**
Research Division

Appendix E

MEMORANDUM

TO: Elementary Educators, Graduate Cohort 2002

FROM: Mary A. Quillen, Doctoral Candidate

DATE: June 20, 2002

RE: Return of survey, questionnaire, and consent for dissertation study, *Preparation of Prospective Elementary Teachers*

This is just a reminder regarding the survey and questionnaire you received concerning *The Preparation of Prospective Elementary School Teachers*. It is extremely important to the success of this study that you complete and return the surveys. The cohort consists of only 40 prospective elementary teachers and it is very important to have as close to 100% participation as possible. It will not require that you participate in an interview if this creates a hardship. Your response will be a valuable asset to future participates in the five-year graduate cohort. It will help to evaluate the program from the prospective of the participants.

If you have already returned the survey, questionnaire, and the consent please disregard this reminder. If you have not returned them, please consider doing so as soon as possible. If you have misplaced the original packet, please e-mail me at <mquillen@vt.edu> or contact me at 540-961-2359 for a second packet. I really appreciate your assistance with this study. Thank you for your valuable time.

Vita

Mary Addington Quillen

A. Professional Preparation

Clinch Valley College	Elementary Education (4-8)	B.S. (1985)
University of Virginia	Curriculum and Instruction	M.Ed. (1989)
Virginia Tech	Curriculum and Instruction	Ph.D. (2004)

B. Professional Experience

2002-present Part-time Research Faculty, Department of Teaching and Learning, Virginia Tech

2000-2002	Graduate Assistant, Department of Teaching and Learning, Virginia Tech
1998-2000	Classroom Teacher, Wise County School Division
1996-1998	Graduate Assistant, Department of Teaching and Learning, Virginia Tech
1985-1996	Classroom Teacher, Wise County School Division
1983-1985	Full Time Student, Clinch Valley College
1981-1983	Teaching Assistant, Wise County School Division and Part Time Student, Clinch Valley College
1974-1983	Teaching Assistant, Wise County School Division

C. Special Qualifications

1997-present Program Director - VA Tech Energy Education Graduate Program for Virginia Science Teachers, Virginia Tech